April 29, 2016

VIA ELECTRONIC FILING

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

Re: FirstLight Hydro Generating Company, FERC Project Nos. 2485 and 1889; Submission of Final License Application and Request for Waiver of Requirement to Include Draft Biological Assessment in Final License Application

Dear Secretary Bose:

Pursuant to the regulations of the Federal Energy Regulatory Commission (Commission or FERC), 18 C.F.R. §§ 5.17 and 5.18 FirstLight Hydro Generating Company (FirstLight) hereby submits this Final License Application (FLA) as part of the Integrated Licensing Process (ILP) for the relicensing of the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889) and Northfield Mountain Pumped Storage Project (Northfield Mountain Project, FERC No. 2485). The current licenses for both the Turners Falls and Northfield Mountain Projects expire on April 30, 2018.

FirstLight is seeking to combine the Turners Falls Project and Northfield Mountain Project into a single license, and requests that the single project be designated as the Northfield Project, comprised of two developments to be called the Turners Falls Development and Northfield Mountain Pumped Storage Development. The FLA refers to the two Developments and single Project.

Status of FERC-Approved Studies

On August 14, 2013, FirstLight filed with FERC its Revised Study Plan (RSP), which included a total of 38 studies (see Table 1). On August 27, 2013 Entergy Corporation announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the FirstLight Projects, would be closing by December 29, 2014[1]. With the closure of VY, certain environmental baseline conditions could have changed during the relicensing study period. On September 13, 2013, FERC issued its first Study Plan Determination (SPD) in which the revised plans for 20 studies were approved, or approved with FERC modifications. However, due to the impending closure of VY, FERC did not act on the remaining 18 aquatic related study plans. The SPD for these 18

[1] The decommissioning of VY began on December 29, 2014.

Gus Bakas
Director – Massachusetts Hydro

Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360
Tel. (413) 422-5915/ Fax. (413) 659-4459/
E-mail: Gus.Bakas@na.engie.com

studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013 regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPD on the remaining 18 studies on February 21, 2014, approving the RSP with certain modifications. An additional ichthyoplankton study resolving a study dispute was added later bringing the total number of studies to 39.

On September 14, 2015, FirstLight filed its Updated Study Report in which only summary reports were provided for many of the aquatic resource studies started in 2015. On January 15, 2016, FERC issued its Determination on Requests for Study Modifications and New Studies, requiring that FirstLight file addendums on two reports previously filed. On March 1, 2016, FirstLight filed 13 study reports and the two addendums. Based on the ILP schedule, FERC will issue its Determination on Requests for Study Modifications and New Studies by June 29, 2016. As noted in its March 1, 2016 letter transmitting study reports, unless otherwise directed by FERC in a revised process plan and schedule, FirstLight is proposing to file an additional 10 reports on October 14, 2016[2]. FirstLight proposes to undergo another study determination process—similar to the Initial Study Report, Updated Study Report, and the process initiated for the March 1, 2016 study reports—for those study reports to be filed on October 14, 2016. The dates for that process are set forth in Table 2, which also includes the other aspects of the ILP process plan and schedule through April 30, 2017.

FirstLight proposes not to undergo another study determination process for the study reports to be filed March 1, 2017. Given the small number of studies, FirstLight does not believe it would be an efficient use of the Commission's or relicensing participants' resources to schedule further study report meetings or establish yet another study determination process. By March 1, 2017, FirstLight's FLA will have been pending before the Commission for almost one year. Relicensing participants will be free to comment on any remaining study reports. If the Commission believes further information is needed with respect to any of these studies, then the Commission can issue additional information requests.

FirstLight's Proposal in the FLA and Plan to File an Amended FLA

The FLA includes a section on Proposed Actions and Alternatives, which typically includes, at a minimum, the no-action alternative and applicant's proposal. Since many of the key FirstLight and TransCanada studies are not yet final, it would be premature for FirstLight to develop a complete licensing proposal for operating the Project in the new license term at this time. Therefore, FirstLight's proposal is limited at this time to minor modifications to the Project boundary, use of more Upper Reservoir storage capacity at the Northfield Mountain Pumped Storage Development, the support of public recreation at the Project through a Recreation Management Plan, and the management of historic properties through a Historic Properties Management Plan (HPMP).

Given the status of the relicensing studies due to circumstances beyond FirstLight's control, portions of the FLA are not complete at this time. See 18 C.F.R. § 5.20(a)(1). However, once FirstLight's studies and TransCanada's studies are complete pursuant to FERC's revised process plan and schedule and FirstLight has had an opportunity to discuss the study results with resource agencies and other stakeholders, FirstLight will be in a better position to develop a comprehensive proposal for relicensing the Project. FirstLight proposes to file an amended FLA on April 30, 2017 to coincide with the deadline for TransCanada to file its FLA. The amended FLA will include analysis of final study results and a more complete proposal for future Project operations and protection, mitigation, and enhancement measures. FirstLight fully

[2] Note that on April 25, 2016 FirstLight agreed to conduct a second year of Study No. 3.3.20 *Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project* and are proposing to file a second year report or supplement the existing report on October 14, 2016 (this would bring the total number of studies to be filed on October 14, 2016 to 11).

anticipates that FERC's revised process plan and schedule will include an opportunity for stakeholders to comment on the amended FLA.

Request for Waiver of Draft Biological Assessment in Final License Application

FirstLight has been designated as the Commission's non-federal representative for purposes of information consultation under Section 7 of the Endangered Species Act (ESA), and would therefore typically file a draft biological assessment (DBA) with its FLA, pursuant to section § 5.18(b)(3)(ii) of the Commission's regulations. However, FirstLight cannot conduct a meaningful assessment of potential impacts of relicensing on ESA-listed species when several key relicensing studies are not yet complete. FirstLight therefore intends to develop a DBA once it completes its instream flow assessment (Study No. 3.3.1), and requests a waiver of the requirement to file a DBA with the FLA. FirstLight will include the DBA in its amended FLA.

Availability of FLA

Some information in the FLA is Critical Energy Infrastructure Information (CEII), which has been removed from the public version of the FLA. In accordance with the Commission's filing guidelines, all CEII is included in a separate volume and has been clearly marked as CEII, as it contains detailed Project facility diagrams and other information relating to the "production, generation, transportation, transmission, or distribution of energy." 18 C.F.R. § 388.113(c).

In addition, as part of the National Historic Preservation Act Section 106 consultation process and in accordance with 18 C.F.R. § 5.18(b)(3)(v), FirstLight is filing with the Commission a draft HPMP. The draft HPMP contains sensitive information regarding the specific location of cultural resources and historic properties which is not to be disclosed to the public under 18 § C.F.R. 5.6(d)(3)(x)(C) and 36 § C.F.R. 800.11(c). Accordingly, pursuant to 18 C.F.R. § 388.112(b), FirstLight requests that the HPMP be accorded privileged treatment and placed within the Commission's non-public file. The draft HPMP is being provided to the State Historic Preservation Offices for Vermont, New Hampshire, and Massachusetts, representatives of area Native American Tribes, local historical commissions, and FERC. FirstLight has requested that those stakeholders provide comments on the draft HPMP directly to FirstLight.

FirstLight is filing the FLA with the Commission electronically. To access the FLA on the Commission's website (http://www.ferc.gov), go to the "eLibrary" link, and enter the docket number, P-1889 or P-2485. FirstLight is also making the FLA available for download at the following website http://www.northfieldrelicensing.com (click on "Documents", and then "2015 Documents"), and is making a hard copy of the FLA, with the exception of the CEII and privileged information, available to the public at the Northfield Mountain Visitor's Center at 99 Millers Falls Road, Northfield, MA during regular business hours.

If you have any questions, or need additional information, please feel free to contact me.

Sincerely,

Gus Bakas
Director – Massachusetts Hydro
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360
Tel. (413) 422-5915/ Fax. (413) 659-4459/
E-mail: Gus.Bakas@na.engie.com

Table 1: Study Report Status Update

Study No.	Title	Study is Complete	Report filed on March 1, 2016	Date Report will be filed with FERC	Date FL is targeting to upload report to website	Comments
3.1.1	2013 Full River Reconnaissance	X				
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability			10/14/2016	6/30/2016	
3.1.3	Sediment Monitoring Study			10/14/2016	9/15/2016	
3.2.1	Water Quality Monitoring Study		X			
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot	X (addendum required)				Addendum filed on 3/1/2016
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station			10/14/2016	9/15/2016	
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad			10/14/2016	9/15/2016	
3.3.3	Evaluate Downstream Passage of Juvenile American Shad			10/14/2016	9/15/2016	
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls		X			
3.3.5	Evaluate Downstream Passage of American Eel			3/1/2017		
3.3.6	Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects		X			
3.3.7	Fish Entrainment and Turbine Passage Mortality Study			10/14/2016		
3.3.8	Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays		X			
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace		X			
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River		X			
3.3.11	Fish Assemblage Assessment		X			
3.3.12	Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station		X			
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat			10/14/2016	06/30/2016	
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	X				

Study No.	Title	Study is Complete	Report filed on March 1, 2016	Date Report will be filed with FERC	Date FL is targeting to upload report to website	Comments
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area			10/14/2016	06/30/2016	
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station			10/14/2016	09/15/2016	
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat	X				
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	X (addendum required)				Addendum filed on 3/1/2016
3.3.19	Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace			3/1/2017		
3.3.20	Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project		X	10/14/2016		Second year (2016) study is being conducted
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources		X			
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats	X				
3.5.1	Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species		X			
3.6.1	Recreation Use/User Contact Survey		X			
3.6.2	Recreation Facilities Inventory and Assessment	X				
3.6.3	Whitewater Boating Evaluation	X				
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats	X				
3.6.5	Land Use Inventory		X			
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use			10/14/2016	09/15/2016	
3.6.7	Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use	X				

Study No.	Title	Study is Complete	Report filed on March 1, 2016	Date Report will be filed with FERC	Date FL is targeting to upload report to website	Comments
3.7.1	Phase IA, IB, and Phase II Archaeological Surveys			TBD	NA (When complete, in accordance with FERC regulations, report will be filed with FERC as "privileged."	Phase IA report was filed in Dec 2014. A modified report was filed in May 2015. In its Phase IA report, FL stated that it would complete Phase IB and Phase II, if needed, in the event that it is determined that observed erosion is Project-induced, or that there are other Project-related effects.
3.7.2	Historic Structures Inventory and National Register Evaluation	X				
3.7.3	Traditional Cultural Properties Study	X				
3.8.1	Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation and Hydropower Generation			3/1/2017		

Table 2 includes the major steps in the relicensing schedule starting in September 2015 through March 1, 2017.

Tasks shown in blue are steps associated with the license application. Tasks in the other colors pertain to Integrated Licensing Process (ILP) process steps required by FERC.

- License Application
- Updated Study Report
- March 1, 2016 Study Reports
- October 14, 2016 Study Reports

Table 2: Relicensing Schedule – late 2015 and early 2017

FERC Reg	Lead	Activity	Timeframe	Due Date
§5.15(f)	FirstLight	File Updated Study Reports	No later than two years from Study Plan approval	09/14/2015
§5.15(c)(2)	FirstLight	Updated Study Results Meeting	Within 15 days of Updated Study Report	09/29-30/2015
§5.15(c)(3)	FirstLight	File Updated Study Results Meeting Summary	Within 15 days of Updated Study Results Meeting	10/14/2015
§5.15(c)(4)	Stakeholders/ FERC	File Updated Study Summary Disagreements/Modification to Study/Propose New Studies	Within 30 days of filing Meeting Summary	11/13/2015
§5.16(a)	FirstLight	File Draft License Application with the FERC and distribute to Stakeholders	Not later than 150 days before final application is due (final application is due 05/02/2016, 2 yrs prior to license expiration)	12/02/2015
§5.15(c)(5)	FirstLight	File Responses to Disagreements (if any)	Within 30 days of disputes	12/14/2015
§5.15(c)(6)	FERC	Resolution of Disagreements (if any)	Within 30 days of filing responses to disputes	01/13/2016
§5.15	FirstLight	Conduct 2016 Field Studies • Study 3.3.19 Ultrasonic Array • Study 3.3.20 Ichthyoplankton Entrainment (Year 2)	Spring and Fall 2016	
§5.16(e)	Stakeholders/ FERC	Comments on Draft License Application, Additional Information Request (if necessary)	Within 90 day of filing Draft License Application	03/01/2016
§5.15(f)	FirstLight	File Study Reports		03/01/2016
§5.15(c)(2)	FirstLight	Study Report Meeting	Within 15 days of filing Study Reports	03/16/2016
§5.15(c)(3)	FirstLight	File Study Report Meeting Summary	Within 15 days of Study Report Meeting	03/31/2016
§5.16(a)	FirstLight	File Final License Application	Two years prior to license expiration	05/02/2016
§5.15(c)(4)	Stakeholders/ FERC	File Updated Study Summary Disagreements/Modification to Study/Propose New Studies	Within 30 days of filing Meeting Summary	05/02/2016
§5.15(c)(5)	FirstLight	File Responses to Disagreements (if any)	Within 30 days of disputes	05/30/2016
§5.15(c)(6)	FERC	Resolution of Disagreements (if any)	Within 30 days of filing responses to disputes	06/29/2016

FERC Reg	Lead	Activity	Timeframe	Due Date
§5.15	FirstLight	Conduct 2016 Field Studies • Study 3.3.5 Downstream Passage of American Eel (Year 2)	Summer and Fall 2016	
§5.15(f)	FirstLight	File Study Reports		10/14/2016
§5.15(c)(2)	FirstLight	Study Report Meeting	Within 15 days of filing Study Reports	10/18/2016
§5.15(c)(3)	FirstLight	File Study Report Meeting Summary	Within 15 days of Study Report Meeting	10/23/2016
§5.15(c)(4)	Stakeholders/ FERC	File Updated Study Summary Disagreements/Modification to Study/Propose New Studies	Within 30 days of filing Meeting Summary	11/22/2016
§5.15(c)(5)	FirstLight	File Responses to Disagreements (if any)	Within 30 days of disputes	12/22/2017
§5.15(c)(6)	FERC	Resolution of Disagreements (if any)	Within 30 days of filing responses to disputes	01/23/2017
§5.15(f)	FirstLight	File Study Reports		03/01/2017
		File Amended Final License Application		04/30/2017

Before the Federal Energy Regulatory Commission

Final Application for New License for Major Water Power Project – Existing Dam

Northfield Project

Northfield Mountain Pumped Storage Project (FERC Project Number 2485)
Turners Falls Hydroelectric Project (FERC Project Number 1889)

FirstLight
GDF SUEZ

INITIAL STATEMENT
ADDITIONAL INFORMATION
VERIFICATION STATEMENT
- **EXHIBIT A- PROJECT DESCRIPTION**
- **EXHIBIT B- PROJECT OPERATIONS AND RESOURCE UTILIZATION**
- **EXHIBIT C- CONSTRUCTION HISTORY**
- **EXHIBIT D- STATEMENT OF COST AND FINANCING**
- **EXHIBIT E- ENVIRONMENTAL REPORT**
- **EXHIBIT F- GENERAL DESIGN DRAWINGS (CEII)**
- **EXHIBIT G- PROJECT BOUNDARY MAPS**
- **EXHIBIT H- PLANS AND ABILITY OF APPLICANT TO OPERATE THE PROJECT**

APRIL 2016

INITIAL STATEMENT PER 18 CFR § 4.51

Before the Federal Energy Regulatory Commission

Application for New License Major Water Power Project - Existing Dam

1. FirstLight Hydro Generating Company ("FirstLight" or "Applicant") applies to the Federal Energy Regulatory Commission ("Commission" or "FERC") for a new license for the existing Turners Falls Hydroelectric Project (Turners Falls Project), FERC Project Number 1889 and for the existing Northfield Mountain Pumped Storage Project (Northfield Mountain Project), FERC Project Number 2485, as described in the attached Exhibits. The current license for the Turners Falls Hydroelectric Project was issued on May 5, 1980 and expires on April 30, 2018. The license for the Northfield Mountain Project was issued on May 14, 1968 and also expires on April 30, 2018. Although the Turners Falls Project and Northfield Mountain Project are currently licensed as separate projects, FirstLight is seeking a single license for both developments, and will hereafter refer to the Turners Falls Project as the Turners Falls Development and the Northfield Mountain Project as the Northfield Mountain Pumped Storage Development or collectively as the Northfield Project (Project).

2. The location of the Project is:

The structures associated with the Turners Falls Development are located in the towns of Montague and Gill, MA. The Turners Falls bypass (Connecticut River) flanks the towns of Greenfield and Montague, MA. The Turners Falls Impoundment borders several towns including Gill, Montague, Northfield, and Erving, MA, with upper portions extending into Vernon, VT and Hinsdale, NH.

The structures associated with the Northfield Mountain Pumped Storage Development are located in the towns of Northfield and Erving, MA.

3. The exact name, address, and telephone number of the Applicant are:

FirstLight Hydro Generating Company
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360
Tel: 413-422-5915

The exact name, address, and telephone number of each person authorized to act as agent for the Applicant in this application are:

Mr. Gus Bakas
Director- Massachusetts Hydro
FirstLight Hydro Generating Company
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360
Tel: 413-422-5915
Email: gus.bakas@gdfsuezna.com

Mr. Michael A. Swiger, Esq.
Ms. Julia S. Wood, Esq.
Van Ness Feldman
1050 Thomas Jefferson Street, NW
Seventh Floor
Washington, DC 20007
Tel: 202-298-1800
Email: mas@vnf.com
jsw@vnf.com

4. The Applicant is a domestic corporation and is not claiming preference under section 7(a) of the Federal Power Act, 16 U.S.C. 796.

5. (i) The statutory or regulatory requirements of the State of Massachusetts which affect the Project as it exists with respect to bed and banks and the appropriation, diversion, and use of water for power purposes, and with respect to the right to engage in the business of developing, transmitting, and distributing power and in any other business necessary to accomplish the purpose of the license under the Federal Power Act, are:

- Applicant must obtain a Water Quality Certification from the Massachusetts Department of Environmental Protection and Section 401 (a)(1) of the Clean Water Act.

(ii) The steps which the Applicant has taken or plans to take to comply with the regulations cited above are:

- The Applicant will submit a request for Water Quality Certification from the Massachusetts Department of Environmental Protection within 60 days of FERC's issuance of a notice that the license application is ready for environmental analysis, as provided for in FERC's regulations. Since this is an application for relicensing two existing developments, the Applicant expects to continue to operate the facility pursuant to approvals, licenses, permits, and exemptions already in effect.

6. FirstLight owns all of the existing Project facilities; there are no Federally owned or operated facilities associated with this application.

ADDITIONAL INFORMATION REQUIRED BY 18 C.F.R. § 5.18(A)

1. **Identify every person, citizen, association of citizens, domestic corporation, municipality, or state that has or intends to obtain and will maintain any proprietary right necessary to construct, operate or maintain the project:**

   FirstLight has or intends to obtain and will maintain the proprietary rights necessary to construct, operate and maintain the Project.

2. **Identify (providing names and mailing addresses):**

   (i) Every county in which any part of the project and any Federal facilities that would be used by the project would be located;

   Franklin County government in Massachusetts was abolished in 1997, although the county continues to exist as a geographical and political entity. County-wide comprehensive planning responsibilities are undertaken by the Franklin Regional Council of Governments (FRCOG). The FRCOG's offices are located at:

   The Franklin Regional Council of Governments
   12 Olive Street, Suite 2
   Greenfield, MA 01301-3318

   Upper portions of the Turners Falls Impoundment extend into the following Vermont and New Hampshire counties:

   Windham County
   P.O. Box 784
   Brattleboro, VT 05302

   Cheshire County
   Administration
   33 West Street
   Keene, NH 03431

   (ii) Every city, town, or similar local political subdivision:

   i. In which any part of the Project, and any Federal facility that would be used by the project, would be located; or

   Town of Erving
   12 East Main Street
   Erving, MA 01344

   Town of Gill
   325 Main Street
   Gill, MA 01354

   Town of Greenfield
   14 Court Street
   Greenfield, MA 01301

   Town of Montague
   1 Avenue A
   Montague, MA 01376

   Town of Northfield
   69 Main Street
   Northfield, MA 01360

   Town of Vernon
   567 Governor Hunt Road
   Vernon, VT 05354

   Town of Hinsdale
   Town Hall
   11 Main Street
   Hinsdale, NH 03451

ii. **That has a population of 5,000 or more people and is located within 15 miles of the project dam.**

The following cities and towns each have a population of 5,000 or more people (2010 census data) and are located within 15 miles of the Project dams:

Town of Amherst (population: 37,819)
Town Clerk
Town Hall
4 Boltwood Avenue
Amherst, MA 01002

Town of Greenfield (population: 17,456)
Town Clerk
14 Court Street
Greenfield, MA 01301

Town of Athol
(population: 8,265)
Town Clerk
584 Main Street, Suite 10
Athol, MA 01331

Town of Hadley (population: 5,250)
Town Clerk
100 Middle Street
Hadley, MA 01035

Town of Brattleboro (population: 7,414)
Town Clerk
230 Main Street, Suite 108
Brattleboro, VT 05301

Town of Montague (population: 8,437)
Town Clerk
One Avenue A
Turners Falls, MA 01376

Town of Deerfield (population: 5,125)
Town Clerk
8 Conway Street
South Deerfield, MA 01373

Town of Orange (population: 7,839)
Town Clerk
6 Prospect Street
Orange, MA 01364

(iii) Every irrigation district, drainage district or similar special purpose political subdivision (A) in which any part of the project is located, and any Federal facility that is or is proposed to be used by the project is located, or (B) that owns, operates, maintains, or uses any project facility or any Federal facility that is or is proposed to be used by the project:

There is no irrigation district, drainage district, or similar special purpose political subdivision in which any part of the Project is located or that owns, operates, maintains, or uses any project facility.

(iv) Every other political subdivision in the general area of the Project that there is reason to believe would likely be interested in, or affected by, the application.

There is no other political subdivision in the general area of the Project that there is reason to believe would be likely to be interested in, or affected by, this notification.

(v) All Indian tribes that may be affected by the Project.

Federally recognized tribes in Massachusetts include:

Wampanoag Tribe of Gay Head (Aquinnah)
Bettina Washington, Tribal Historic Preservation Officer
20 Black Brook Road
Aquinnah, MA 02535-1546

Mashpee Wampanoag Indian Tribe
Ramona Peters, Historic Preservation Director
431 Main Street
Mashpee, MA 02649

Narragansett Indian Tribe
Doug Harris, Deputy Tribal Historic Preservation Officer
4425-A South County Trail
Charlestown, RI 02813

Stockbridge-Munsee Band of Mohican Indians
Bonney Hartley, Tribal Historic Preservation Assistant
New York Office, P.O. Box 718
Troy, NY 12181

There are no federally recognized tribes in New Hampshire or Vermont.

There are no state recognized tribes in Massachusetts or New Hampshire. There are two Vermont state-listed tribes as well as other tribes that may potentially be interested in the relicensing as listed below:

Nulhegan Abenaki Tribe
Chief Don Stevens
156 Bacon Drive
Shelburne, VT 05482

Koasek Tradional Band Abenaki Nation
Peggy Fullterton
P.O. Box 272
Newbury, VT, 05051

Abenaki Nation of Missisquoi
Chief Lawrence Moose Lampman
P.O. Box 133
Swanton, VT 05488

Elnu Abenaki Tribe
Robert Longtoe Sheehan
Tribal Headquarters
5243 VT Route 30
Jamaica, VT 05343

Nolumbeka Project, Inc.
Joseph Graveline, President
88 Columbus Avenue
Greenfield, MA 01301

3.

(i) For a license (other than a license under section 15 of the Federal Power Act), state that the applicant has made, either at the time of or before filing the application, a good faith effort to give notification by certified mail of the filing of the application to:

(A) Every property owner of record of any interest in the property within the bounds of the Project, or in the case of the Project without a specific boundary, each such owner of property which would underlie or be adjacent to any Project works, including any impoundments; and

(B) The entities identified in paragraph (2) above, as well as any other federal, state, municipal or other local government agencies that there is reason to believe would likely be interested in or affected by the application.

Because this is an application for a new license under section 15 of the FPA, this regulatory provision does not apply.

PURPA Benefits

FirstLight is not seeking any PURPA benefits in association with the relicensing of the Project.

VERIFICATION STATEMENT

This application is executed in the

STATE OF: Massachusetts

COUNTY OF: Franklin

By: Gus Bakas, being duly sworn, deposes and says that the contents of this application are true to the best of his knowledge or belief. The undersigned has signed the application this 27 day of April, 2016.

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

Subscribed and sworn to before me, a Notary Public of the State of Massachusetts, this 27 day of April 2016.

Notary Public

KRISTYN E. BATES
Notary Public
COMMONWEALTH OF MASSACHUSETTS
My Commission Expires
June 22, 2018

My Commission Expires: June 22, 2018

ACRONYMS AND ABBREVIATIONS

2D	two dimensional
3D	three dimensional
A	ampere
AC	alternating current
ACHP	Advisory Council of Historic Preservation
AMC	Appalachian Mountain Club
ARLAC	Ashuelot River Local Advisory Committee
AWWA	American Whitewater Association
CAFRC	Conte Anadromous Fish Research Center
CFR	Code of Federal Regulations
cfs	cubic feet per second
CFU	colony forming units
CL&P	Connecticut Light & Power
cm	centimeter
CRASC	Connecticut River Atlantic Salmon Commission
CRJC	Connecticut River Joint Commissions
CRSEC	Connecticut River Streambank Erosion Committee
CRWC	Connecticut River Watershed Council
CT	Connecticut
CTDEP	Connecticut Department of Environmental Protection
CTDEEP	Connecticut Department of Energy and Environmental Protection
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
°C	degrees Celsius
°F	degrees Fahrenheit
ft	foot or feet
ft^2	square feet
DLA	Draft License Application
DRTU	Deerfield River Chapter of Trout Unlimited
DO	dissolved oxygen
EA	Environmental Assessment
ECP	Erosion Control Plan
EFH	essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FCD	Franklin Conservation District
FCRP	Friends of the Connecticut River Paddlers
FEMA	Federal Emergency Management Agency
FERC or Commission	Federal Energy Regulatory Commission
FIS	Flood Insurance Study
FGS	Field Geology Services
FirstLight	FirstLight Hydro Generating Company
FLA	Final License Application
FPA	Federal Power Act
FRCOG	Franklin Regional Council of Governments
FRR	Full River Reconnaissance
FSF	Four Star Farms
GPD	gallons per day

HEC	USACE Hydrologic Engineering Center
HPMP	Historic Properties Management Plan
hr	hour
ILP	Integrated Licensing Process
ISR	Initial Study Report
ISO-NE	ISO New England
kV	kilovolt
kW	kilowatt
kWH	kilowatt-hour
l	liter
LCCLC	Landowners and Concerned Citizens for License Compliance
MA	Massachusetts
MAEOEEA	Massachusetts Executive Office of Energy and Environmental Affairs
MACRIS	Massachusetts Cultural Resources Information System
MADFW	Massachusetts Division of Fish and Wildlife
MAFBF	Massachusetts Farm Bureau Federation, Inc.
MAWMA	Massachusetts Water Management Act
MBI	Midwest Biodiversity Institute
MDEP	Massachusetts Department of Environmental Protection
m	meter
mi	mile
mg	milligram
MGD	million gallons per day
MHC	Massachusetts Historical Commission
mi^2	square miles
ml	milliliter
MOA	Memorandum of Agreement
msl	mean sea level
MVA	megavolt ampere
MW	megawatt
MWH	megawatt-hour
NEMBA	New England Mountain Biking Association
NEPA	National Environmental Policy Act
NEE	New England Environmental
NE FLOW	New England Flow
NEFU	New England Farmers Union
NEPOOL	New England Power Pool
NET	New England National Scenic Trail
NID	National Inventory of Dams
NIT	Narragansett Indian Tribe
NGVD29	National Geodetic Vertical Datum of 1929
NH	New Hampshire
NHDES	New Hampshire Department of Environmental Services
NHDHR	New Hampshire Division of Historical Resources
NHESP	Natural Heritage and Endangered Species Program
NHFGD	New Hampshire Fish and Game Department
NHPA	National Historic Preservation Act
NID	National Inventory of Dams
NLCD	National Land Cover Database
NMFS	National Marine Fisheries Service
NMTTC	Northfield Mountain Tour and Trail Center

NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NOI	Notice of Intent
NTU	Nephelometric Turbidity Unit
NU	Northeast Utilities
NWI	National Wetland Inventory
NY-ISO	New York ISO
O&M	operation and maintenance
PAD	Pre-Application Document
PCBs	polychlorinated biphenyls
PLC	Programmable logic controller
PM&E	Protection, Mitigation & Enhancement
PIT	passive integrated transponder
Project	Northfield Project (collectively the Northfield Mountain Pumped Storage Development and the Turner Falls Development)
PSP	Proposed Study Plan
PVPC	Pioneer Valley Planning Commission
QA/QC	quality control/quality assurance
REA	Ready for Environmental Analysis
RM	River mile
RTE	Rare, Threatened, and Endangered
RRA	River Residents Association
RSP	Revised Study Plan
S&A	Simons and Associates
SAV	submerged aquatic vegetation
SCORP	State Comprehensive Outdoor Recreation Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SHPO	State Historic Preservation Officer
SPDL	Study Plan Determination Letter
TDS	total dissolved solids
TFI	Turners Falls Impoundment
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
TN	total nitrogen
TNC	The Nature Conservancy
TP	total phosphorus
TSS	total suspended solids
Turners Falls Development	Turners Falls Hydroelectric Development
UMass	University of Massachusetts at Amherst
USACE	United States Army Corps of Engineers
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report
µS	microsiemens
UMass	University of Massachusetts at Amherst
VT	Vermont
VTANR	Vermont Agency of Natural Resources

VTDEC	Vermont Department of Environmental Conservation
VTDHP	Vermont Division of Historic Preservation
VTFWD	Vermont Fish and Wildlife Department
VY	Vermont Yankee Nuclear Facility
WMECO	Western Massachusetts Electric Company
WMA	Wildlife Management Area
WQC	Water Quality Certificate
YOY	young-of-the-year

Final Application for New License for Major Water Power Project – Existing Dam

Northfield Project
Northfield Mountain Pumped Storage Project (FERC Project Number 2485)
Turners Falls Hydroelectric Project (FERC Project Number 1889)

EXHIBIT A-PROJECT DESCRIPTION

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EXHIBIT A – PROJECT DESCRIPTION

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51(b) describes the required content of this Exhibit.

Exhibit A is a description of the project. This exhibit need not include information on project works maintained and operated by the U.S. Army Corps of Engineers, the Bureau of Reclamation, or any other department or agency of the United States, except for any project works that are proposed to be altered or modified. If the project includes more than one dam with associated facilities, each dam and the associated component parts must be described together as a discrete development. The description for each development must contain:

1. *The physical composition, dimensions, and general configuration of any dams, spillways, penstocks, powerhouses, tailraces, or other structures, whether existing or proposed, to be included as part of the project;*

2. *The normal maximum surface area and normal maximum surface elevation (mean sea level), gross storage capacity, and usable storage capacity of any impoundments to be included as part of the project;*

3. *The number, type, and rated capacity of any turbines or generators, whether existing or proposed, to be included as part of the project;*

4. *The number, length, voltage, and interconnections of any primary transmission lines, whether existing or proposed, to be included as part of the project (see 16 U.S.C. 796(11));*

5. *The specifications of any additional mechanical, electrical, and transmission equipment appurtenant to the project; and*

6. *All lands of the United States that are enclosed within the project boundary described under paragraph (h) of this section (Exhibit G), identified and tabulated by legal subdivisions of a public land survey of the affected area or, in the absence of a public land survey, by the best available legal description. The tabulation must show the total acreage of the lands of the United States within the project boundary.*

1 TURNERS FALLS DEVELOPMENT

The Northfield Project (Project) consists of the Turners Falls Development and Northfield Mountain Pumped Storage Development.

The Turners Falls Development is located on the Connecticut River in the Commonwealth of MA, and the states of New Hampshire (NH) and Vermont (VT) (Figure 1.0-1). The greater portion of the Turners Falls Development, including developed facilities and most of the lands within the Project boundary, is located in Franklin County, MA; specifically, in the towns of Erving, Gill, Greenfield, Montague and Northfield. The northern reaches of Project boundary extend into the town of Hinsdale, in Cheshire County, NH, and the town of Vernon, in Windham County, VT. The Turners Falls Dam is located at approximately river mile 122 (above Long Island Sound) on the Connecticut River, at coordinates 42°36'38.77" north and 72°33'05.76" west, in the towns of Gill and Montague, MA.

The Turners Falls Dam creates the Turners Falls Impoundment (TFI), which is approximately 20 miles long, and extends upstream to the base of TransCanada's Vernon Hydroelectric Project and Dam (FERC No. 1904). Most of the TFI lies in MA, however, approximately 5.7 miles of the northern portion of the impoundment is located in NH and VT. The TFI also serves as the lower reservoir for the Northfield Pumped Storage Development (described later).

The Turners Falls Dam is located on a "Z turn" in the river, and is oriented on a northeast-southwest axis, with the impounded area on the east side of the dam, and extending north. At the southwest end of the Turners Falls Dam is the gatehouse (Figure 1.0-2). Below the dam, originating at the gatehouse, is the Turners Falls power canal. Paralleling this power canal is a bypassed section of the Connecticut River. Associated with this power canal are the two hydroelectric generating facilities: Station No. 1 and Cabot Station. Station No. 1 is located approximately one-third of the way down the power canal. Water is conveyed from the power canal, to a small branch canal feeding the Station No. 1 turbines, before discharging into the bypassed reach of the Connecticut River. Cabot Station is located at the downstream terminus of the power canal, where it rejoins the main stem of the Connecticut River. Station No. 1 and Cabot Station discharge into the Connecticut River approximately 0.9 miles and 2.7 miles downstream of the Turners Falls Dam, respectively.

At Turners Falls Dam, the total drainage area is approximately 7,163 square miles (mi^2), or about 64% of the Connecticut River Basin drainage area (11,250 mi^2). The Connecticut River is the largest and longest river in New England, and is tidal up to Windsor Locks, CT, which is located approximately 60 miles from Long Island Sound.

The Turners Falls Development consists of: a) two individual concrete gravity dams separated by an island; b) a gatehouse controlling flow to the power canal; c) the power canal and a short branch canal; d) two hydroelectric powerhouses, located on the power canal, known as Station No. 1 and Cabot Station; e) a bypassed section of the Connecticut River and f) a reservoir known as the TFI. Each of these is described in detail below.

1.1 Turners Falls Dam

The Turners Falls Dam consists of two individual concrete gravity dams, referred to as the Gill Dam and Montague Dam, which are connected by a natural rock island known as Great Island. The 630-foot-long Montague Dam is founded on bedrock and connects Great Island to the west bank of the Connecticut River.

It includes four bascule[1] type gates, each 120 feet wide by 13.25 feet high and a fixed crest section which is normally not overflowed. All four bascule gates are operated by hydraulic cylinders. The bascule gate closest to the gatehouse (bascule gate no. 1) is typically used to provide any required flow releases to the bypass reach by means of "pond-following". Pond-following means that the gate can be set to discharge a certain magnitude of flow and the gate position automatically adjusts to release the same flow based on changes in the TFI elevation. The average height above bedrock is 35 feet and the dam crest elevation is 172.26 feet (NGVD29[2]). When fully upright, the top of the bascule gates are at elevation 185.5 feet.

The Gill Dam is approximately 55-feet-high and 493-feet-long extending from the Gill shoreline (east bank) to Great Island. It includes three 40-foot-wide by 39-foot-high tainter spillway gates. The tainter gates discharge water from the base of the gates. Each tainter[3] gate is operated by a motor/gearbox driving a torsion shaft connected to two lifting chains. When closed, the elevation atop the tainter gate is at elevation 185.5 feet.

1.2 Turners Falls Impoundment

The TFI, formed by the Turners Falls Dam, extends upstream approximately 20 miles to the base of TransCanada's Vernon Dam in Vernon, VT. To provide storage capacity for the Northfield Mountain Pumped Storage Development, the TFI elevation may vary, per the FERC license, from a minimum elevation of 176.0 feet to a maximum elevation of 185.0 feet constituting a 9 foot fluctuation as measured at the Turners Falls Dam. The usable storage capacity in this 9 foot fluctuation, as measured at the Turners Falls Dam, is approximately 16,150 acre-feet. This fluctuation decreases as one travels upstream. The impoundment has a surface area of approximately 2,110 acres and a gross storage volume of approximately 20,300 acre-feet at elevation 185.0 feet msl (as measured at Turners Falls Dam).

The TFI, between Turners Falls Dam and Vernon Dam, has a water surface profile that varies pending the magnitude of flow in the Connecticut River and the storage used for the Northfield Mountain Pumped Storage Development. The profile slope steepens as the magnitude of flow increases. At pinch-points or hydraulic controls such as at the French King Gorge, the water level upstream of the hydraulic control is higher than below. Under inflow above the useable Project capacity, the TFI level upstream of the Turners Falls Dam will exceed 185.5 ft in accordance with the river backwater curve and inflow amount.

1.3 Gatehouse

The power canal gatehouse is located on the Montague side of the Connecticut River. The gatehouse dimensions are 33 feet wide by 214 feet long. It forms the abutment for connecting the Montague Dam spillway with the shoreline and is equipped with headgates controlling flow from the TFI to the power canal. The structure is of masonry and reinforced concrete foundations with a brick walled superstructure. The gatehouse houses 15 operable gates controlling flow to the power canal. Six (6) of the gates are 10'-8" high

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[1] A bascule gate is a hinged crest gate. Each bascule gate is controlled by a pair of hydraulic cylinders, mounted in the concrete gravity dam.

[2] Unless otherwise noted in this License Application, reported elevations are based on the National Geodetic Vertical Datum (NGVD) of 1929.

[3] A tainter gate is a spillway gate whose face is a section of a cylinder; it rotates about a horizontal axis on the downstream end of the gate and can be closed under its own weight.

by 9 feet wide wooden gates and nine (9) of the gates are 12'-7" high by 9'-6" wide wooden gates. The Gatehouse fishway passes through the gatehouse at the east bank.

The local controls and operating equipment for the dam's bascule gates are in the gatehouse. They are normally operated remotely from the control room located at Northfield Mountain. The tainter gates are operated locally at the Gill Dam. The magnitude of flow passing through the gatehouse is a function of the gate(s) opening and the hydraulic head or the differential in the TFI elevation and the power canal elevation.

1.4 Power Canal

The power canal is approximately 2.1 miles long and ranges in width from approximately 920 feet in the Cabot forebay (downstream terminus of canal) to 120 feet in the canal proper. Under a normal power canal elevation of 173.5 feet, the power canal depth varies from 17 feet deep just below the Gatehouse to 30 feet deep above Cabot Station. The canal has a design capacity of approximately 18,000 cubic feet per second (cfs). There are several entities that have indentured rights to the first flows from the canal; Table 1.4-1 lists the water users, approximate hydraulic capacity, and FERC project number (where applicable).

Table 1.4-1: Entities Having Rights to Withdraw Water from Power Canal

Facility Name	Owner	Approximate Hydraulic Capacity (cfs)	FERC Project No.
Paperlogic	Southworth Company**	113 cfs	N/A
Turners Falls Hydro, LLC	Turners Falls Hydro**	288 cfs	2622
Station No. 1	FirstLight Hydro Generating Co.	2,210 cfs	1889
Cabot Station	FirstLight Hydro Generating Co.	13,728 cfs	1889
United States Geological Survey, Conte Anadromous Fish Laboratory	United States Geological Survey	Variable[4]	N/A

**Paperlogic[5] and Turners Falls Hydro, LLC[6] have indentured water rights. FirstLight currently has an agreement with each of these entities which provides that the entity will not generate power unless the hydraulic capacity of the Station No. 1 and Cabot stations is exceeded. The United States Geological Survey (USGS), which withdraws water for the Conte Anadromous Fish Laboratory, also has a water use agreement with FirstLight; however, its water use is minimal.

[4] Per Exhibit B of the May 25, 1988 conveyance agreement, the allowable withdrawal rate (in cfs) and number of days of withdrawal varies based on the month. It can range from a maximum of 200 cfs for 13 days in October to a minimum of 2 cfs for 28 days in February.

[5] A water use agreement between then Esleeck Manufacturing Company (a predecessor to Paperlogic) and then Turners Falls Power and Electric Company (a predecessor to FirstLight) was signed in August 1928.

[6] A water exchange agreement between then Keith Paper Company (a predecessor to Turners Falls Hydro, LLC) and then Western Massachusetts Electric Company (a predecessor to FirstLight) was signed in September 1951.

The power canal can be drained via the Keith Drainage Tunnel near the upper end of the power canal (between the gatehouse and Station No. 1 branched canal) and via a Lower Drainage Tunnel near Cabot (located just upstream of where the power canal widens above Cabot Station). The Keith Drainage Tunnel is constructed of concrete, is approximately 7 feet in diameter and 200 feet long. The Lower Drainage Tunnel is constructed of concrete, is approximately 5 feet in diameter and 955 feet long. The Lower Drainage tunnel is abandoned and has never been used. Both tunnels discharge into the Connecticut River.

1.5 Station No. 1

From the power canal there is an approximate 700-foot-long by 100-foot-wide branch canal. Under the normal power canal elevation of 173.5 feet, the depth of the branch canal ranges from 23 feet deep at the intersection of the power canal and branch canal to 16 feet deep in front of the Station No. 1 intake. At the end of the branch canal is the entrance to Station No. 1, consisting of eight bays, each 15 feet wide for a total intake width of 120 feet. Trashracks are angled across the entire entrance, totaling 120 feet wide by 20.5 feet high. With a normal canal elevation of approximately 173.5 feet, the effective trashrack opening is approximately 114 feet wide by 15.9 feet high, resulting in a gross area of 1,812.6 square feet (ft^2). The bar rack thickness is 0.375 inches and the bars are 3 inches on center, thus the clear spacing between bars is 2.625 inches.

After passing the trashrack, the intakes narrow down to four individual 13’-1.5” diameter steel penstocks, approximately 100 feet long, feeding the original seven horizontal Francis turbines housed in the powerhouse. The steel penstocks were lined with reinforced gunite. Only five of the turbines are operational. The powerhouse consists of brick masonry on concrete foundations. The powerhouse has five generators, all alternating current (AC) horizontal type, 60 cycle, and 2300 volt. The powerhouse dimensions are approximately 64 feet wide by 134 feet long.

Penstock 1 feeds Unit 1, penstock 2 feeds Units 2 and 3, penstock 3 feeds Units 4 and 5, and penstock 4 feeds Units 6 and 7. Note that penstock 2 bifurcates into pipes leadings to Unit 2 and Unit 3, penstock 3 bifurcates into pipes leading to Unit 4 and 5, and penstock 4 originally bifurcated into pipes leading to Units 6 and 7, but the branch pipe to Unit 6 was removed and a bulkhead was installed; Units 4 and 6 are no longer in service. The steel branch pipes leading to Units 2 and 4 are approximately 23 feet long and 5 feet in diameter. The branch pipe leading to Unit 2 is lined with epoxy reinforced with fiberglass. The main penstocks at Units 1, 3, 5, and 7 increase to 14 ft diameter at the upstream turbine, which is situated inside the penstocks. Station No. 1 operates under a gross head of 43.7 feet, and has an approximate total electrical nameplate capacity and hydraulic capacity of 5,693 kilowatts (kW) and 2,210 cfs, respectively.

The Station No. 1 steel draft tubes are approximately 21 feet long and 6.5 feet in diameter (the diameter does vary).

Table 1.5-1 includes information on Station No. 1’s generators and turbines. FirstLight does not throttle these smaller units, thus the minimum hydraulic capacity for each of the turbines listed below is unknown.

Table 1.5-1: Generator and Turbine Characteristics of Station No. 1

	Generators		Turbines			
Unit No.	**Electrical Capacity (kW)**	**Amps**	**Runner Size**	**Hydraulic Capacity (cfs)**	**Horsepower (hp)**	**Speed (rpm)**
1	1,500	376	2-48” horizontal double runners	560	2100	200
2*	365	—	1-33” horizontal runner	140	590	257

	Generators		Turbines			
Unit No.	Electrical Capacity (kW)	Amps	Runner Size	Hydraulic Capacity (cfs)	Horsepower (hp)	Speed (rpm)
3	1,276	314	2-42" horizontal double runners	500	1900	200
4						
5	1,276	252	2-39" horizontal double runner	490	1635	200
6						
7	1,276	251	2-42" horizontal double runner	520	1955	200
Total	**5,693**			**2,210**		

*Unit 2 is directly connected to a 1600 amp, 257 rpm, 115 volt exciter.

Transmission facilities at Station No. 1 include generator leads and the 2.4 kV bus. Station No. 1 has one bank consisting of a single, three phase, 4.8/6.0 VA, 13800-2400 volts, oil immersed, self-cooled transformer. Table 1.5-2 includes information on the generator leads.

Table 1.5-2: Generator Leads at Station No. 1

Leads	Length	Voltage	Conductors per phase
Unit 1 to bus	50'	2.4 KV	1
Unit 2 to bus	45'	2.4 KV	1
Unit 3 to bus	40'	2.4 KV	1
Unit 5 to bus	45'	2.4 KV	1
Unit 7 to bus	70'	2.4 KV	1
Bus to substation	110'	2.4 KV	4
To set up transformer	20'	2.4 KV	1

None of these items above are transmission voltage items.

The three single phase pole mounted station service transformers are rated 50KVA, 13800-480 WYE/277 V.

1.6 Cabot Station

Cabot Station is located at the downstream terminus of the power canal. The trashrack opening is 217 feet wide by 31 feet high, resulting in a gross area of 6,727 ft^2. The trashracks are angled, and include upper and lower racks. The top 11 feet of the upper racks have clear bar spacing of 0.94 inches (15/16-inch, and the bottom 7 feet of the upper racks have clear bar spacing of 3 9/16 inches. The entire 13 feet of the lower racks have clear bar spacing of 3 9/16 inches. After passing through the trashracks, flow is conveyed through one of six concrete penstocks to turbines housed in the powerhouse. Each penstock has three headgates followed by a 13'-6" high x 9'-4" wide section that join into one scroll. The total length of penstock from headgate to centerline of turbine is approximately 70 feet long. The powerhouse footprint is approximately 79.5 feet wide by 235 feet long. It is a brick and steel structure set on a concrete substructure on a rock foundation. It houses six identical vertical, Francis type, single runner turbines. At a 60-foot head, each unit is rated at 13,867 horsepower. The wicket gates for each unit are operated by two servomotors.

Each concrete draft tube is approximately 41 feet long and has a diameter of approximately 13.5 feet (the diameter varies between 12.5 feet and 14.5 feet).

Transmission facilities at Cabot Station consist of (i) generator leads and two 13.8 kV buses for three units each for a total of six units, (ii) one 13.8 kV transmission line, about 200 feet long and extending across the power canal to the Montague substation, and (iii) one 13.6/115 kV oil immersed air cooled transformer and appurtenant facilities. Table 1.6-1 includes information on the generator leads.

The six generators are 13.8 kV. Each unit has its own static excitation system rated at 160 volts DC, 781 amps.

Table 1.6-1: Generator Leads at Cabot Station

Leads	Length	Voltage	Conductors per phase
Unit 1 to bus	80’	13.8 KV	1
Unit 2 to bus	80’	13.8 KV	1
Unit 3 to bus	100’	13.8 KV	1
Unit 4 to bus	125’	13.8 KV	1
Unit 5 to bus	250’	13.8 KV	1
Unit 6 to bus	250’	13.8 KV	1
Bus to roof	60’	13.8 KV	4
Overhead cable to step up transformer	200’	13.8 KV	2

Cabot Station has a total station nameplate capacity of 62.016 megawatts (MW) or approximately 10.336 MW/unit. The station has a total hydraulic capacity of approximately 13,728 cfs or 2,288 cfs/unit. The minimum hydraulic capacity of a single unit is approximately 1,400 cfs.

At the downstream terminus of the power canal and adjacent to the Cabot Powerhouse are eight wooden 16’-8” high by 13’-7” wide spillway gates, which permit the discharge of approximately 12,000 cfs. These gates are used to rapidly draw down the power canal in the event of a Cabot Station load rejection or canal dike breach or to sluice ice and debris. In addition, there is a 16’-2” wide by 13’-1” high log sluice gate located at the downstream end of the forebay.

1.7 Fish Passage Facilities

1.7.1 Upstream Fish Passage Facilities

The Turners Falls Development is equipped with three upstream fish passage facilities, including (in order from downstream to upstream): the Cabot fishway, the Spillway fishway, and the Gatehouse fishway. These fish passage facilities were based on a design recommended by the United States Fish and Wildlife Service (USFWS). Fish ladders of similar design pass Pacific salmon species and American shad on the Columbia River. It was believed that these same designs could be applied to pass Atlantic salmon and American shad, the original target species. American shad is the primary species using these fish passage facilities.

The Cabot fishway is a modified “ice harbor” design; it consists of 66 pools, with each pool situated approximately one foot higher than the previous pool. Fish enter the Cabot fishway below Cabot Station. Fish pass through the Cabot fishway into the power canal; from there, they swim 2.1 miles upstream to the Gatehouse fishway. The dimensions of the Cabot fishway are 16 feet wide by 10 feet high by approximately 850 feet long. The hydraulic capacity of the Cabot fishway is approximately 33 cfs. The Cabot attraction flow is 400 cfs per the design specifications. A programmable logic computer (PLC) maintains a one foot differential at the ladder entrance. As the river level changes, the attraction gates will open to maintain the one foot differential. There are two attraction gates, each capable of 350 cfs.

Fish that bypass the Cabot fishway move upstream via the bypassed reach, where they will ultimately encounter the Turners Falls Dam. Fish arriving here are passed upstream via the Spillway fishway into a gallery leading to the Gatehouse fishway, where they rejoin fish that have passed to this point via the Cabot Ladder. The Spillway fishway is also of modified ice harbor design, with 42 pools. The dimensions of the Spillway fishway are 10 feet wide by 10 feet high by approximately 500 feet long. The hydraulic capacity of the Spillway fishway is approximately 18 cfs. The attraction flow is 64-400 cfs per the design specifications. A PLC maintains a one foot differential at the ladder entrance. As the river level changes, the attraction gates will open to maintain the one foot differential. There are two attraction gates, each capable of 350 cfs.

Fish from the upstream end of the power canal can enter the gallery via two entrances; a 70-foot-long flume extending into the canal on the river side of the canal, and a 5-foot-wide opening on the town side of the canal and are passed upstream of the gatehouse via the Gatehouse fishway. The Gatehouse fishway is a vertical slot fishway which delivers fish into the TFI to continue their journey up the Connecticut River. The dimensions of the Gatehouse fishway are 16 feet wide by 17.5 feet high at the entrance (21.5 feet high at the gatehouse) by approximately 225 feet long. The Gatehouse attraction flow is 400 cfs per the design specifications, but will vary with changing TFI elevation, power canal elevation and with varying flows in the entrance for the Gatehouse ladder. The slotted fishway flow, per modeling, is on average approximately 250 cfs, but could be as low as 210 cfs and as high as 270 cfs.

The Connecticut River Atlantic Salmon Commission (CRASC[7]) establishes an annual schedule for the operation of upstream fish passage facilities at the Connecticut River dams. The schedules are based on the projected movement of migratory fish and may be adjusted in season to address actual observations. Table 1.7.1-1 lists the 2016 schedule for upstream fish passage operations at the Turners Falls Development.

Table 1.7.1-1: Upstream Fish Passage Schedule for Cabot, Gatehouse, and Spillway Fishways

Development	Species	Life Stage	Dates of Operation	Hours of Operation
Turners Falls	Salmon	adult	Apr 7-Jul 15	24 hours/day
	Salmon	adult	Sep 15-Nov 15	24 hours/day
	shad & herring	adult	Apr 7-Jul 15	24 hours/day

Source: CRASC letter to FirstLight, 3/4/2016

Downstream Fish Passage Facilities

The downstream fish passage facility is located at Cabot Station, at the downstream terminus of the power canal. Assuming no spill is occurring at Turners Falls Dam, fish moving downstream pass through the gatehouse (which has no racks) and into the power canal. Downstream fish passage facilities at Cabot Station consist of: reduced bar-spacing in the upper 11 feet of the intake racks; a broad-crested weir with an elliptical floor developed specifically to enhance fish passage at the log sluice; the log sluice itself, which has been resurfaced to provide a passage route; above-water lighting; and a sampling facility. Although the log sluice gate is approximately 16 feet wide, there is an 8 foot wide weir that is inserted in the sluice opening during downstream fish passage season. The sluiceway is 6 feet high and 180 feet long. With the

[7] CRASC membership consists of the USFWS, NMFS, and state fishery agencies from CT, MA, NH, and VT.

weir in place, the amount of flow conveyed downstream varies based on the power canal elevation, but typically ranges from 110 to 253 cfs. During fish passage season, the gate is set 3.5 feet open if/when the weir is removed, which results in a flow of approximately 130 cfs.

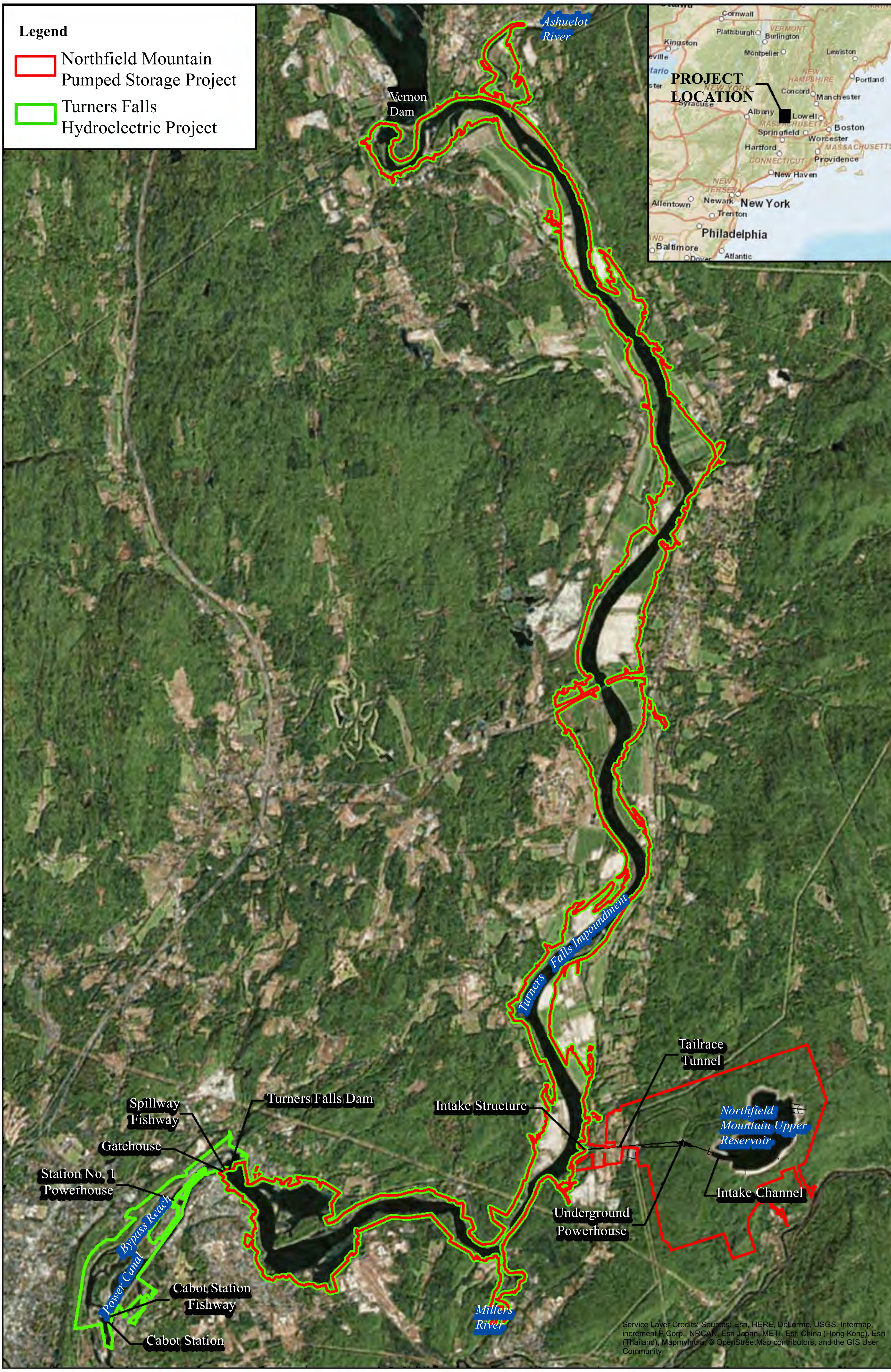
The log sluice gate can be lowered to an elevation of 163.6 ft, NGVD 1929 (i.e., open 11.5 feet). With the weir removed, and the gate fully open, the log sluice can pass approximately 1,600 cfs.

As described for upstream passage, the CRASC also establishes an annual schedule for the operation of downstream fish passage facilities at the Connecticut River dams. Table 1.7.1-2 lists the 2016 schedule for downstream fish passage operations at the Project.

Table 1.7.1-2: Downstream Fish Passage Schedule

Development	Downstream Fish Passage Exit	Species	Life Stage	Dates of Operation	Hours of Operation
Turners Falls	Log sluice and trash sluice	salmon	smolt	Not required	24 hours/day
		salmon	adult	Oct 15-Dec 31[1]	24 hours/day
		shad	adult	Apr 7-Jul 31	24 hours/day
		shad	juvenile	Aug 1-Nov 15	24 hours/day
		eels	adult	Sep 1-Nov 15	24 hours/day

[1]Downstream passage operation, for adults will only be required if 50 or more adults are documented as passing upstream of a dam/facility.
Source: CRASC letter to FirstLight, 3/4/2016



FirstLight
GDF SUEZ

N

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit A

0 0.5 1 2 Miles
1 in = 1 miles

Figure 1.0-1
Turners Falls Development and Northfield Development Boundary Map

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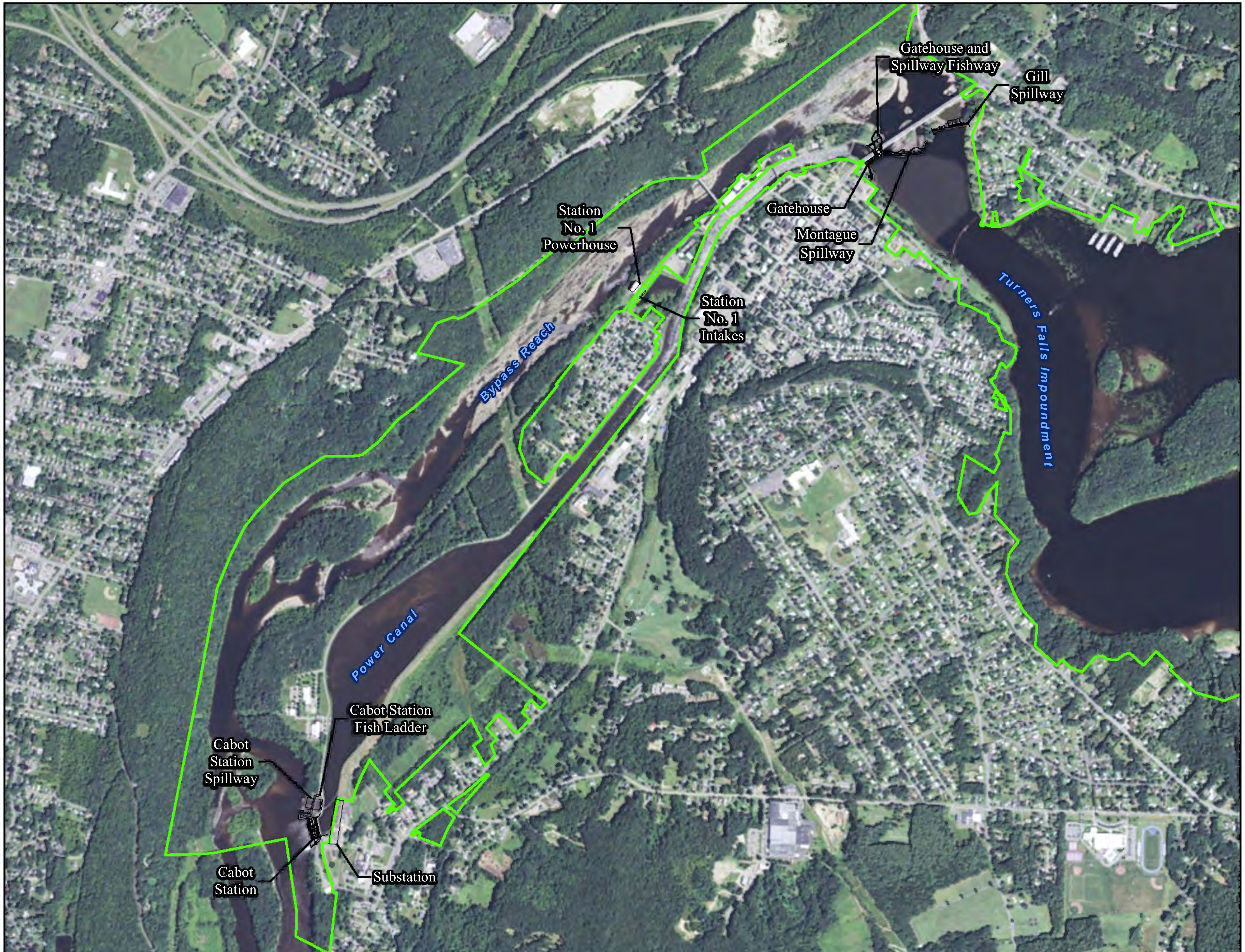

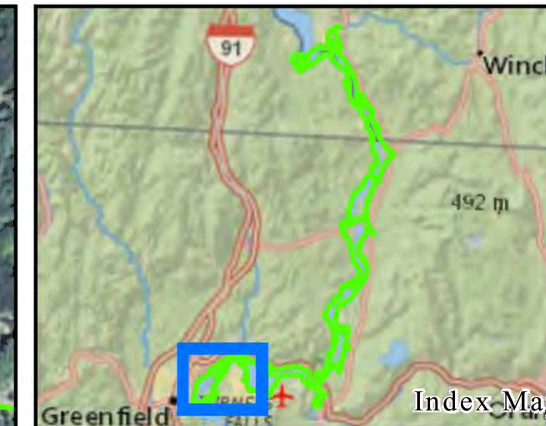

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit A

Figure 1.0-2
Turners Falls Development
Features

Legend

Project Boundary

N

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1 inch = 1,200 feet

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2 NORTHFIELD MOUNTAIN PUMPED STORAGE DEVELOPMENT

The Northfield Mountain Pumped Storage Development (Figure 2.0-1) is a pumped-storage facility located on the Connecticut River in Massachusetts (MA) that uses the TFI as its lower reservoir. The tailrace of the Northfield Mountain Pumped Storage Development is located approximately 5.2 miles upstream of Turners Falls Dam, on the east side of the TFI. The Development's Upper Reservoir is a man-made structure situated atop Northfield Mountain, to the east of the Connecticut River. During pumping operations, water is pumped from the TFI to the Upper Reservoir. When generating, water is passed from the Upper Reservoir through an underground pressure shaft to a powerhouse cavern and then a tailrace tunnel delivers the water back to the TFI.

The Northfield Mountain Pumped Storage Development consists of: a) the Upper Reservoir dam/dikes; b) an intake; c) pressure shaft; d) an underground powerhouse; and c) a tailrace.

2.1 Northfield Mountain Upper Reservoir Dams and Dikes

Main Dam

The crest of this structure, known as the Main Dam, is at elevation 1010 feet, and is 30 feet wide, with a 2 foot high rock/earthfill wave berm along the upstream edge. The height of the Main Dam varies between 30 to 140 feet; it is approximately 1 mile long. The upstream slope is 1:1.8 (V:H) (the top 15 feet of the upstream slope is at a steeper 1:1.5 slope); downstream slope = 1:1.6. The top of impervious core is at elevation 1005.25 feet. The core is 12 feet wide with 3:1 (V:H) upstream and downstream slopes. The core is founded on sound groutable rock at approximately elevation 860 feet. There are sand and gravel filter zones upstream and downstream of the impervious core. Oversize rock zones form the upstream and downstream faces. The impervious core was raised in 1979 on the downstream portion of the crest in the Main Dam to elevation 1006.25 feet from station 3+00 to station 31+00 in response to settlement shortly after construction. This dam contains an intake structure at station 27 + 28 and sub-foundation pipe for possible future water-supply diversion to the Quabbin Reservoir, a principal water supply for the City of Boston and parts of the Greater Boston metropolitan area. The base of the intake structure is at elevation 921 ft and the top is at elevation 1010 ft. The structure is designed with two 7 ft x 9 ft sluice gates and an 8 ft ID outlet pipe with invert elevation of 923 ft. The Main Dam has a 24-inch diameter x 589 foot long low level outlet pipe at station 8 + 00 with an inlet at elevation of 893 ft, with a Gage House at the end.

Three Vertical Impervious-Core Rock-Fill Dikes

The three dikes, known as the North, Northwest and West Dikes, are constructed in a similar manner and to the same crest elevation as the main rock fill dam, with a central impervious core-filter and compacted rock-filled embankments. They help form the Upper Reservoir. The North dike is approximately 25 feet high and 425 feet long. The Northwest dike is approximately 45 feet high and 2,800 feet long. The West dike is approximately 40 feet high and 1,700 feet long.

Concrete Gravity Dam

Located at the west end of the intake channel, the concrete gravity dam is 327 feet long and 10-20 feet high, with a crest at elevation 1010 feet. The downstream face has been back-filled to elevation 1002 feet. The concrete walls at both ends of the gravity section are constructed to a higher level, allowing a parapet wall to be constructed against the retaining wall on the right side of the intake. The remaining section, approximately perpendicular to the main section, varies from 5-10 feet in height.

Intake Channel

The intake channel directs water from the Upper Reservoir into the pressure conduit intake. The channel is 1,890 feet long and is excavated in rock with side slopes of 4:1 (V:H). The invert is 130 feet wide at elevation 880 feet. There is a small check dam (submerged) at the upstream end of the intake channel with a stoplog and gate structure. The purpose of this control structure, a low dam between the Upper Reservoir and intake channel, is to prevent stormwater from entering the pressure conduit when the intake channel is dewatered. The submerged check dam is 63 feet long and approximately 9 feet high with a crest at elevation 900 feet. It has two manually operated sluice gates (2.75 feet high by 6 feet wide), two 18 foot wide stoplog slots which usually hold eight concrete stoplogs (weighing approximately 3,000 lbs each).

Concrete Gravity Spillway Structure

The ungated concrete gravity overflow structure is 550 feet long with a crest elevation of 1006.5 feet. There is a 20 foot long notch at elevation 1005.0 feet near the center of the structure which is designed to concentrate small discharges due to precipitation and runoff when the reservoir is full. The overflow spillway is approximately 6 feet high on the upstream side. The remaining spillway length has been sized to prevent overtopping of the embankments due to over-pumping.

2.2 Pressure Shaft

The pressure conduit system consists of a reinforced concrete intake portal, a 200 foot long concrete lined transition section, a portal 55 feet wide by 80 feet high, an inclined concrete-lined pressure shaft connecting the intake and manifold shaft (31 feet diameter, 853 feet long, inclined 50º from the horizontal), concrete-lined manifold formed by branching of the pressure shaft into two 22 feet diameter conduits (approximately 100 to 150 feet long) and then into four 14 feet diameter tunnels leading to four steel-lined penstocks (340 feet long, diameter decreases from 14 to 9.5 feet). During pumping operation, water is pumped from the TFI through a tailrace tunnel to the powerhouse cavern and then through the pressure shaft to the Upper Reservoir. During generation, water flows from the Upper Reservoir back through the pressure shaft to the powerhouse and then the tailrace tunnel delivers the water back to the TFI.

2.3 Tailrace Tunnel

Water flows between the powerhouse cavern and the TFI via the tailrace tunnel. There are four 11 foot diameter concrete draft tubes, approximately 25 feet long[8] connected by a manifold to a common tailrace tunnel. The tailrace tunnel is concrete-lined, horseshoe shaped and 5,136 feet long, with a maximum width of 33 feet and a height of 31 feet. The tunnel discharges during generation through a concrete exit structure into the TFI. The exit structure includes a transition from the horseshoe shape into a trapezoidal shape. Steel stop logs (approximately 35 feet long and 8 tons each) are used in the exit structure when needed to dewater the tailrace tunnel; the stoplogs are stacked to a total height of approximately 40 feet when in use. A floating boom, approximately 400 feet long, is provided across the exit channel to provide a barrier to large debris and boaters.

The trapezoidal trashrack opening has the following dimensions: top width: 99’-6”, bottom width: 74’4”, depth: 48’-0”, resulting in a gross area opening of 4,400 ft^2. The bar thickness is 0.75 inches, with a clear-spacing of 6 inches.

[8] The length does not include a transition to a 17 foot diameter draft tube, which is approximately 20 feet long.

2.4 *Upper Reservoir*

The Upper Reservoir, formed by the Main Dam, the Rockfill Dikes, and the Concrete Gravity Dam, has a gross storage capacity of 17,050 acre-feet. Per the current FERC license for the Northfield Mountain Pumped Storage Development, the Upper Reservoir may operate between 1000.5 feet and 938 feet (constituting a 62.5 foot drawdown), which equates to a useable storage capacity of approximately 12,318 acre-feet. This is equivalent to approximately 8,729 MWhs (formerly 8,475 MWhs) of stored energy. The surface area at elevations 938 and 1000.5 feet are 134 and 286 acres, respectively. The Upper Reservoir was constructed to accommodate an elevation of 1004.5 feet as approved by FERC in 1976. In addition, the reservoir retains useable storage capacity down to elevation 920 feet. The useable storage volume between elevation 1004.5 feet and 920 feet is approximately 15,327 acre-feet, which is equivalent to approximately 10,779 MWhs (formerly 10,465 MWhs) of stored energy. FirstLight has received temporary amendments from FERC in the past to use more of the Upper Reservoir Storage. Most recently, from December 1, 2015 to March 31, 2016 FirstLight was granted a temporary amendment from FERC to use the storage between elevations 1004.5 feet and 920 feet.

2.5 *Powerhouse*

The underground powerhouse is 328 feet long and 70 feet wide, the floor of the spherical valve gallery is at elevation 56 feet, the roof is at 190 feet. It contains four reversible pump/turbines operating at gross heads ranging from 753 to 824.5 feet. Each of the four units has an electrical capacity of 291.7 MW, for a total station nameplate capacity of 1,166.80 MW. Historically, the total station capacity was 1,080 MW (270 MW/unit); however, Units 2, 3 and 4 underwent efficiency improvements with the replacement of the turbine runner, and rewind of the motor-generator[9]. A new runner was installed in Unit 1 in 2004, and the rewind commenced in August 2015 and was completed in February 2016.

When operating in a pumping mode, the maximum hydraulic capacity (4 pumps) is approximately 15,200 cfs (3,800 cfs/pump). Alternatively, when operating in a generation mode, the approximate maximum hydraulic capacity (4 turbines) is approximately 20,000 cfs (5,000 cfs/turbine). The minimum flow to safely spin one unit and produce power is approximately 2,300 cfs.

At the north end of the underground powerhouse is a ventilation and emergency access shaft from elevation 123 feet to elevation 751 feet. The shaft is 18 feet in diameter at the lower end and 15 feet in diameter at the upper end. At the ground level opening of the shaft is the ventilation shaft house. The shaft provides ventilation for exhaust air from the powerhouse, ventilation for intake and exhaust air from the surge shafts, access to the powerhouse by means of stairs, and access to the surge gallery and draft tube gantry crane from the powerhouse.

Transmission Facilities

Each of the four generators is connected to its respective unit breaker by means of an Iso phase bus. Each pair of units is provided with a dual secondary step-up transformer (rated 345/13.8 kV, 666 MVA, 3 phase, 60 cycle) to step from 13.8 kV generating voltage up to 345 kV. Each transformer is located in a vault, excavated in the rock adjacent to the powerhouse. For these two transformers, power is transmitted through two 345 kV pipe type cables, installed in the access tunnel (approximately 24 feet high by 26 feet wide by

[9] On August 17, 2011, and supplemented on January 17, 2012, February 14, 2012, and February 24, 2012, FirstLight filed an amendment application to revise the authorized installed capacity of Northfield Mountain. FERC issued an order amending the license and revising annual changes on March 23, 2012.

2,365 feet long), to the Northfield Switching Station which is located near the access tunnel. Table 2.5-1 includes information on the generator leads.

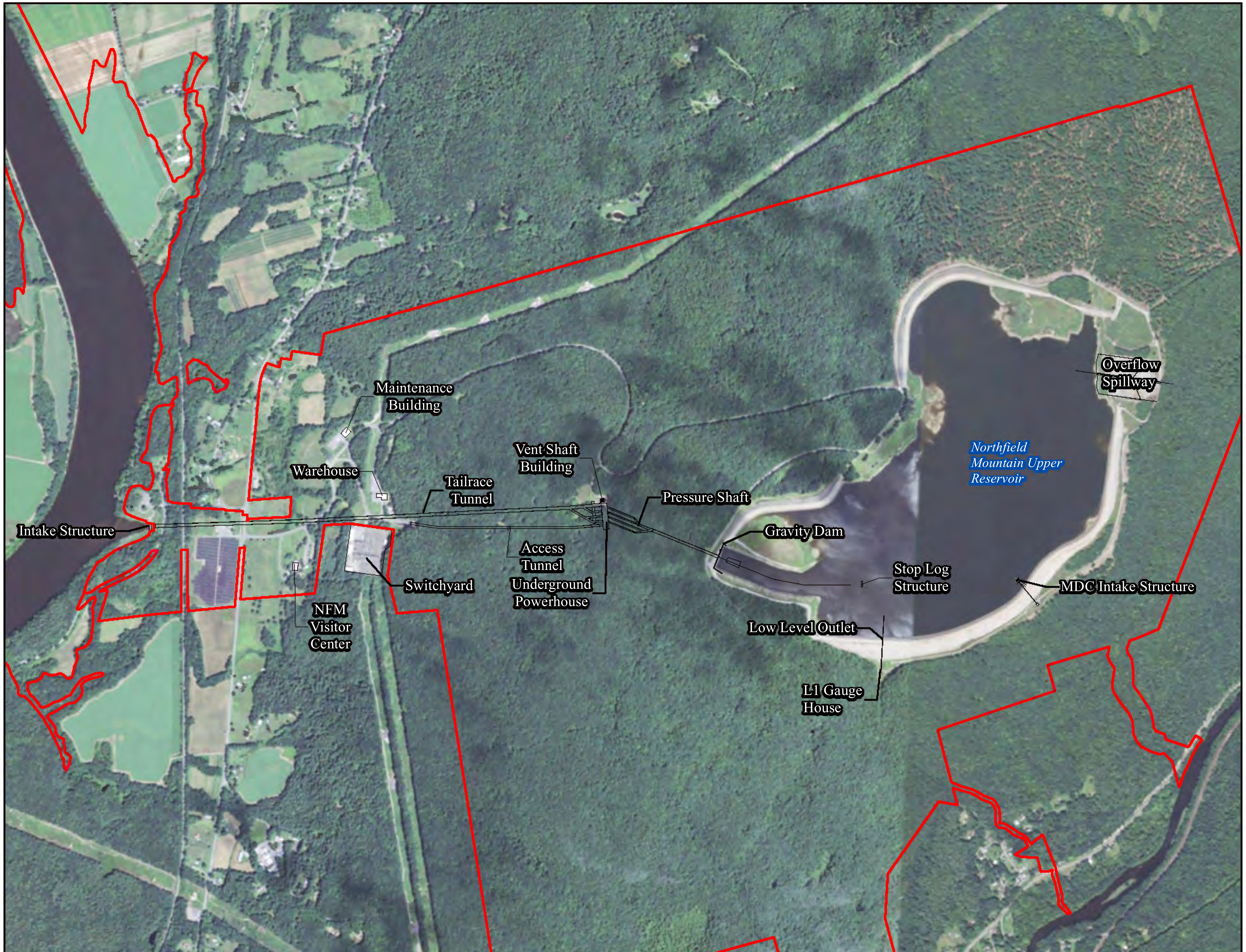
Table 2.5-1: Generator Leads at Northfield Mountain Pumped Storage Facility

Leads	Length	Voltage	Conductors per phase
Unit 1 to1X Transformer	26’	13.8 KV	1
Unit 2 to 1X Transformer	26’	13.8 KV	1
1X Transformer to Switching Station	3000’	345 KV	1
Unit 3 to 3X Transformer	26’	13.8 KV	1
Unit 4 to 3X Transformer	26’	13.8 KV	1
3X Transformer to Switching Station	3000’	345 KV	1

The pipe cables to the switchyard are of transmission voltage.

2.6 Fish Passage Facilities

A fixed-position guide net approximately 650 feet long by 15 feet deep, has historically been deployed since 1995 to reduce entrainment of Atlantic salmon smolts in flows pumped from the TFI to the Upper Reservoir during downstream migration. After the initial evaluation in 1995, further net modifications were field tested in 1996 and 1997. Since then, the guide net has been deployed annually during downstream smolt migration season. During the period when the guide net was installed, FirstLight limited the number of pumps operating to a maximum of three during the downstream migration. In 2015, the CRASC agreed to not require the installation of the barrier net. In 2016, CRASC did not require installation of the barrier net. This decision was based on concerns for a variety of potential negative impacts or other effects to the relicensing studies being conducted in 2015. The barrier net is not intended to be installed in 2016 and thereafter.



FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit A

Figure 2.0-1
Northfield Mountain Pumped Storage
Development Features

Legend

Project Boundary

N

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0 600 1,200 2,400 Feet

1 inch = 1,200 feet

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3 ADDITIONAL EQUIPMENT

The Project also includes various turbine governors, generator exciters, batteries, control panels and circuit breakers.

4 LANDS OF THE UNITED STATES

There are approximately 20 acres of federal lands within the current Project boundary associated with the USGS's Conte Anadromous Fish Laboratory. However, the proposed Project boundary would not include any federal lands, because the lands are not needed for project purposes.

Final Application for New License for Major Water Power Project – Existing Dam

Northfield Project
Northfield Mountain Pumped Storage Project (FERC Project Number 2485)
Turners Falls Hydroelectric Project (FERC Project Number 1889)

EXHIBIT B-PROJECT OPERATION AND RESOURCE UTILIZATION

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EXHIBIT B – PROJECT OPERATION AND RESOURCE UTILIZATION

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (c) describes the required content of this Exhibit.

Exhibit B is a statement of project operation and resource utilization. If the project includes more than one dam with associated facilities, the information must be provided separately for each such discrete development. The exhibit must contain:

(1) A statement whether operation of the powerplant will be manual or automatic, an estimate of the annual plant factor, and a statement of how the project will be operated during adverse, mean, and high water years;

(2) An estimate of the dependable capacity and average annual energy production in kilowatt hours (or a mechanical equivalent), supported by the following data:

(i) The minimum, mean, and maximum recorded flows in cubic feet per second of the stream or other body of water at the powerplant intake or point of diversion, with a specification of any adjustments made for evaporation, leakage, minimum flow releases (including duration of releases), or other reductions in available flow; monthly flow duration curves indicating the period of record and the gauging stations used in deriving the curves; and a specification of the period of critical streamflow used to determine the dependable capacity;

(ii) An area-capacity curve showing the gross storage capacity and usable storage capacity of the impoundment, with a rule curve showing the proposed operation of the impoundment and how the usable storage capacity is to be utilized;

(iii) The estimated hydraulic capacity of the powerplant (minimum and maximum flow through the powerplant) in cubic feet per second;

(iv) A tailwater rating curve; and

(v) A curve showing powerplant capability versus head and specifying maximum, normal, and minimum heads;

(3) A statement, with load curves and tabular data, if necessary, of the manner in which the power generated at the project is to be utilized, including the amount of power to be used on-site, if any, the amount of power to be sold, and the identity of any proposed purchasers; and

(4) A statement of the applicant's plans, if any, for future development of the project or of any other existing or proposed water power project on the stream or other body of water, indicating the approximate location and estimated installed capacity of the proposed developments.

1 EXISTING AND PROPOSED PROJECT OPERATIONS

1.1 Existing Project Operation

The Turners Falls Development consists of two facilities- Cabot Station and Station No. 1. Cabot Station is used at all river flows. During low flow periods, Cabot Station is operated as a peaking plant; during high flows in excess of 13,728 cfs (its approximate maximum hydraulic capacity), it operates as a base load plant. Station No. 1 is a base load plant and typically operates when inflows to the Turners Falls Impoundment (TFI) are less than Station No. 1's hydraulic capacity of approximately 2,210 cfs or when inflows exceed the hydraulic capacity of Cabot Station.

The Northfield Mountain Pumped Storage Development is a pumped storage hydroelectric facility. Water is pumped from the TFI to the Upper Reservoir which has 12,318 acre-feet of useable storage available for pumped storage operations. Typically, pumping occurs during low-load periods when energy costs are low, while generation occurs during high-load periods when energy costs are high.

2 PROPOSED PROJECT OPERATIONS

At the time of filing the license application, not all of the FirstLight studies are complete. As such, FirstLight has not finalized its proposed operation for the Project. However, FirstLight is proposing to utilize more of the Upper Reservoir storage capacity. As noted in Exhibit A, the current FERC license allows the Upper Reservoir to operate between 1000.5 feet to 938 feet, for a 62.5 foot drawdown. FirstLight proposes to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown.

2.1 Annual Plant Factor

The average annual plant factor is determined using the following equation:

Average Annual Generation/Nameplate Capacity x 8,760 hrs per year= Avg. Annual Plant Factor

The Turners Falls Development has an average annual generation of approximately 328,022 MWh per year for the period 2000-2014, and an annual plant factor of approximately 55% (328,022/593,043) based on its current combined nameplate capacities of Cabot Station and Station No. 1 of 62.016 MW and 5.683 MW, respectively (total of 67.699 MW).

The Northfield Mountain Pumped Storage Development has an average annual generation of approximately 1,053,891 MWh per year and an average annual energy consumption of approximately 1,437,464 MWh/year for the period 2000-2014 (excluding 2010 due to the Northfield Mountain Pumped Storage Development being out of operation for several months). The Northfield Mountain Pumped Storage Development's annual plant factor is approximately 11% (1,053,891/9,804,192) based on a nameplate capacity of 1119.2 MW per FERC Order issued March 23, 2012 after the efficiency improvements on Units 3 and 2. On May 23, 2014, FirstLight notified the FERC of the completion of the efficiency upgrade of Unit 4, and on March 2, 2016, FirstLight notified the FERC of the completion of a generator rewind of Unit 1. The current nameplate capacity of the Northfield Mountain Pumped Storage Development, as reflected in FERC's records, is 1,166.80 MW.

2.2 Operation During Adverse, Mean, and High Water Years

Under the current FERC license, to provide the storage capacity for pumped storage operations of the Northfield Mountain Pumped Storage Development, the water level of the TFI can vary from a minimum elevation of 176.0 feet to a maximum operating elevation of 185.0 feet as measured at the Turners Falls Dam. Also under the current FERC license, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow, whichever is less below the Turners Falls Development. Below is a summary of how the Turners Falls Development and Northfield Mountain Pumped Storage Development operate over a range of flow conditions.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are < 1,433 cfs (Minimum Flow)

When naturally routed flows are very low, i.e. less than 1,433 cfs (current minimum flow), FirstLight generally maintains the TFI elevation between 180.5 and 182.0 feet to create sufficient hydraulic head to pass flow through the gatehouse.

At flows less than 1,433 cfs, Cabot Station does not operate and Station No. 1 operates as a run-of-river facility. Station No. 1 generally operates over two flow ranges as follows: a) at low flows (too low to operate one turbine at Cabot); and b) at flows exceeding Cabot's hydraulic capacity of approximately 13,728 cfs.

Bypass flows are provided at Turners Falls Dam as required for fishery needs during certain periods of the year. If bypass flows are required, they are provided by bascule gate No. 1 closest to the gatehouse.

At these low flows (less than 1,433 cfs), the Northfield Mountain Pumped Storage Development may operate during peak hours of the day or when the price of power is high, while pumping back typically at night or when the price of power is less. The number of turbines operating and the magnitude of generation flow will vary depending on demand.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 1,433 cfs and 13,728 cfs (Cabot Capacity)

Under moderate flow conditions, i.e., naturally routed flows are between 1,433 cfs and 13,728 cfs (river flow exceeds 13,728 cfs approximately 34% of the time), the TFI elevation is typically managed around elevation 180.5 feet, but fluctuates under these inflow conditions due to Vernon peaking operations, Cabot peaking operations, and the pumping/generating cycle at the Northfield Mountain Pumped Storage Development. Under most circumstances, the TFI elevation fluctuates between 180.5 and 184.0 feet under these inflow conditions. The target elevation in the power canal at the Cabot forebay remains at 173.5 feet.

When naturally routed flows are between 1,433 cfs and 13,728 cfs (the approximate hydraulic capacity of Cabot Station), FirstLight will typically operate Cabot Station, while Station No. 1 remains idle. Depending on the inflow, electrical demand or energy pricing, Cabot Station may be operated as a peaking facility, with the number of peaks per day varying with electrical demand and / or price. If demand and / or price are high, such as in the summer and winter, Cabot may be peaked twice a day, in the morning and late afternoon. Outside of these hours, Cabot's generation is typically curtailed to base load needs, by reducing the flow through the gatehouse. Excess inflow to Turners Falls Dam is stored within the TFI. If inflow is consistently in the 13,728 cfs range, Cabot will operate continuously at full capacity.

In the summer and winter seasons, the Northfield Mountain Pumped Storage Development typically peaks twice a day- in the morning and late afternoon. During other months, commonly called shoulder months, the Northfield Mountain Pumped Storage Development may be peaked one to two times a day, pending electrical demand and / or price. In both cases, water is typically pumped back to the Upper Reservoir during the night or during low energy priced hours.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 13,728 cfs and 15,937 cfs (full capacity of Station No. 1 and Cabot)

Under these flow conditions, operations are similar to above; however, Cabot is typically operated at full hydraulic capacity, while the remaining flow is passed through Station No. 1. On an annual basis, river flow exceeds 15,937 cfs approximately 28% of the time.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 15,937 cfs and 30,000 cfs

Under normal to somewhat high flows, as the naturally routed inflow to the TFI exceeds the hydraulic capacity of Cabot and Station No. 1, both facilities operate at full capacity. Per the agreement with the United States Army Corps of Engineer (USACE) as required by Article 32 of the Turners Falls Project license (May 5, 1980 FERC License), and Article 43 of the Northfield Mountain Project license, the maximum TFI elevation during inflows of this magnitude is 186.5 feet, although FirstLight typically opens the bascule gates at the Turners Falls Dam, as needed, to maintain the TFI elevation closer to 180-182 feet. On an annual basis, river flow exceeds 30,000 cfs approximately 11% of the time.

Per the USACE agreement, FirstLight must release water through Cabot and Station No.1 and via the Turners Falls Dam gates so that at the start of the Northfield pumping, there is enough water stored in the TFI to restore the Upper Reservoir to its full capacity.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 30,000 cfs and 65,000 cfs

When flows are in this high range, Turners Falls Development and Northfield Mountain Pumped Storage Development operations are generally the same as above, with one exception: the USACE requires that FirstLight draw the TFI elevation down as far as possible, but not below elevation 176.0 feet. In drawing the TFI down, discharges cannot be increased by more than 10,000 cfs per hour above the naturally routed flows. The TFI elevation is maintained down until the naturally routed flow drops below 30,000 cfs or the actual discharge exceeds 65,000 cfs. When the actual discharge past Turners Falls Dam rises to 65,000 cfs (river flow exceeds 65,000 cfs approximately 1% of the time), the discharge is maintained at 65,000 cfs until the TFI elevation has fallen to 176.0 feet or the TFI begins to rise, at which point a constant TFI elevation is maintained.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows are between 65,000 cfs and 126,000 cfs

Per the USACE agreement, when the naturally routed flow exceeds 65,000 cfs, but is expected to be less than 126,000 cfs (this flow is very rarely exceeded), the outflow at Turners Falls should be regulated according to the operating schedule of the Northfield Mountain Pumped Storage Development. If the Northfield Mountain Pumped Storage Development is operating, it is required to keep the combined useable volume of the Upper Reservoir and TFI constant. If the Northfield Mountain Pumped Storage Development is not operating, it is required to keep the TFI elevation constant until the spillway gates are wide open.

Turners Falls Development and Northfield Mountain Pumped Storage Development Operations when Naturally Routed Flows exceed 126,000 cfs

When the naturally routed flow is expected to be greater than 126,000 cfs, the operating rules continue to require the following: if the Northfield Mountain Pumped Storage Development has not been operating in the previous hour, it is required to maintain a constant TFI elevation. If the Northfield Mountain Pumped Storage Development has been operating in the previous hour, it is required to maintain a constant combined useable storage volume.

2.3 HEC-ResSim Operations Model

FirstLight developed an operations model to better understand how operational changes at the three[1] TransCanada hydroelectric projects and FirstLight's Northfield Project affect the timing of river flows and energy generation. The model takes into account each Project's engineering data and operational constraints, such as current FERC licensed water level fluctuations and minimum flow requirements. The model outputs include hourly flow and generation from the TransCanada and FirstLight hydroelectric facilities.

The model calibration procedure involved adjusting several model parameters and constraints to reasonably match historic (2002-2003) Project data (flow, stage, generation). The calibrated model was subsequently updated to reflect today's equipment; this model is termed the baseline model. The baseline model was subsequently used to predict the impact of Project operations on generation over a longer-term period (1960-2013).

Some sections of this license application, including Exhibit D and Exhibit E-Developmental Analysis, utilize the Baseline model outputs. Sections using model outputs will explicitly state when model results (as opposed to actual data) are presented.

3 DEPENDABLE CAPACITY AND AVERAGE ANNUAL GENERATION

3.1 Estimate of Dependable Capacity and Average Annual Generation

The net dependable capacity of the Turners Falls Development is 67.699 MW (62.016 MW at Cabot and 5.683 MW at Station No. 1).

The net dependable capacity of the Northfield Mountain Pumped Storage Development is 1,166.8.

Average annual generation of the Turners Falls Development for the period 2000-2014 was 328,022 MWh. The monthly and annual generation at the Turners Falls Development for the period 2000-2014 is provided in Table 3.1-1.

Average annual net generation at the Northfield Mountain Pumped Storage Development for the period 2000-2014 (excluding 2010) was 1,053,891 MWh. Average annual pumping generation use by the Northfield Mountain Pumped Storage Development for the same time period was 1,437,464 MWh. The monthly and annual net generation and pumping energy use for the period 2000-2014 is provided in Table 3.1-2 and Table 3.1-3, respectively.

3.2 Streamflow

FirstLight estimates the total instantaneous inflow to the TFI – referred to as the naturally routed flow-- as the sum of the Vernon Hydroelectric Project discharge and inflow from two larger tributaries equipped with United States Geological Survey (USGS) gages – the Ashuelot and Millers Rivers. The drainage areas at the Vernon Dam and Turners Falls Dam are 6,266 square miles (mi^2) and 7,163 mi^2, respectively, a difference of 897 mi^2. Thus, 87% of the inflow to the TFI is controlled by the Vernon Hydroelectric Project. Information on the Ashuelot and Millers Rivers is shown in Table 3.2-1.

[1] TransCanada is in the process of relicensing three projects in series on the Connecticut River located immediately upstream of the Turners Falls Development and having the same license expiration date of April 30, 2018 as the FirstLight Projects. They included in upstream to downstream order: Wilder Hydroelectric Project (FERC No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855) and the Vernon Hydroelectric Project (FERC No. 1904).

Table 3.2-1: USGS Gages on Tributaries to the Turners Falls Impoundment

Gage No.	Gage Name	Period of Record	Drainage Area	Regulation
01161000	Ashuelot River at Hinsdale, NH	1907-current	420 mi^2	Regulated by Corps Storage Reservoir- Surry Dam since 1941.
01166500	Millers River at Erving, MA	1915-current	372 mi^2	Regulated by Corps Storage Reservoirs- Tully Dam and Birch Hill Dams since 1949 and 1941, respectively.

The total drainage area of these two gages is 792 mi^2, which represents 88% (792/897) of the remaining drainage area.

TransCanada reports the Vernon Hydroelectric Project discharge to FirstLight, including flow through the Vernon turbines (total station hydraulic capacity of 17,130 cfs) plus any spill via the gates. Spill at Vernon is estimated via rating curves for the various gates.

FirstLight sums the reported Vernon Hydroelectric Project instantaneous discharge plus the flow contributions from the Millers and Ashuelot Rivers as measured at the USGS gages and then adjusts it based on the travel time required to reach the Turners Falls Dam. FirstLight refers to the adjusted flow on its log sheets as the "natural routed flow". Note that the electronically available data is only available for the period 2000-2014. Thus, to estimate the inflow to Turners Falls Dam over a long period of record a different method was used to estimate inflow as described below.

The Connecticut River flow at the Turners Falls Dam was estimated using two USGS gages as listed in Table 3.2-2.

Table 3.2-2: USGS Gages to Estimate inflow to Turners Falls Dam

Gage No.	Gage Name	Period of Record	Drainage Area	Regulation
01170500	Connecticut River at Montague City, MA	1904-current	7,860 mi^2	Regulated seasonally by dams on the CT River (and other major tributaries): First and Second CT Lakes, Moore Reservoir and Comerford Reservoir.
0117000	Deerfield River at West Deerfield, MA	1940-current	557 mi^2	Regulated seasonally by dams on the Deerfield River: Somerset and Harriman Reservoirs.

The Montague USGS gage is located approximately 4,500 feet downstream of the Cabot Powerhouse. It represents the total flow on the Connecticut River including flow from the Deerfield River. The Deerfield River USGS gage is located further upstream from its confluence with the Connecticut River. As noted above, the drainage area of the Connecticut River at the Turners Falls Dam is 7,163 mi^2. The additional drainage area at the Montague USGS gage compared to the Turners Falls Dam is 697 mi^2, of which the bulk of the increase is attributable to the Deerfield River (557 mi^2 as measured at the USGS gage and 665 mi^2 as measured at its confluence with the Connecticut River). The Deerfield River gage flow was prorated by a factor of 1.25 (697/557) to represent the additional flow from the 697 mi^2 drainage area. This prorated flow was then subtracted from the corresponding flow measured at the Montague USGS Gage to estimate the flow at Turners Falls Dam. The following equation was applied to estimate the flow at Turners Falls Dam:

$Q_{Turners\ Falls\ Dam} = Q_{Montague\ USGS\ Gage} - 1.25(Q_{Deerfield\ USGS\ Gage})$, where

$Q_{Turners\ Falls\ Dam}=$	calculated approximate inflow to Turners Falls Dam (cfs)
$Q_{Montague\ USGS\ Gage}=$	flow recorded at the Montague USGS Gage (cfs)
1.25 =	ratio of the drainage areas (697/557)
$Q_{DeerfieldUSGS\ Gage}=$	flow recorded at the Deerfield USGS gage (cfs)

The annual and monthly mean and median flows, and flow per square mile of drainage area at the Turners Falls Dam was calculated for the period 1940-2013 as shown in Table 3.2-3.

Table 3.2-3: Estimated Connecticut River at Turners Falls Dam Drainage Area= 7,163 mi^2, Period of Record Oct 1941-Dec 2013 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	10,153	9,753	18,889	33,399	19,513	11,848	8,207	7,447	6,328	11,701	13,940	14,504	14,008
Mean/ mi^2	1.42	1.36	2.64	4.66	2.72	1.65	1.15	1.04	0.88	1.63	1.95	2.02	1.96
Median	7,862	7,699	13,450	30,163	17,200	8,893	4,908	4,104	4,072	6,038	9,883	9,525	8,464
Median/ mi^2	1.10	1.07	1.88	4.21	2.40	1.24	0.69	0.57	0.57	0.84	1.38	1.33	1.18

Figures 3.2-1 through 3.2-5 show the annual and monthly flow duration curves representing calculated Turners Falls Dam average daily flows, respectively.

3.3 Area Capacity Curve

The TFI stage versus storage curve is shown in Table 3.3-1 and plotted in Figure 3.3-1. The TFI licensed operating range is between 185 feet and 176 feet, a 9 foot fluctuation providing a total usable storage of approximately 16,150 acre-ft. The TFI has a surface area of approximately 2,110 acre at elevation 185 ft.

The Upper Reservoir stage versus storage curves is shown in Table 3.3-2 and plotted in Figure 3.3-2. The Upper Reservoir licensed operating range is between 1000.5 and 938 ft, a 62.5 foot fluctuation providing a total usable storage of 12,318 acre-feet. As noted earlier, FirstLight is proposing to increase the Upper Reservoir storage operating limits to be between 1004.5 ft and 920 ft, a 84.5 foot fluctuation providing a total usable storage of 15,327 acre-ft. The Upper Reservoir has a surface area of approximately 278 acres at elevation 1000.5 ft.

Combined Useable Storage Volume in the Northfield Mountain Pumped Storage Development System

The combined useable volume in the Northfield Mountain Pumped Storage Development is the sum of useable water volumes in the Upper Reservoir and the TFI. At any given time, a comparison of the actual combined useable storage volume and the useable storage in the full Upper Reservoir (12,318 acre-feet) provides an indication of whether the TFI useable storage volume is adequate for filling the deficit in the Upper Reservoir. The useable volume in the Upper Reservoir plus the useable volume in the TFI equals 12,318 acre-feet when the system is balanced. At any given time three situations are possible as follows:

- *Combined Useable Storage = 12,318 acre-feet*. This indicates a balanced condition, where the total storage in the TFI and Upper Reservoir is 12,318 acre-feet.
- *Combined Useable Storage < 12,318 acre-feet*. This indicates there is insufficient water available in the TFI to refill the Upper Reservoir. During periods of low flow, this deficiency can be rectified by curtailing generation at Cabot or Station No. 1 to allow the TFI to fill.
- *Combined Useable Storage > 12,318 acre-feet*. This indicates there is more than enough water available in the TFI to refill the Upper Reservoir.

In general, FirstLight strives to maintain a near balanced condition or a positive imbalance where the combined useable storage is close to 12,318 acre-feet.

3.4 Hydraulic Capacity

The Turners Falls Hydroelectric Development includes two facilities – Station No. 1 and Cabot Station located on the power canal. Unit hydraulic capacities of Station No. 1 are shown in Table 3.4-1. At Station No. 1, only five (5) of the seven (7) turbines are operational. The total hydraulic capacity of Station No. 1 is 2,210 cfs.

Table 3.4-1 Station No. 1 Hydraulic Capacity

Unit No.	Hydraulic Capacity (cfs)
1	560
2*	140
3	500
4	--
5	490
6	--
7	520
Total	2,210

*Unit No. 2 is directly connected to a 1600 amp, 257 rpm, 115 volt exciter.

Cabot Station has six identical turbines for a total hydraulic capacity of 13,728 cfs or approximately 2,288 cfs/turbine.

The Northfield Mountain Pumped Storage Development includes four reversible pump turbines. The hydraulic capacity of the Northfield Mountain Pumped Storage Development when in a pumping and generating mode is approximately 15,200 cfs (3,800 cfs/pump) and 20,000 cfs (5,000 cfs/turbine), respectively.

3.5 Tailwater Rating Curve

Station No. 1 discharges into the Turners Falls bypass reach further upstream than Cabot Station. The Station No. 1 tailwater rating curve is shown in Figure 3.5-1.

Cabot Station discharges into the end of the Turners Falls bypass reach. The Cabot Station tailwater rating curve is shown in Figure 3.5-2.

The Northfield Mountain Pumped Storage Development uses the TFI as its lower reservoir. TFI elevations reflect multiple influences, including operations of the Vernon Hydroelectric Project, Northfield Mountain Pumped Storage Development, and Turners Falls Development. Therefore, Northfield Mountain Pumped Storage Development hourly operations do not necessarily correlate with TFI elevations, such that a traditional tailwater elevation versus plant discharge relationship can be produced. However, FirstLight maintains a long-term water logger in the Northfield Mountain tailrace and hourly TFI elevations at the tailrace are electronically available for the period 2000-2014. An elevation duration curve was developed at the Northfield Mountain tailrace as shown in Figure 3.5-3. The tailrace elevation generally ranges from 181.1 ft (90% exceedance elevation) to 184.9 ft (10% exceedance elevation).

3.6 Powerplant Capability versus Head Curve

Head (feet) versus generation capacity (kW) curves for Station No. 1 and Cabot Station are shown in Figure 3.6-1 and 3.6-2, respectively.

Head versus generation capacity curves for the Northfield Mountain Pumped Storage Development is shown in Figure 3.6-3.

4 UTILIZATION OF PROJECT POWER

The primary purpose of the Project is to supply energy, capacity, regulation and other ancillary services to the New England ISO Interconnection, a regional transmission organization that coordinates the movement of wholesale electricity.

The Northfield Mountain Pumped Storage Development typically pumps water to the Upper Reservoir during the low cost hours of the night, when the power demand is low and generates during the higher priced hours of the day when power demand is high. The Northfield Mountain Pumped Storage Development provides critical energy, operating reserves and operational flexibility to ISO-NE system operation. The fact that ISO-NE, as part of its daily operational planning processes, can rely on the Northfield Mountain Project to supply these operational flexibilities from a certain fuel supply is of high value to ISO-NE and the New England region. In many periods, this significant supply of operational flexibility has avoided the commitment of many other less flexible resources to provide for a more efficient system dispatch. This peak load ability provides rapid response power resources to the grid to prevent regional blackouts.

Storage provides other important reliability benefits to the system. These include helping to manage light load, or excess generation conditions during off peak periods and the ability to respond very quickly to energy and operating reserve needs on the power system during any time of the day or year. New England is deficient in flexible, quick-start capacity today and will remain so for at least the near future.

In the future, if wind and solar energy were to expand considerably in the Northeast, it is possible there could be surplus power from these sources on the grid during the daytime. If these conditions were to occur, it is possible that the Northfield Mountain Pumped Storage Development could pump water to the Upper Reservoir during low demand daytime hours when the price of power is low.

5 PLANS FOR FUTURE DEVELOPMENT

There are no plans for future development of the Project. Pending the magnitude of any future minimum flow releases from the Turners Falls Dam, FirstLight may evaluate installing a minimum flow turbine-generator in the future.

Table 3.1-1.Turners Falls Development- Summary of Monthly and Annual Generation (MWH) for 2000 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	28,432	18,654	38,145	34,688	39,156	26,144	13,313	22,643	10,714	15,350	23,739	23,573	294,551
2001	21,281	19,462	21,789	23,905	27,295	16,773	6,504	1,875	2,766	4,012	9,147	13,482	168,291
2002	12,713	19,935	31,642	38,169	38,051	28,866	13,579	6,776	7,017	11,432	22,380	22,830	253,390
2003	18,684	14,809	24,167	41,200	40,239	21,315	7,551	19,320	15,825	25,252	26,701	26,774	281,837
2004	25,901	15,833	26,903	33,799	35,155	20,759	13,250	22,084	28,301	16,303	23,364	39,848	301,500
2005	34,623	21,565	25,497	39,151	42,809	36,913	20,571	10,860	13,190	27,190	34,807	35,016	342,192
2006	37,182	35,423	31,076	42,935	38,360	41,285	27,079	26,590	12,804	32,698	43,538	43,658	412,628
2007	26,814	17,662	31,725	39,604	41,986	22,144	21,251	10,740	6,579	22,768	36,026	33,569	310,868
2008	38,050	39,282	43,283	37,361	32,209	27,491	28,503	37,856	16,278	23,966	36,272	42,953	403,504
2009	31,690	23,968	44,716	43,861	39,277	29,916	42,117	33,954	10,548	29,548	39,309	40,310	409,214
2010	31,416	27,633	41,142	43,506	32,466	20,856	14,012	13,797	7,541	37,047	38,314	35,832	343,562
2011	26,269	19,431	39,341	39,448	45,213	34,294	14,704	18,156	25,336	38,674	35,033	44,346	380,245
2012	34,633	25,227	40,104	30,139	42,125	29,565	11,983	8,349	9,577	24,229	24,868	33,528	314,327
2013	27,118	26,881	33,500	44,208	33,628	40,650	40,622	18,168	21,957	13,963	25,577	30,104	356,376
2014	35,353	22,059	23,709	38,911	45,584	28,200	32,620	23,501	9,183	21,757	25,366	41,609	347,852
Average	28,677	23,188	33,116	38,059	38,237	28,345	20,511	18,311	13,174	22,946	29,629	33,829	328,022

Table 3.1-2 Northfield Mountain Pumped Storage Development- Summary of Net Monthly and Annual Generation (MWH) for 2000 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	109,864	93,567	92,126	89,140	109,320	100,727	137,576	153,957	131,579	123,193	98,718	113,447	1,353,214
2001	101,351	77,503	107,797	121,528	117,901	123,672	137,954	149,880	145,696	138,503	114,467	119,844	1,456,096
2002	95,850	78,303	97,810	103,238	108,275	92,970	111,514	132,978	145,309	125,227	121,123	119,287	1,331,884
2003	95,056	92,116	81,976	65,973	71,618	94,434	96,930	85,811	99,356	61,691	86,925	102,546	1,034,432
2004	99,038	68,077	83,489	75,299	81,302	91,938	89,748	91,846	104,555	87,248	90,696	93,304	1,056,540
2005	81,856	47,618	60,445	58,132	60,958	92,404	104,355	95,351	73,493	77,921	76,339	81,201	910,073
2006	79,856	58,120	76,698	81,847	86,519	79,207	101,082	102,527	91,914	80,443	96,297	100,885	1,035,395
2007	93,798	54,954	43,704	46,464	60,212	87,499	107,016	142,983	139,486	122,630	98,251	103,570	1,100,567
2008	90,188	91,888	101,507	99,094	95,346	116,186	153,354	102,877	82,032	77,478	85,450	84,183	1,179,583
2009	66,037	52,512	61,739	68,409	60,943	79,981	97,749	124,674	93,964	92,274	77,584	96,730	972,596
[1]2010	86,164	73,981	78,598	52,630	672	0	0	0	0	0	18,440	62,204	372,689
2011	65,671	64,477	46,452	42,301	50,058	56,290	103,392	79,772	67,771	76,893	52,454	51,629	757,160
2012	45,074	26,698	52,722	68,596	74,068	55,938	98,932	110,138	61,517	59,794	72,925	55,424	781,826
2013	66,781	65,362	57,176	51,085	61,099	60,465	109,059	76,220	57,764	60,570	64,130	79,232	808,943
2014	68,726	64,673	67,949	58,571	81,431	74,821	98,883	101,214	99,761	82,828	89,316	87,993	976,166
[2]Average	82,796	66,848	73,685	73,548	79,932	86,181	110,539	110,731	99,586	90,478	87,477	92,091	1,053,891

[1]The Northfield Mountain Pumped Storage Development was out of operation for much of 2010.
[2]The average does not include 2010, given this year was an anomaly due to the Northfield Mountain Pumped Storage Development extended outage.

Table 3.1-3 Northfield Mountain Pumped Storage Development- Summary of Net Monthly and Annual Generation (MWH) Consumption in Pumping Mode for 2000 to 2014

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	157,351	131,094	125,737	129,019	144,954	139,323	190,031	205,477	184,650	167,439	139,645	155,752	1,870,472
2001	138,633	105,502	150,565	164,074	160,922	172,880	187,517	203,549	201,358	191,469	153,844	168,665	1,998,978
2002	136,523	103,437	141,198	133,679	146,994	132,568	146,600	185,188	196,329	174,822	168,801	167,005	1,833,144
2003	130,126	124,585	112,260	98,449	89,020	133,009	134,548	119,934	134,217	84355	116,700	139,201	1,416,404
2004	141,351	90,200	112,840	103,857	112,097	125,896	112,995	128,896	136,736	119,890	122,353	128,224	1,435,335
2005	110,358	61,864	87,156	74,377	86,454	125,696	138,225	126,601	98027	109,068	104,009	109,238	1,231,073
2006	109,578	82,360	98,692	107,359	118,492	110,219	133,915	139,214	120,725	113,678	125,271	139,147	1,398,650
2007	132,605	76,064	54,029	62,831	82,046	118,986	146,089	194,557	195,152	165,484	133,335	141,776	1,502,954
2008	127,655	128,575	138,742	141,327	127,381	160,269	212,444	146,638	111,357	104,468	120,801	118,252	1,637,909
2009	90,332	82,182	76,542	97,149	86,154	107,715	135,735	176,610	131,289	126,293	106,205	133,929	1,350,135
[1]2010	126,198	99,201	109,006	71,612	83	0	0	0	0	0	32,244	89,887	528,231
2011	96,439	82,752	72,367	55,866	69,610	81,690	142,141	106,248	93,523	110,491	71,918	69,741	1,052,786
2012	57,045	38,936	65,705	93,555	99,673	77,037	132,357	140,865	86,191	74,027	99,027	77,183	1,041,601
2013	88,692	85,026	71,356	68,421	83,307	81,206	144,181	94,930	80,654	76,997	84,133	110,535	1,069,438
2014	85,727	87,745	87,358	84,204	105,758	100,985	129,180	129,100	128,599	113,603	119,270	114,094	1,285,623
Average[2]	114,458	91,452	99,611	101,012	108,062	119,106	148,997	149,843	135,629	123,720	118,951	126,624	1,437,464

[1]The Northfield Mountain Pumped Storage Development was out of operation for much of 2010.
[2]The average does not include 2010, given this year was an anomaly due to the Northfield Mountain Pumped Storage Development extended outage.

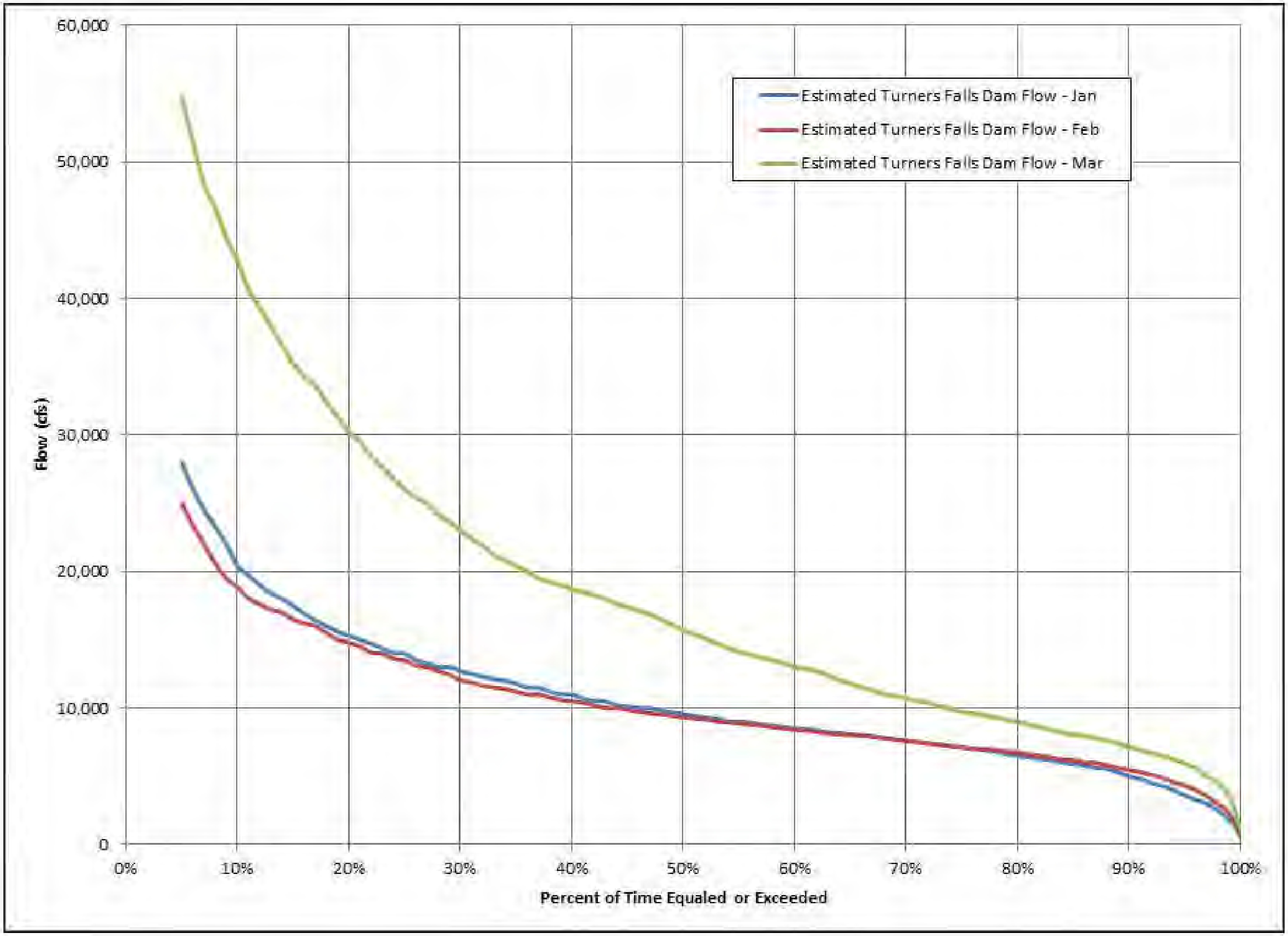

Figure 3.2-1. Connecticut River at Turners Falls Dam, Jan-Mar Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi^2

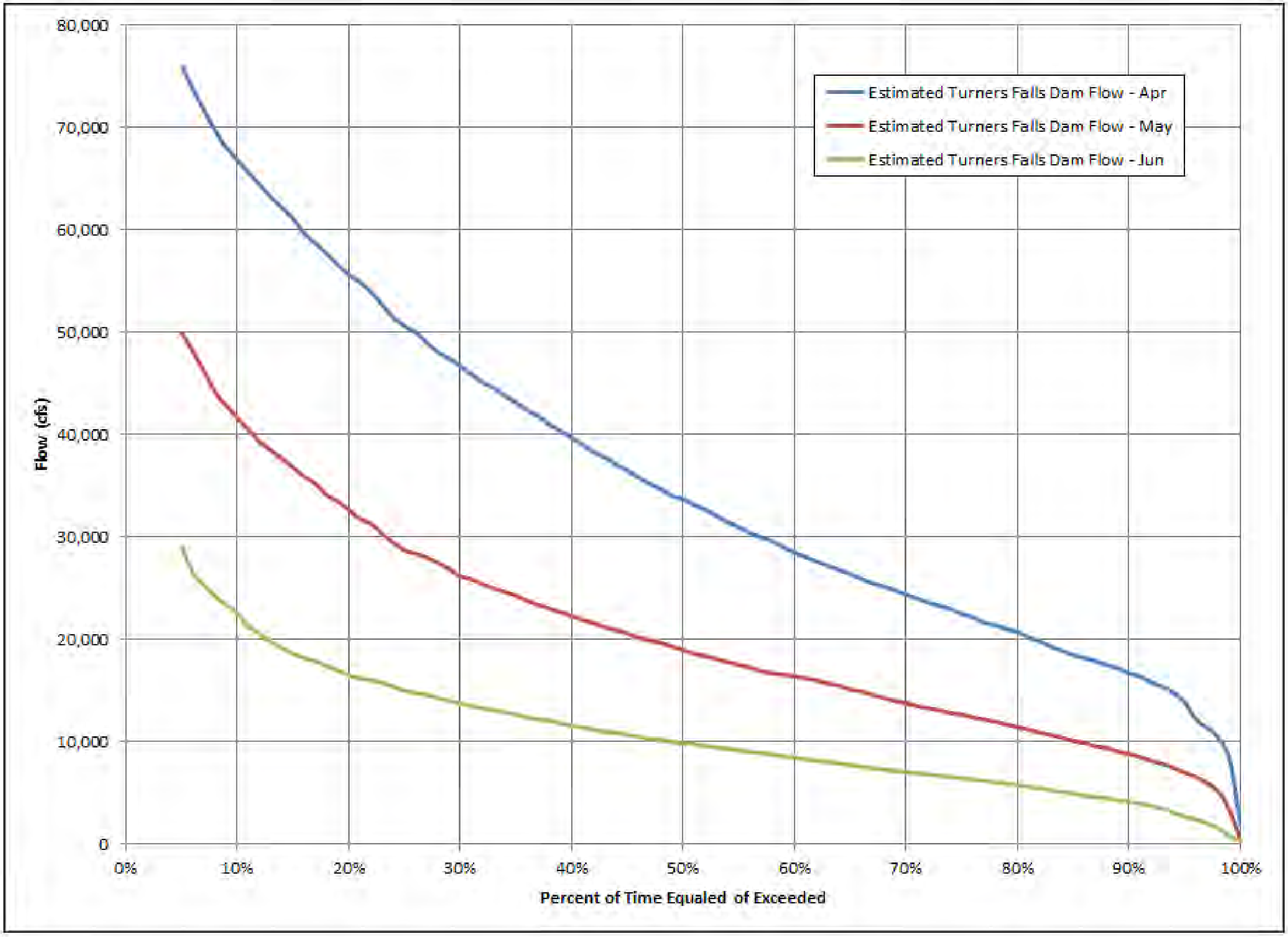

Figure 3.2-2. Connecticut River at Turners Falls Dam, Apr-Jun Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi^2

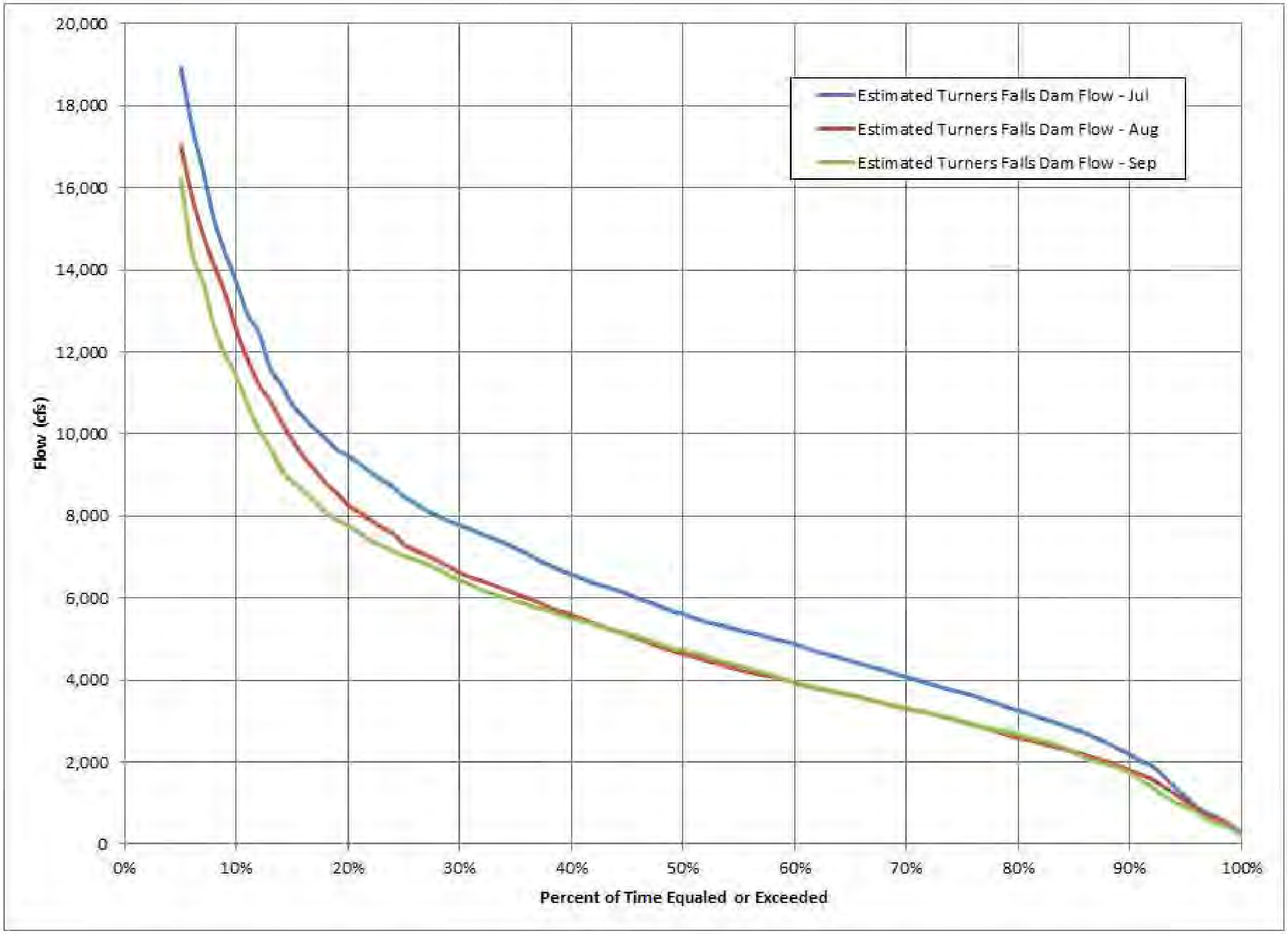

Figure 3.2-3. Connecticut River at Turners Falls Dam, Jul-Sep Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi²

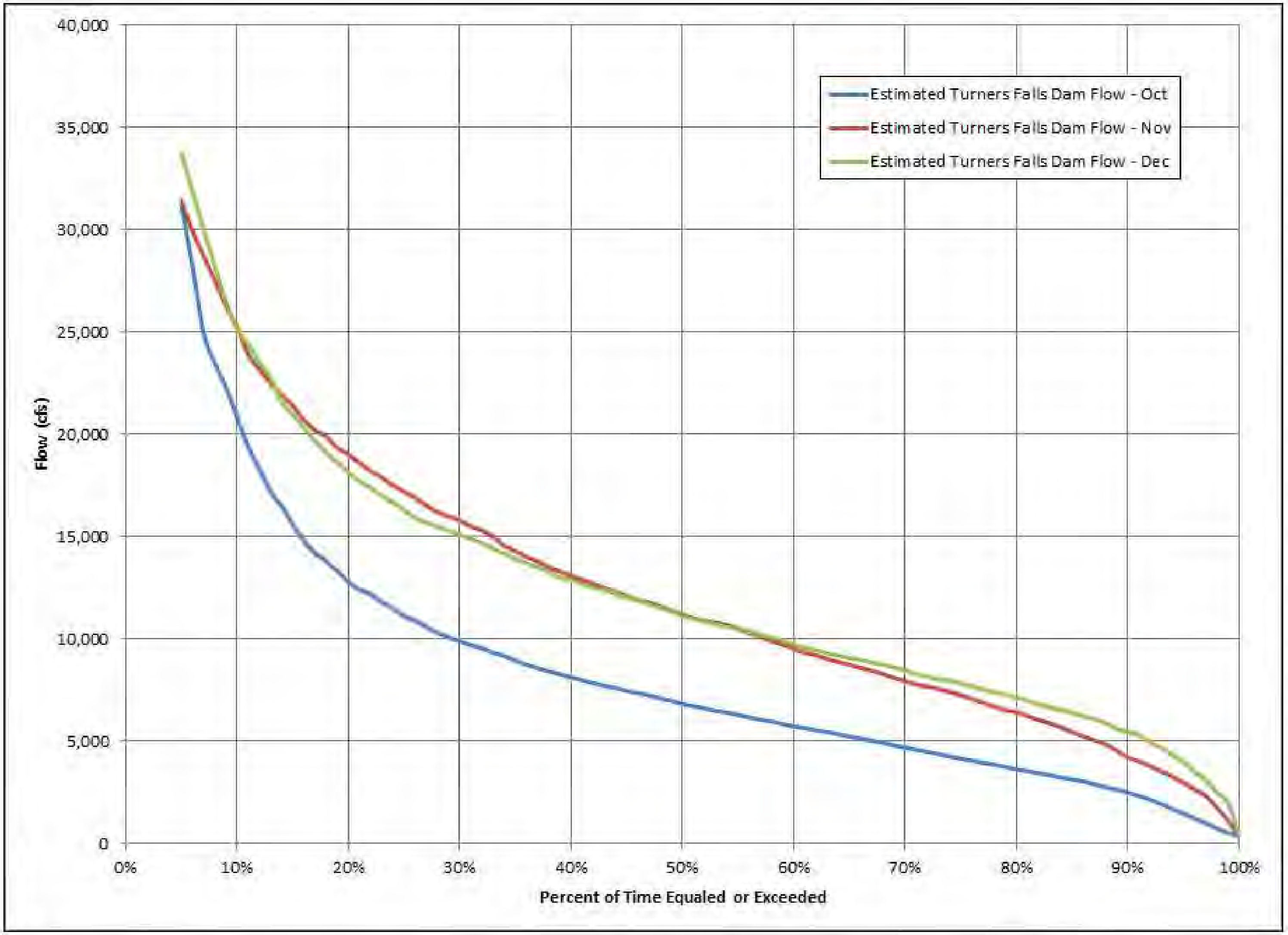

Figure 3.2-4. Connecticut River at Turners Falls Dam, Oct-Dec Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi^2

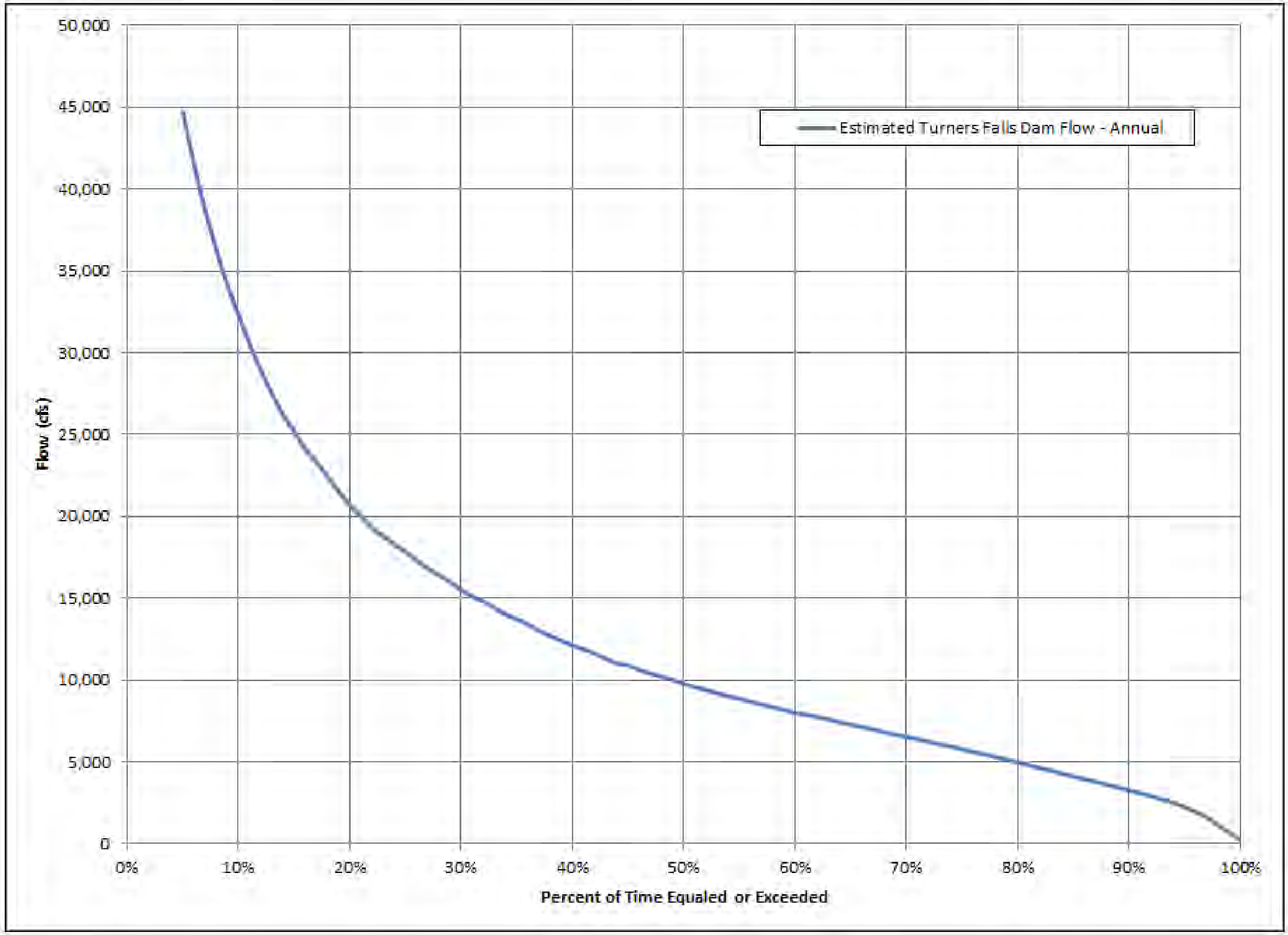

Figure 3.2-5. Connecticut River at Turners Falls Dam, Annual Flow Duration Curve, Oct 1940-Dec 2013, Drainage Area= 7,163 mi^2

Table 3.3-1: Turners Falls Impoundment Stage versus Storage Curve

Turners Falls Impoundment Elev (ft)	**Storage** (acre-ft)
172.26	0
176	4,150
177	5,600
178	7,500
179	9,200
180	11,100
181	13,000
182	14,750
183	16,600
184	18,450
185	20,300
186	22,100
186.5	23,000

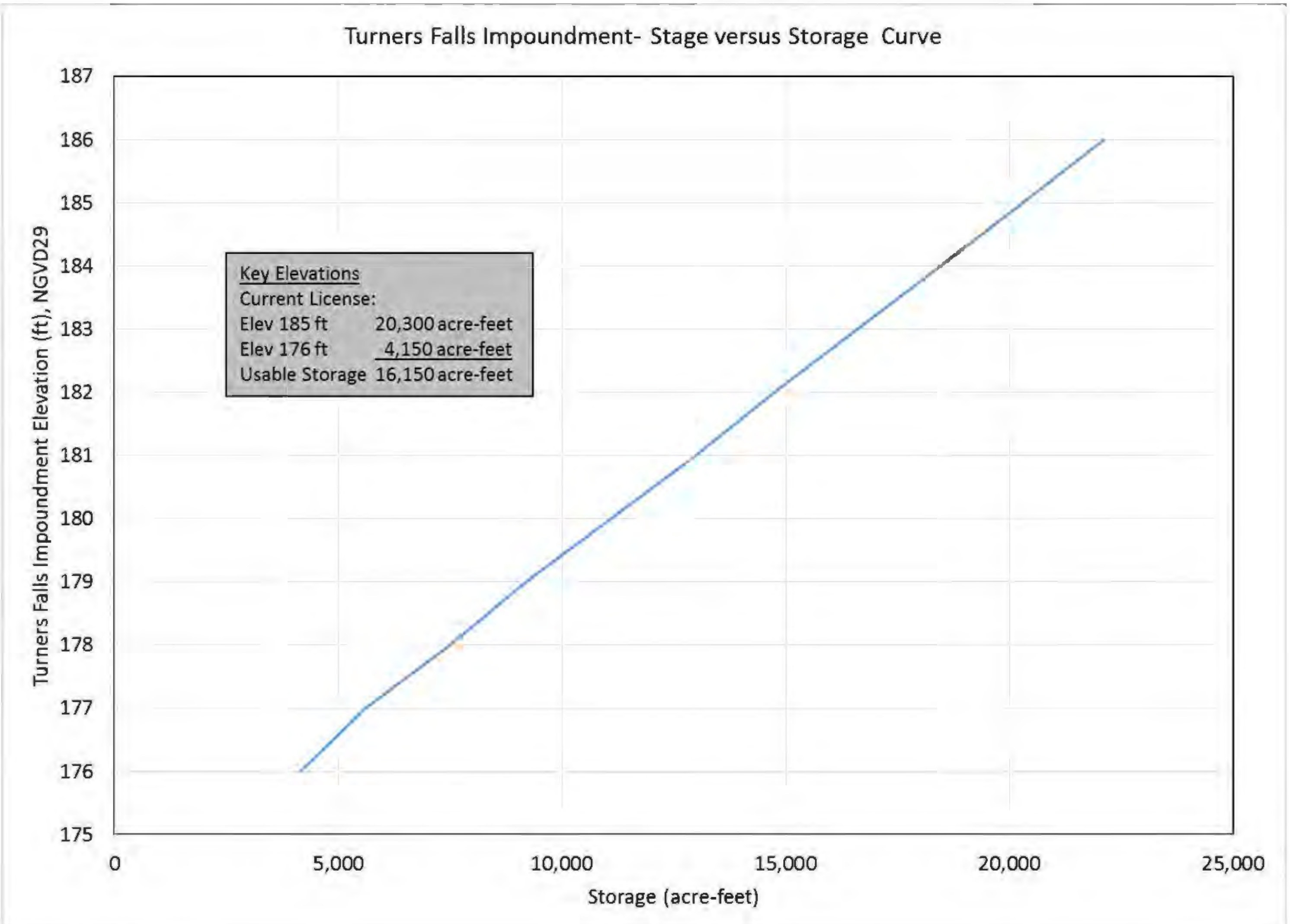

Figure 3.3-1: Turners Falls Impoundment Stage versus Storage Curve

Table 3.3-2: Upper Reservoir Stage versus Storage Curve

Upper Reservoir Elev (ft)	**Storage** (acre-ft)	**Upper Reservoir Elev** (ft)	**Storage** (acre-ft)
920	0	966	6,141
921	88	967	6,328
922	177	968	6,519
923	269	969	6,713
924	363	970	6,910
925	459	971	7,110
926	558	972	7,314
927	658	973	7,520
928	760	974	7,729
929	865	975	7,940
930	972	976	8,155
931	1,081	977	8,374
932	1,192	978	8,596
933	1,306	979	8,820
934	1,422	980	9,046
935	1,540	981	9,276
936	1,660	982	9,508
937	1,781	983	9,743
938	1,905	984	9,980
939	2,030	985	10,221
940	2,157	986	10,464
941	2,286	987	10,710
942	2,417	988	10,958
943	2,550	989	11,208
944	2,685	990	11,461
945	2,823	991	11,751
946	2,962	992	11,971
947	3,101	993	12,229
948	3,244	994	12,489
949	3,387	995	12,750
950	3,532	996	13,014
951	3,678	997	13,280
952	3,827	998	13,547
953	3,976	999	13,816
954	4,128	1000	14,087
955	4,281	1000.5	14,223
956	4,436	1001	14,360
957	4,593	1002	14,633
958	4,752	1003	14,969
959	4,912	1004	15,187
960	5,077	1004.5	15,327
961	5,248		
962	5,425		
963	5,597		
964	5,775		
965	5,956		

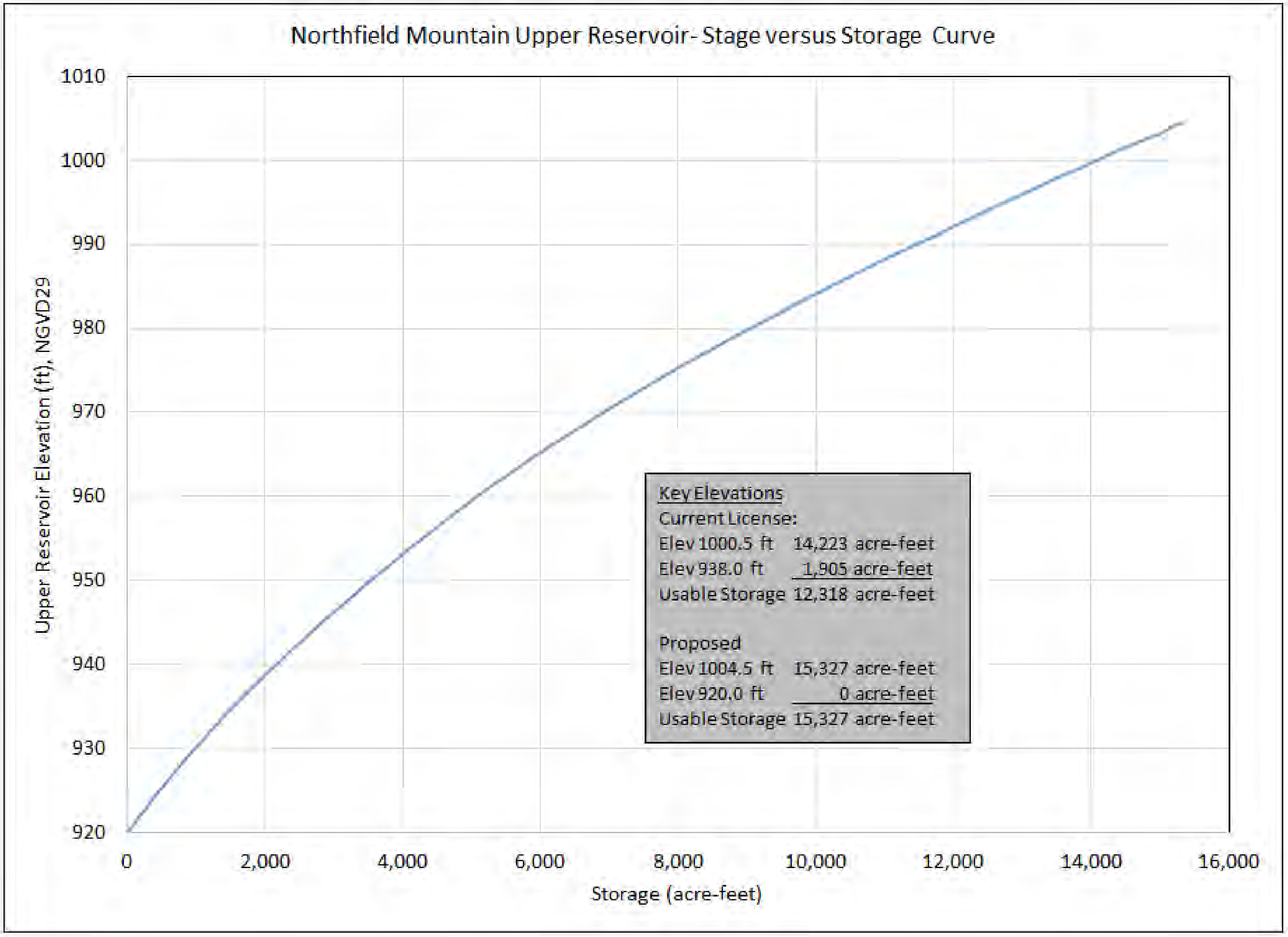

Figure 3.3-2: Northfield Mountain Upper Reservoir Stage versus Storage Curve

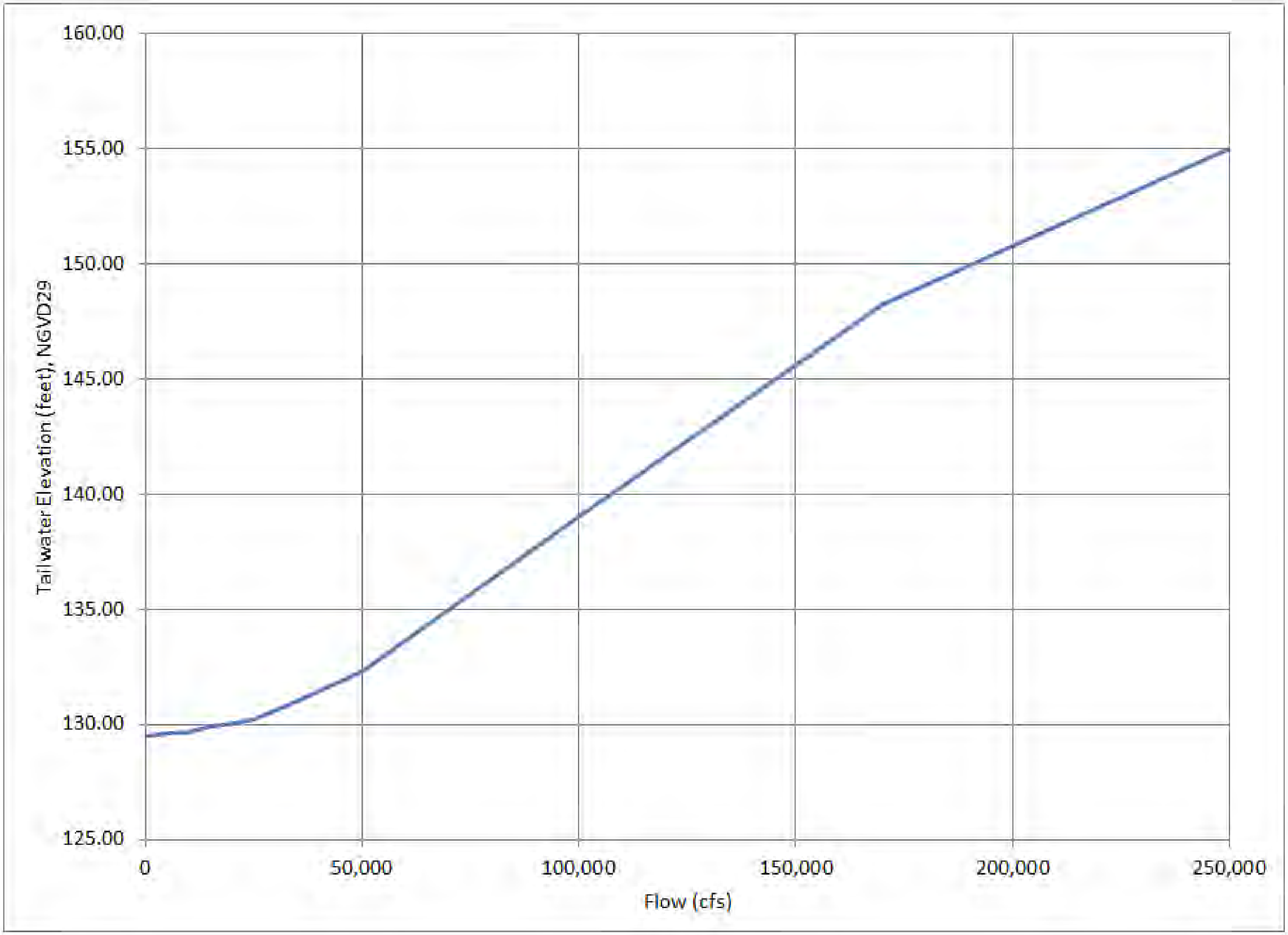

Figure 3.5-1: Station No. 1 Tailwater Rating Curve

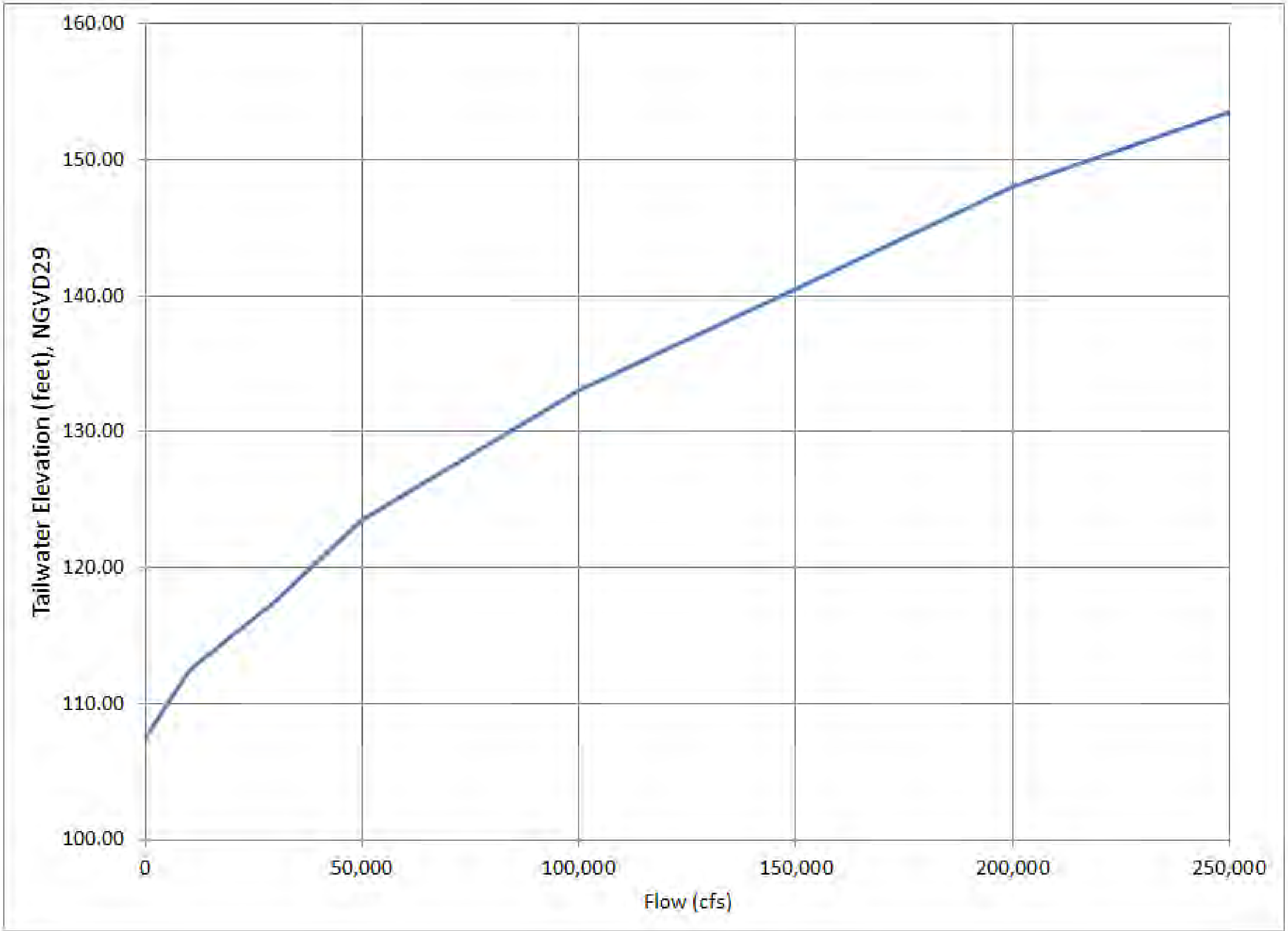

Figure 3.5-2: Cabot Station Tailwater Rating Curve

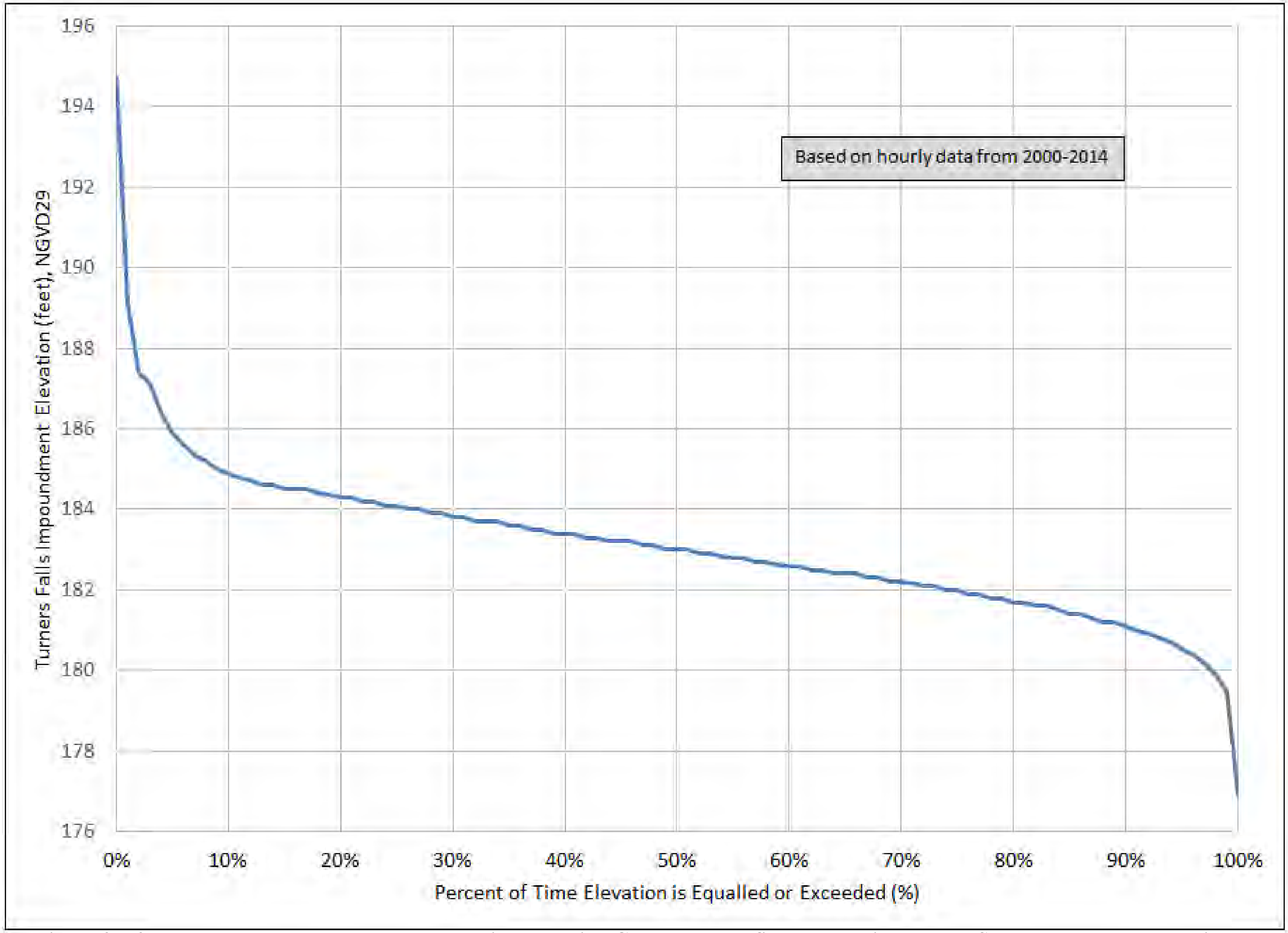

Figure 3.5-3: Turners Falls Impoundment- Elevation Duration Curve at Northfield Mountain Pumped Storage Development Tailrace
(based on hourly data from 2000-2014)

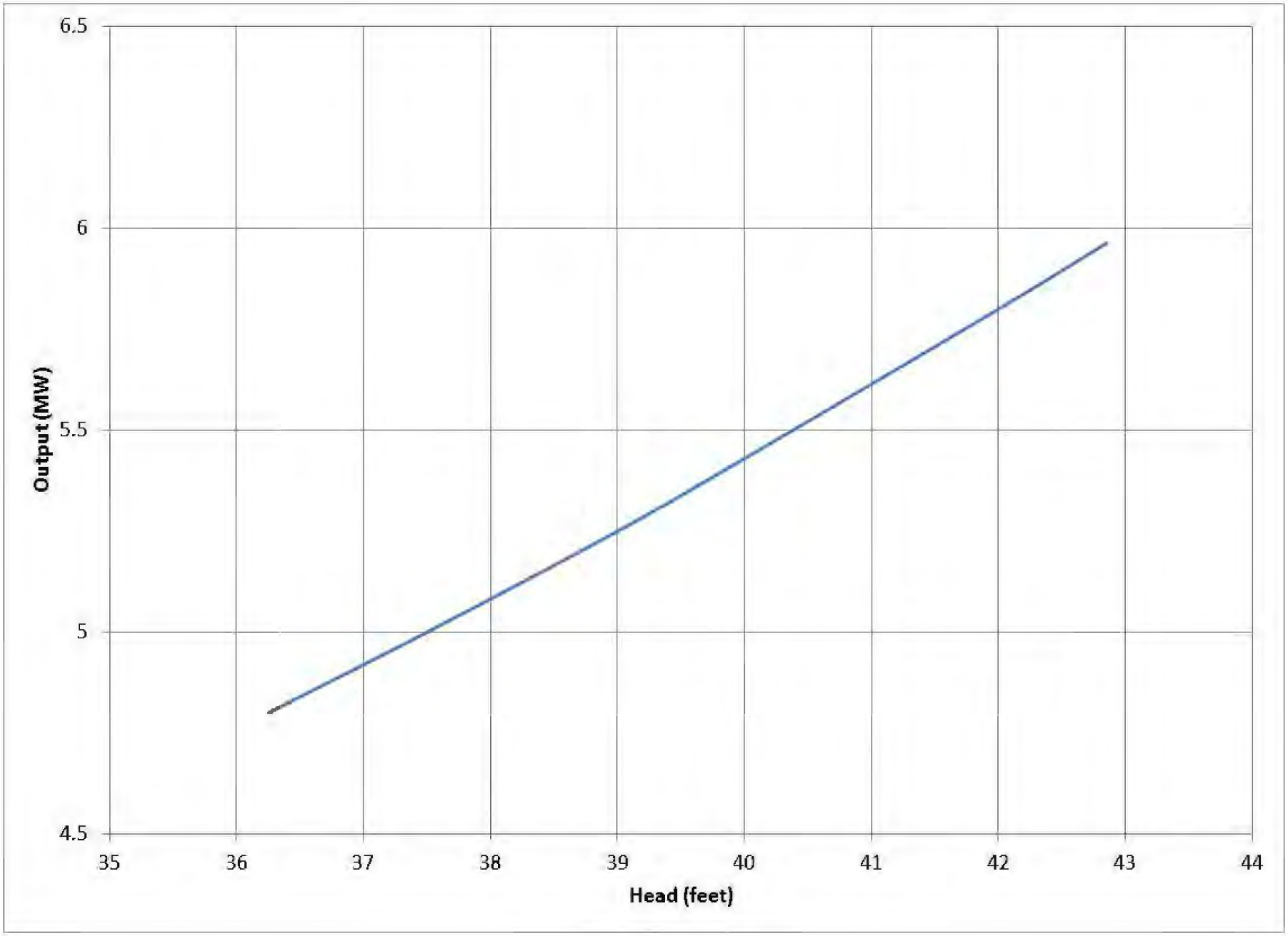

Figure 3.6-1. Station No. 1 - Plant Capability (MW) versus Head (ft) Curve

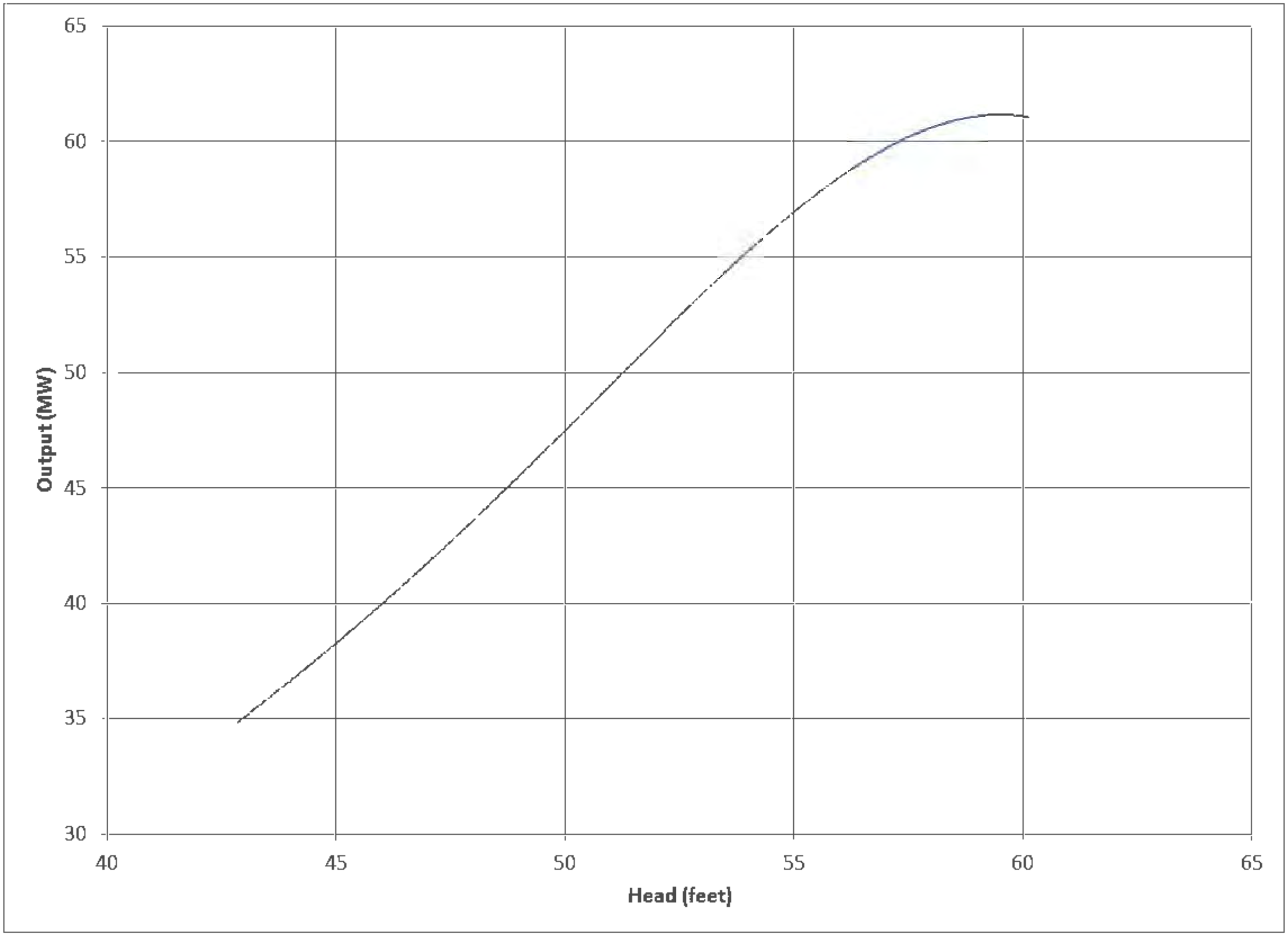

Figure 3.6-2. Cabot Station - Plant Capability (MW) versus Head (ft) Curve

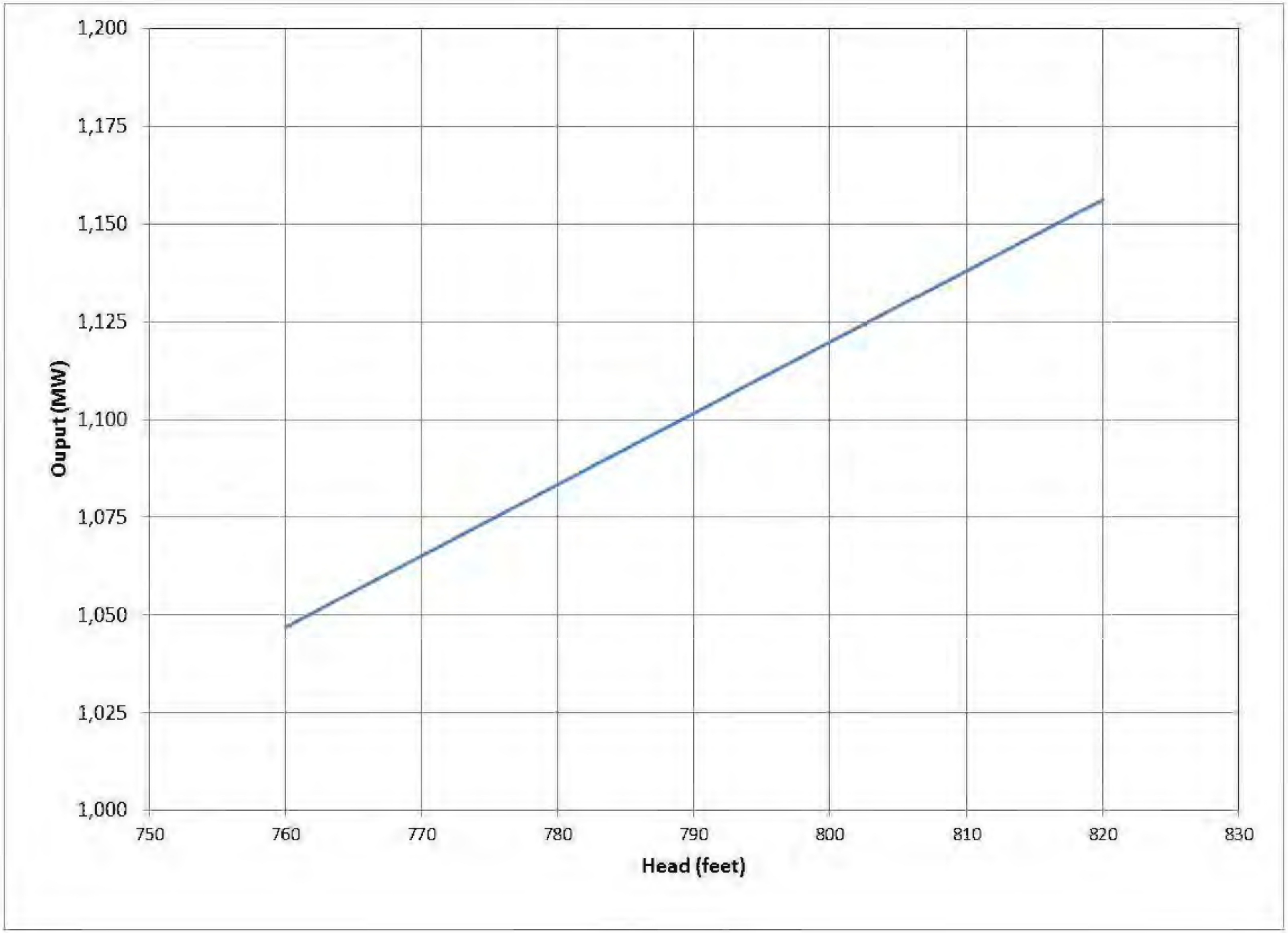

Figure 3.6-3. Northfield Mountain Pumped Storage Development - Plant Capability (MW) versus Head (ft) Curve

Final Application for New License for Major Water Power Project – Existing Dam

Northfield Project
Northfield Mountain Pumped Storage Project (FERC Project Number 2485)
Turners Falls Hydroelectric Project (FERC Project Number 1889)

EXHIBIT C-CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION

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EXHIBIT C – CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (d) describes the required content of this Exhibit.

(d) Exhibit C is a construction history and proposed construction schedule for the project. The construction history and schedules must contain:

(1) If the application is for an initial license, a tabulated chronology of construction for the existing projects structures and facilities described under paragraph (b) of this section (Exhibit A), specifying for each structure or facility, to the extent possible, the actual or approximate dates (approximate dates must be identified as such) of:

(i) Commencement and completion of construction or installation;

(ii) Commencement of commercial operation; and

(iii) Any additions or modifications other than routine maintenance; and

(2) If any new development is proposed, a proposed schedule describing the necessary work and specifying the intervals following issuance of a license when the work would be commenced and completed.

1 PROJECT HISTORY

FirstLight Hydro Generating Company (FirstLight) is licensed by the Federal Energy Regulatory Commission to operate the Northfield Project (Project).

Turners Falls Development

The Turners Falls Development is located on the Connecticut River in the states of Massachusetts (MA), New Hampshire (NH) and Vermont (VT). The greater portion of the Turners Falls Development, including developed facilities and most of the lands within the Project boundary, are located in Franklin County, MA; specifically, in the towns of Erving, Gill, Greenfield, Montague and Northfield. The northern reaches of the Project boundary extend into the town of Hinsdale, in Cheshire County, NH, and the town of Vernon, in Windham County, VT. The Turners Falls Dam is located at approximately river mile 122 (above Long Island Sound) on the Connecticut River, at coordinates 42°36'38.77" north and 72°33'05.76" west, in the towns of Gill and Montague, MA.

The Turners Falls Development currently consists of: a) two individual concrete gravity dams separated by an island; b) a gatehouse controlling flow to the power canal; c) the power canal and a short branch canal; d) two hydroelectric powerhouses, located on the power canal, known as Station No. 1 and Cabot Station; e) a bypassed section of the Connecticut River and f) a reservoir known as the Turners Falls Impoundment (TFI).

The original Turners Falls Dam and canal was constructed in the 1860s. Improvements to the dam and enlargement of the canal, as well as the construction of the Cabot Station and Station No. 1 powerhouses commenced in the early 1900s; Station No. 1 commenced operation in 1905, while the Cabot Station powerhouse commenced operation in 1915. In 1944, the Federal Power Commission, predecessor to the Federal Energy Regulatory Commission (FERC), issued to Western Massachusetts Electric Company a 50-year license for the Turners Falls Development designated as FERC No. 1889. The Turners Falls Development began operation with six vertical Francis turbines at Cabot Station with a capacity of 51 MW and six horizontal Francis turbines at Station No. 1 with a capacity of 6 MW.

To accommodate for the Northfield Mountain Pumped Storage Development, the Turners Falls license was amended by FERC in the same Order as the original license for the Northfield Project. This amendment approved the reconstruction of the Turners Falls Dam and Canal gatehouse. The completion of these improvements resulted in an increase in the permitted headpond level to elevation 185.0 ft mean sea level (msl). A subsequent license for the Turners Falls Project was issued by FERC in 1980.

Northfield Mountain Pumped Storage Development

The Northfield Mountain Pumped Storage Development is a pumped-storage facility located on the eastern bank of the Connecticut River in MA and is located approximately 5.2 miles upstream of Turners Falls Dam. The TFI serves as its lower reservoir. This Development's Upper Reservoir is a man-made structure situated atop Northfield Mountain, to the east of the Connecticut River. During pumping operations, water is pumped from the TFI to the Upper Reservoir. When generating, water is passed from the Upper Reservoir through an underground pressure shaft to a powerhouse cavern and then a tailrace tunnel delivers the water back to the TFI.

The Northfield Mountain Pumped Storage Development currently consists of: a) an Upper Reservoir and dam/dikes; b) an intake channel; c) pressure shaft; d) an underground powerhouse; and c) a tailrace tunnel. The TFI serves as the lower reservoir.

On May 14, 1968, the Federal Power Commission issued an original license to Connecticut Light and Power Company, Hartford Electric Company, and Western Massachusetts Electric Company for the construction of the proposed 1,000 MW Northfield Mountain Hydroelectric Project. The Project included four (4) 250 MW reversible pump-turbines. Construction of the Northfield Project began in 1968, and was completed when the first unit went into commercial operation in 1972.

The Project is maintained through regularly scheduled maintenance inspections and replacement of deficient equipment as necessary. In addition to the routine maintenance, various components of the Project have been refurbished. An overview of the history of Project improvements is summarized in Table 1.0-1.

Table 1.0-1. Turners Falls Development and Northfield Mountain Pumped Storage Development Milestones.

Date	Location/Equipment	Description
Turners Falls Development		
1905	Turners Falls, Station No.1	Station No.1 - Generation Units began operation
1916	Turners Falls, Cabot Station	Cabot Station - Generation Units began operation 2/26/1916
1973	Turners Falls, Station No.1	Powerhouse deactivated
1982	Turners Falls, Station No.1	Units 1,2&3 refurbished, Powerhouse reactivated
1987	Turners Falls, Station No.1	Units 5&7 overhauled
1987	Turners Falls, Cabot Station	30 ton Gantry Crane replaced
1990	Turners Falls, Cabot Station	Control update to allow remote operation
1995	Turners Falls, Cabot Station	Control update to allow automated operation for Gatehouse and Canal
2002	Turners Falls, Cabot Unit 1-6	Generator step-up transformer upgraded
2002	Turners Falls, Cabot Unit 1&2	Turbine runner replacement and generator rewind
2003	Turners Falls, Cabot Unit 3&4	Turbine runner replacement and generator rewind
2004	Turners Falls, Cabot Unit 5&6	Turbine runner replacement and generator rewind
2006	Turners Falls, Cabot Station	Trashrack frames and supporting structure replaced
Northfield Mountain Pumped Storage Development		
1972	Northfield	First unit, Unit 4 began commercial operation 11/30/72
1973	Northfield	Units 1, 2, 3 began commercial operation; U1 02/28/73, U3 07/25/73, U2 10/08/73
2004	Northfield, Unit 1	Turbine runner and generator circuit breaker replacement
2006	Northfield, Unit 3	Electrical equipment replacement
2007	Northfield	1X Main power step-up Transformer replacement
2008	Northfield, Units 2 and 4	Electrical equipment replacement
2011	Northfield, Unit 3	Turbine runner and 3X Main power step-up Transformer replacement and generator rewind
2012	Northfield, Unit 2	Turbine runner replacement and generator rewind
2014	Northfield Unit 4	Turbine runner replacement and generator rewind
2015-16	Northfield Unit 1	Generator rewind

2 SCHEDULE FOR PROPOSED PROJECT DEVELOPMENT

As noted earlier in the Final License Application, the closure of the Vermont Yankee Nuclear facility (VY) during the relicensing study period resulted in delaying the aquatic and water quality studies one year. In FERC's February 21, 2014 study plan determination letter (Appendix C of that determination), it states that the aquatic and water studies reports should be filed by March 1, 2016, after the Draft License Application is to be filed. Given the delay in conducting the aquatic and water quality studies due to closure of VY in December 2014, coupled with FERC requiring two additional studies in 2016, FirstLight has not completed all of it scientific studies needed to support a full license application. Until these studies are complete, FirstLight is not proposing any new development at the Project. However, pending the magnitude of any future minimum flow release at the Turners Falls Dam, FirstLight will likely evaluate the feasibility of a minimum flow turbine generator at the dam.

Final Application for New License for Major Water Power Project – Existing Dam

Northfield Project
Northfield Mountain Pumped Storage Project (FERC Project Number 2485)
Turners Falls Hydroelectric Project (FERC Project Number 1889)

EXHIBIT D – STATEMENT OF COST AND FINANCING

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EXHIBIT D – STATEMENT OF COSTS AND FINANCING

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (e) describes the required content of this Exhibit.

(e) Exhibit D is a statement of costs and financing. The statement must contain:

(1) If the application is for an initial license, a tabulated statement providing the actual or approximate original cost (approximate costs must be identified as such) of:
(i) Any land or water right necessary to the existing project; and
(ii) Each existing structure and facility described under paragraph (b) of this section (Exhibit A).

(2) If the applicant is a licensee applying for a new license, and is not a municipality or a state, an estimate of the amount which would be payable if the project were to be taken over pursuant to section 14 of the Federal Power Act upon expiration of the license in effect [see 16 U.S.C. 807], including:
(i) Fair value;
(ii) Net investment; and
(iii) Severance damages.

(3) If the application includes proposals for any new development, a statement of estimated costs, including:
(i) The cost of any land or water rights necessary to the new development; and
(ii) The cost of the new development work, with a specification of:
(A) Total cost of each major item;
(B) Indirect construction costs such as costs of construction equipment, camps, and commissaries;
(C) Interest during construction; and
(D) Overhead, construction, legal expenses, taxes, administrative and general expenses, and contingencies.

(4) A statement of the estimated average annual cost of the total project as proposed specifying any projected changes in the costs (life-cycle costs) over the estimated financing or licensing period if the applicant takes such changes into account, including:
(i) Cost of capital (equity and debt);
(ii) Local, state, and Federal taxes;
(iii) Depreciation and amortization;
(iv) Operation and maintenance expenses, including interim replacements, insurance, administrative and general expenses, and contingencies; and
(v) The estimated capital cost and estimated annual operation and maintenance expense of each proposed environmental measure.

(5) A statement of the estimated annual value of project power, based on a showing of the contract price for sale of power or the estimated average annual cost of obtaining an equivalent amount of power (capacity and energy) from the lowest cost alternative source, specifying any projected changes in the cost of power from that source over the estimated financing or licensing period if the applicant takes such changes into account.

(6) A statement specifying the sources and extent of financing and annual revenues available to the applicant to meet the costs identified in paragraphs (e) (3) and (4) of this section.

(7) An estimate of the cost to develop the license application;

(8) The on-peak and off-peak values of project power, and the basis for estimating the values, for projects which are proposed to operate in a mode other than run-of-river; and

(9) The estimated average annual increase or decrease in project generation, and the estimated average annual increase or decrease of the value of project power, due to a change in project operations (i.e., minimum bypass flows; limits on reservoir fluctuations).

1 COST OF ORIGINAL DEVELOPMENT

This application is for a new license, not an initial license; the Turners Falls Hydroelectric Project and the Northfield Mountain Pumped Storage Project were previously licensed in 1980 and 1968, respectively. Accordingly, the Commission's regulations do not require FirstLight to include a statement of costs of lands, water rights, structures or facilities. 18 C.F.R. § 4.51(e)(1). FirstLight is seeking a single license for the facilities which are referenced below as the Turners Falls Development and the Northfield Mountain Pumped Storage Development (collectively the Northfield Project or Project).

2 ESTIMATED AMOUNT PAYABLE IN THE EVENT OF PROJECT TAKEOVER

To date, no agency or interested party has recommended a Federal takeover of the Project pursuant to Section 14 of the Federal Power Act (FPA). If such a takeover were to occur, FirstLight would have to be reimbursed for the net investment, not to exceed the fair value of the property taken, plus severance damages, if any, to property of the licensee valuable, serviceable, and dependent for its usefulness on the continuance of the license, but not taken. (Section 14, FPA).

2.1 Fair Value

The term "fair value" is not defined in the FPA Section 14. FirstLight, through its parent company GDF SUEZ Energy Generation, NA has recently entered into a definitive agreement for the sale of FirstLight Hydro Generating Company. Based upon an allocation of the purchase price, the fair market value of the Project is $1,037 M USD. Because of the unique role of the Project in ensuring electrical reliability of the regional grid, FirstLight believes an alternative approximation of fair value is the cost to construct and operate a comparable power generating facility.

2.2 Net Investment

The FPA defines "net investment" as the original cost, plus additions, minus the sum of the following items (to the extent that such items have been accumulated during the period of the license from earnings in excess of a fair return on such investment): (a) unappropriated surplus; (b) aggregate credit balances of current depreciated accounts; and (c) aggregate appropriations of surplus or income held in amortization, sinking fund, or similar reserves.

The Turners Falls and Northfield Mountain Pumped Storage Development's net investments are $284,970,827 and $926,156,091, respectively, with a combined net investment of $1,211,126,918.

2.3 Severance Damages

Severance damages are determined either by the cost of replacing (retiring) equipment that is "dependent for its usefulness upon the continuance of the License" but not taken (Section 14, FPA). At this time, the only equipment, facilities or structures and related contractual obligations and requirement that are not required for the successful operation of the Project are associated with the approximately 3 MW solar array on the east bank of the Connecticut River within the Project Boundary. This solar project has no connection to the Turners Falls or Northfield Pumped Storage Developments and if the Project were taken, the Solar Farm would need to be compensated.

It will not be possible to separate the Solar Farm from the Project because a portion of the Northfield Mountain Pumped Storage tailrace runs under the land occupied by the Solar Farm. Rather, the Solar

Farm would remain and incremental Operations and Maintenance Costs resulting from the assumption of the Northfield Pumped Storage Development Project would be due to the Owner as Severance Damages.

Under the terms of its current Lease and O&M Agreements with FirstLight Hydro Generating Company, NFM Solar Power, LLC pays an annual land lease fee as well as those costs associated with O&M related expenses. It is assumed that the land lease fee would remain unchanged. However, the O&M costs, specifically labor costs, are based upon the operations and maintenance personnel from Northfield Mountain Station performing these duties. If the federal government were to assume the Northfield Pumped Storage Development Project, there would be an incremental increase in labor cost because either additional staff or external resources would be required to perform the tasks currently undertaken by Northfield personnel. This is estimated to be one full time equivalent person at a fully loaded annual cost of $100,000 (2016 USD). Allowing for the current labor cost included in the O&M Budget the incremental labor cost would be $75,000 per year (2016 USD).

3 ESTIMATED CAPITAL COST OF PROPOSED DEVELOPMENT

The Final License Application (FLA) is incomplete at this time as many of the studies have not been finalized. At this time, FirstLight is not proposing to add any additional power generation facilities to the Turners Falls Development or Northfield Mountain Pumped Storage Development. However, pending the magnitude of any future minimum flow release at the Turners Falls Dam, FirstLight will likely evaluate the feasibility of a minimum flow turbine generator at the dam.

4 ESTIMATED AVERAGE ANNUAL COST OF PROJECT AS PROPOSED

The average annual cost of the Project as proposed includes capital costs, taxes, depreciation, as well as operations and maintenance costs. The average annual costs also will include capital costs and operation and maintenance expenses associated with proposed Protection, Mitigation and Enhancement (PME&E) measures. At this time, because some studies are incomplete, FirstLight is not proposing any PM&E measures. When studies are complete and the impact of Project operations on various resources are further evaluated, FirstLight will evaluate potential PM&E measures.

4.1 Capital Costs

The estimated average annual capital costs for the Turners Falls Development and Northfield Mountain Pumped Storage Development as currently proposed are $1,901,763 and $15,308,478, respectively (total of $17,210,241). These costs include life cycle costs such as runner replacements, generator rewinds, and oil circuit breaker replacements and routine replacement of vehicles and tools.

4.2 Taxes

The actual annual property taxes for the fiscal year ending June 2015 for the Turners Falls Development and Northfield Mountain Pumped Storage Development are $3,747,920 and $8,307,402, respectively. FirstLight estimates paying for the Turners Falls Development and Northfield Mountain Pumped Storage Development approximately $2,627,492 and $11,166,499, respectively in Development-related Federal income taxes, and approximately $157,649 and $669,989, respectively in Development-related state income taxes annually. A summary of the local, state and federal taxes for the fiscal year ending June 2015 are shown in Table 4.2-1.

Table 4.2-1: Federal, State, and Local Taxes Associated with the Project (FY 2015 dollars)

Tax	Turners Falls Development	Northfield Mountain Pumped Storage Development	Total
Local (property)	$3,747,920	$8,307,402	$12,055,322
State	$157,649	$669,989	$827,638
Federal	$2,627,492	$11,166,499	$13,793,991
Total	**$6,533,061**	**$20,143,890**	**$26,676,951**

4.3 Depreciation and Amortization

The estimated annual depreciation and amortization costs associated with the Turners Falls Development and the Northfield Mountain Pumped Storage Development are $6,771,000 and $28,957,000 (total of $35,728,000), respectively.

4.4 Operation and Maintenance Expenses

Annual operations and maintenance (O&M) expenses include interim replacements, insurance, and administrative and general costs associated with the operation of the Project, as well as compliance with environmental measures. The estimated O&M costs for the Turners Falls Development and Northfield Mountain Pumped Storage Development as currently proposed are approximately $3,731,591 per year and $11,023,783 per year, respectively (total of $14,755,374).

4.5 Costs of Environmental Measures

FirstLight is not proposing any environmental measures until the results of the on-going studies have been completed and the results analyzed. If measures are added, they would add capital costs, and increase annual operations and maintenance costs for the Project.

5 ESTIMATED ANNUAL VALUE OF PROJECT POWER

Turners Falls Development

If all of the Turners Falls Development generation was sold into the market, it would be priced at the Day Ahead and Real Time Locational Marginal Prices that clear for each generator. For 2013, the Turners Falls Development had a realized energy value of $58.18 per MWh (this is a realized value calculated as revenue divided by generation). The economic analysis of the Turners Falls Development also recognizes that the New England Power Pool (NEPOOL) market values the capacity, reserve and ancillary/regulation services provided by generation facilities.

Capacity is required by NEPOOL to ensure the reliability of the electric system and the price is established by NEPOOL through the forward capacity auction process. For 2013, the actual capacity revenue received by the Turners Falls Development was $2.22 million.

In addition to energy and capacity the Turners Falls Development produces ancillary and real-time reserve services necessary for effective system control. For 2013, the ancillary services revenue has been calculated as ($112,592) per year and the revenue from real-time reserve is $77,441.

Table 5.0-1 below shows the total valuation of the power based on the product components identified above. This assumes an average net generation of 356,376 MWh annually. The annual market value of the energy, capacity and reserve and ancillary services is approximately $22,915,259 per year, which equates to $64.30 per MWh.

Table 5.0-1: Valuation of the Annual Output of the Turners Falls Development (2013)

Revenue Source	Value
Energy ($58.185/MWh for Year 2013 for 356,376 MWh)	$20,735,750
Capacity	$2,214,660
Reserve	$77,441
Ancillary*	($112,592)
Total Value	$22,915,259
Total Value per MWh ($22,915,259/356,376 MWh)	$64.30

NOTE: Numbers may not be exact due to rounding.
* Ancillary includes Utility charges for electric production

Northfield Mountain Pumped Storage Development

If all of the Northfield Mountain Pumped Storage Development generation was sold into the market, it would be priced at the Day Ahead and Real Time Locational Marginal Prices that clear for each generator. For 2013, the Northfield Mountain Pumped Storage Development had a realized energy value of $85.17 per MWh (this is a realized value calculated as revenue divided by generation). The economic analysis of the Northfield Mountain Pumped Storage Development also recognizes that the NEPOOL market values the capacity, reserve and ancillary/regulation services provided by generation facilities.

Capacity is required by NEPOOL to ensure the reliability of the electric system and the price is established by NEPOOL through the forward capacity auction process. For 2013, the calendar average forward capacity auction clearing price was $2.951/KW-month while the capacity revenue received by the Northfield Mountain Pumped Storage Development was approximately $35.5 million.

Forward Reserve Market is an ISO-New England (ISO-NE) market to acquire, in advance, capability to supply pool-required Operating Reserve. It is a voluntary market and the price is set through two Forward Reserve Auctions per year, a four month summer season and an eight month winter season. In 2013, the Northfield Mountain Pumped Storage Development participated in the forward reserve auction and real-time reserves with the revenue received from this market of $14,931,318.

In addition to energy, capacity and forward reserve market, the Northfield Mountain Pumped Storage Development produces ancillary and regulation services that provide spinning and offline reserve and "fine tuning" necessary for effective system control by responding to minute-to-minute changes in load. For 2013, the ancillary services and regulation revenue has been calculated as $3,561,234.

Table 5.0-2 below shows the total valuation of the power based on the product components identified above. Off-peak energy costs for pumping in 2013 reflects the NEPOOL Western Massachusetts real time Locational Marginal Price for all of 2013. This assumes an average net generation of 808,943 MWh annually. The annual market value of the energy, cost for energy, capacity and forward reserve and ancillary/regulation services is approximately $81,791,723, which equates to $101.11 per MWh.

Table 5.0-2: Valuation of the Annual Output of the Northfield Mountain Pumped Storage Development (2013)

Revenue Source	Value
Energy ($85.172/MWh for 808,943 MWh)	$68,899,098
Energy for Pumping ($40.012/MWh) for 1,069,438 MWh	($42,790,965)
Capacity	$35,520,940
Locational Forward Reserve Market and Real-Time Reserves	$14,931,318
Ancillary (NCPC, Posturing, ISO-Fees)	$1,670,097

Revenue Source	Value
Regulation	$3,561,234
Total Value	$81,791,723
Total Value per MWh ($81,791,723/808,943 MWh)	$101.11

NOTE: Numbers may not be exact due to rounding.
* Ancillary includes ISO-NE expenses

6 SOURCES AND EXTENT OF FINANCING

The Project finances capital projects using cash flow from operations and as necessary additional debt obligations. The Project is part of a portfolio of 13 hydro assets which together service an existing first mortgage bond obligation. Based on the value of Project power, the Project should have adequate financial resources to meet the costs of operation of the Project for the term of the new license.

7 ESTIMATED COST TO DEVELOP LICENSE APPLICATION

The cost to develop the information necessary to complete the license application through March 2016 is estimated to be $18,100,000. Note that cost is expected to rise as some studies are not final. This estimate includes all study costs, Integrated Licensing Process (ILP) costs, and personnel and administrative costs associated with processing.

8 ON-PEAK AND OFF-PEAK VALUES OF POWER

The Northfield Mountain Pumped Storage Development and the Turners Falls Development operate within NEPOOL, whose geographic area includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont[1].

The Market has provided the historical 2013 Real Time On-Peak and Off-Peak prices for the Northfield Mountain Pumped Storage Development generation node:

On-Peak Price	$62.99/MWh
Off-Peak Price	$47.34/MWh

The Market has provided the historical 2013 Real Time On-Peak and Off-Peak prices for the Turners Falls Development generation node:

On-Peak Price	$63.43/MWh
Off-Peak Price	$48.70/MWh

9 ESTIMATED AVERAGE ANNUAL INCREASE OR DECREASE IN PROJECT GENERATION

At the time of filing the license application, not all of the FirstLight studies are complete. Thus, FirstLight has not determined if average annual Project generation will increase or decrease. FirstLight has not finalized its proposed operation for the Project. However, FirstLight is proposing to utilize more of the Upper Reservoir storage capacity, which could result in an increase in Project generation. As noted in Exhibit A, the current FERC license allows the Upper Reservoir to operate between 1000.5 feet to 938

[1] The data referenced were the historical Day Ahead LMP values for Northfield Mountain for 2013 retrieved from nMarket. The Northfield Mountain Pricing node (Pnode) ID is #14220.

feet, for a 62.5 foot drawdown. FirstLight proposes to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown.

Final Application for New License for Major Water Power Project – Existing Dam

Northfield Project
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EXHIBIT E – ENVIRONMENTAL REPORT

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EXHIBIT E – ENVIRONMENTAL REPORT

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 5.18(b) describes the required content of this Exhibit.

Exhibit E—Environmental Exhibit. The specifications for Exhibit E in §§4.41, 4.51, or 4.61 of this chapter shall not apply to applications filed under this part. The Exhibit E included in any license application filed under this part must address the resources listed in the Pre-Application Document provided for in §5.6; follow the Commission's "Preparing Environmental Assessments: Guidelines for Applicants, Contractors, and Staff," as they may be updated from time-to-time; and meet the following format and content requirements:

(1) General description of the river basin. Describe the river system, including relevant tributaries; give measurements of the area of the basin and length of stream; identify the project's river mile designation or other reference point; describe the topography and climate; and discuss major land uses and economic activities.

(2) Cumulative effects. List cumulatively affected resources based on the Commission's Scoping Document, consultation, and study results. Discuss the geographic and temporal scope of analysis for those resources. Describe how resources are cumulatively affected and explain the choice of the geographic scope of analysis. Include a brief discussion of past, present, and future actions, and their effects on resources based on the new license term (30–50 years). Highlight the effect on the cumulatively affected resources from reasonably foreseeable future actions. Discuss past actions' effects on the resource in the Affected Environment Section.

(3) Applicable laws. Include a discussion of the status of compliance with or consultation under the following laws, if applicable:

> *(i) Section 401 of the Clean Water Act. The applicant must file a request for a water quality certification (WQC), as required by Section 401 of the Clean Water Act no later than the deadline specified in §5.23(b). Potential applicants are encouraged to consult with the certifying agency or tribe concerning information requirements as early as possible.*
>
> *(ii) Endangered Species Act (ESA). Briefly describe the process used to address project effects on federally listed or proposed species in the project vicinity. Summarize any anticipated environmental effects on these species and provide the status of the consultation process. If the applicant is the Commission's non-Federal designee for informal consultation under the ESA, the applicant's draft biological assessment must be included.*
>
> *(iii) Magnuson-Stevens Fishery Conservation and Management Act. Document from the National Marine Fisheries Service (NMFS) and/or the appropriate Regional Fishery Management Council any essential fish habitat (EFH) that may be affected by the project. Briefly discuss each managed species and life stage for which EFH was designated. Include, as appropriate, the abundance, distribution, available habitat, and habitat use by the managed species. If the project may affect EFH, prepare a draft "EFH Assessment" of the impacts of the project. The draft EFH Assessment should contain the information outlined in 50 CFR 600.920(e).*
>
> *(iv) Coastal Zone Management Act (CZMA). Section 307(c)(3) of the CZMA requires that all federally licensed and permitted activities be consistent with approved state Coastal Zone Management Programs. If the project is located within a coastal zone boundary or if a project affects a resource located in the boundaries of the designated coastal zone, the applicant must certify that the project is consistent with the state Coastal Zone Management Program. If the project is within or affects a resource within the coastal zone, provide the date the applicant sent the consistency certification information to the state agency, the date the state agency received the certification, and the date and action taken by the state agency (for example, the agency will either agree or disagree*

with the consistency statement, waive it, or ask for additional information). Describe any conditions placed on the state agency's concurrence and assess the conditions in the appropriate section of the license application. If the project is not in or would not affect the coastal zone, state so and cite the coastal zone program office's concurrence.

(v) National Historic Preservation Act (NHPA). Section 106 of NHPA requires the Commission to take into account the effect of licensing a hydropower project on any historic properties, and allow the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on the proposed action. "Historic Properties" are defined as any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP). If there would be an adverse effect on historic properties, the applicant may include a Historic Properties Management Plan (HPMP) to avoid or mitigate the effects. The applicant must include documentation of consultation with the Advisory Council, the State Historic Preservation Officer, Tribal Historic Preservation Officer, National Park Service, members of the public, and affected Indian tribes, where applicable.

(vi) Pacific Northwest Power Planning and Conservation Act (Act). If the project is not within the Columbia River Basin, this section shall not be included. The Columbia River Basin Fish and Wildlife Program (Program) developed under the Act directs agencies to consult with Federal and state fish and wildlife agencies, appropriate Indian tribes, and the Northwest Power Planning Council (Council) during the study, design, construction, and operation of any hydroelectric development in the basin. Section 12.1A of the Program outlines conditions that should be provided for in any original or new license. The program also designates certain river reaches as protected from development. The applicant must document consultation with the Council, describe how the act applies to the project, and how the proposal would or would not be consistent with the program. (vii) Wild and Scenic Rivers and Wilderness Acts. Include a description of any areas within or in the vicinity of the proposed project boundary that are included in, or have been designated for study for inclusion in, the National Wild and Scenic Rivers System, or that have been designated as wilderness area, recommended for such designation, or designated as a wilderness study area under the Wilderness Act.

(4) Project facilities and operation. Provide a description of the project to include:

(i) Maps showing existing and proposed project facilities, lands, and waters within the project boundary;

(ii) The configuration of any dams, spillways, penstocks, canals, powerhouses, tailraces, and other structures;

(iii) The normal maximum water surface area and normal maximum water surface elevation (mean sea level), gross storage capacity of any impoundments;

(iv) The number, type, and minimum and maximum hydraulic capacity and installed (rated) capacity of existing and proposed turbines or generators to be included as part of the project;

(v) An estimate of the dependable capacity, and average annual energy production in kilowatt hours (or mechanical equivalent);

(vi) A description of the current (if applicable) and proposed operation of the project, including any daily or seasonal ramping rates, flushing flows, reservoir operations, and flood control operations.

(5) Proposed action and action alternatives.

(i) The environmental document must explain the effects of the applicant's proposal on resources.

For each resource area addressed include:

(A) A discussion of the affected environment;

(B) A detailed analysis of the effects of the applicant's licensing proposal and, if reasonably possible, any preliminary terms and conditions filed with the Commission; and

(C) Any unavoidable adverse impacts.

(ii) The environmental document must contain, with respect to the resources listed in the Pre-Application Document provided for in §5.6, and any other resources identified in the Commission's scoping document prepared pursuant to the National Environmental Policy Act and §5.8, the following information, commensurate with the scope of the project:

(A) Affected environment. The applicant must provide a detailed description of the affected environment or area(s) to be affected by the proposed project by each resource area. This description must include the information on the affected environment filed in the Pre-Application Document provided for in §5.6, developed under the applicant's approved study plan, and otherwise developed or obtained by the applicant. This section must include a general description of socio-economic conditions in the vicinity of the project including general land use patterns (e.g., urban, agricultural, forested), population patterns, and sources of employment in the project vicinity.

(B) Environmental analysis. The applicant must present the results of its studies conducted under the approved study plan by resource area and use the data generated by the studies to evaluate the beneficial and adverse environmental effects of its proposed project. This section must also include, if applicable, a description of any anticipated continuing environmental impacts of continued operation of the project, and the incremental impact of proposed new development of project works or changes in project operation. This analysis must be based on the information filed in the Pre-Application Document provided for in §5.6, developed under the applicant's approved study plan, and other appropriate information, and otherwise developed or obtained by the Applicant.

(C) Proposed environmental measures. The applicant must provide, by resource area, any proposed new environmental measures, including, but not limited to, changes in the project design or operations, to address the environmental effects identified above and its basis for proposing the measures. The applicant must describe how each proposed measure would protect or enhance the existing environment, including, where possible, a non-monetary quantification of the anticipated environmental benefits of the measure. This section must also include a statement of existing measures to be continued for the purpose of protecting and improving the environment and any proposed preliminary environmental measures received from the consulted resource agencies, Indian tribes, or the public. If an applicant does not adopt a preliminary environmental measure proposed by a resource agency, Indian tribe, or member of the public, it must include its reasons, based on project specific information.

(D) Unavoidable adverse impacts. Based on the environmental analysis, discuss any adverse impacts that would occur despite the recommended environmental measures. Discuss whether any such impacts are short- or long-term, minor or major, cumulative or site-specific.

(E) Economic analysis. The economic analysis must include annualized, current cost-based information. For a new or subsequent license, the applicant must include the cost of operating and maintaining the project under the existing license. For an original license, the applicant must estimate the cost of constructing, operating, and maintaining the proposed project. For either type of license, the applicant should estimate the cost of each proposed resource protection, mitigation, or enhancement measure and any specific measure filed with the Commission by agencies, Indian tribes, or members of the public when the application is filed. For an existing license, the applicant's economic analysis must estimate the value of developmental resources associated with the project under the current license and the applicant's proposal. For an original license, the applicant must estimate the value of the

developmental resources for the proposed project. As applicable, these developmental resources may include power generation, water supply, irrigation, navigation, and flood control. Where possible, the value of developmental resources must be based on market prices. If a protection, mitigation, or enhancement measure reduces the amount or value of the project's developmental resources, the applicant must estimate the reduction.

(F) Consistency with comprehensive plans. Identify relevant comprehensive plans and explain how and why the proposed project would, would not, or should not comply with such plans and a description of any relevant resource agency or Indian tribe determination regarding the consistency of the project with any such comprehensive plan.

(G) Consultation Documentation. Include a list containing the name, and address of every Federal, state, and interstate resource agency, Indian tribe, or member of the public with which the applicant consulted in preparation of the Environmental Document.

H) Literature cited. Cite all materials referenced including final study reports, journal articles, other books, agency plans, and local government plans.

(6) The applicant must also provide in the Environmental Document:

(A) Functional design drawings of any fish passage and collection facilities or any other facilities necessary for implementation of environmental measures, indicating whether the facilities depicted are existing or proposed (these drawings must conform to the specifications of §4.39 of this chapter regarding dimensions of full-sized prints, scale, and legibility);

(B) A description of operation and maintenance procedures for any existing or proposed measures or facilities;

(C) An implementation or construction schedule for any proposed measures or facilities, showing the intervals following issuance of a license when implementation of the measures or construction of the facilities would be commenced and completed;

(D) An estimate of the costs of construction, operation, and maintenance, of any proposed facilities, and of implementation of any proposed environmental measures.

(E) A map or drawing that conforms to the size, scale, and legibility requirements of §4.39 of this chapter showing by the use of shading, cross-hatching, or other symbols the identity and location of any measures or facilities, and indicating whether each measure or facility is existing or proposed (the map or drawings in this exhibit may be consolidated).

1 INTRODUCTION

1.1 FirstLight's Application for a New License

FirstLight Hydro Generating Company (FirstLight), in accordance with Sections (§§) 5.17 and 5.18 of Title 18 of the Code of Federal Regulations (CFR), is filing with the Federal Energy Regulatory Commission (FERC or Commission) an Application for New License for Major Project- Existing Dam. The current license for the Turners Falls Hydroelectric Project (Turners Falls Project) was issued on May 5, 1980 and expires on April 30, 2018. The license for the Northfield Mountain Pumped Storage Project was issued on May 14, 1968 and also expires on April 30, 2018. Although the Turners Falls Project and Northfield Project are currently licensed as separate projects, FirstLight is seeking a single license for both developments, and will hereafter refer to the Turners Falls Project as the Turners Falls Development and the Northfield Project as the Northfield Mountain Pumped Storage Development or collectively as the Northfield Project (or Project).

The Turners Falls Development includes the Turners Falls Dam, which creates the Turners Falls Impoundment (TFI) on the Connecticut River. The Turners Falls Dam consists of two individual concrete gravity dams, referred to as the Gill Dam and Montague Dam, which are connected by a natural rock island known as Great Island. The 630-foot-long Montague Dam connects Great Island to the west bank of the Connecticut River and includes four bascule type gates, each 120 feet wide by 13.25 feet high and a fixed crest section which is normally not overflowed. The Gill Dam is approximately 55-feet-high and 493-feet-long extending from the Gill shoreline (east bank) to Great Island and includes three tainter spillway gates, each 40-foot-wide by 39-foot-high.

Adjacent to the Montague Dam is the 214-foot-long gatehouse equipped with 15 operating gates controlling flow to the power canal. Six (6) of the gates are 10'-8" high by 9' wide wooden gates and nine (9) of the gates are 12'-7" high by 9'-6" wide wooden gates. The Gatehouse fishway, described below, passes through the gatehouse at the east bank.

The power canal is approximately 2.1 miles long and ranges in width from approximately 920 feet in the Cabot Station forebay (downstream terminus of canal) to 120 feet in the canal proper. The canal has a design capacity of approximately 18,000 cfs. Several entities withdraw water from the power canal. The major ones are FirstLight's Station No. 1 and Cabot Station. Station No. 1 is located closer to the beginning of the power canal and Cabot Station is located at the downstream terminus of the power canal. The generation and hydraulic capacity of Station No. 1 are 5,963 kW and 2,210 cfs, respectively. The generation and hydraulic capacity of Cabot Station are 62.016 MW and 13,728 cfs, respectively.

The Turners Falls Development is equipped with three upstream fish passage facilities, including (in order from downstream to upstream): the Cabot fishway, the Spillway fishway, and the Gatehouse fishway. The Cabot fishway moves migrating fish from the Connecticut River into the power canal. The Spillway fishway moves migrating fish from the Connecticut River into a gallery leading to the Gatehouse fishway, where they rejoin fish that have passed to this point via the Cabot fishway; however some fish do drop out into the canal. The Gatehouse fishway moves fish from the power canal to above the Turners Falls Dam. A downstream fish passage facility is located at Cabot Station, at the downstream terminus of the power canal. Assuming no spill is occurring at Turners Falls Dam, fish moving downstream pass through the gatehouse (which has no racks) and into the power canal.

The TFI extends approximately 20 miles upstream to just below the Vernon Hydroelectric Project (FERC No. 1904), which is owned and operated by TransCanada. To provide storage capacity for the Northfield Mountain Pumped Storage Development, the TFI elevation may vary, per the FERC license, from a minimum elevation[1] of 176.0 feet to a maximum elevation of 185.0 feet constituting a 9 foot fluctuation as measured at the Turners Falls Dam. The usable storage capacity in this 9 foot fluctuation, as measured at the Turners Falls Dam, is approximately 16,150 acre-feet.

The Northfield Mountain Pumped Storage Development consists of an Upper Reservoir and dam/dikes, an intake, pressure shaft, underground powerhouse and tailrace. The crest elevation of the Upper Reservoir's Main Dam is at elevation 1010 feet. In addition to the Main Dam there are several dam/dikes forming the Upper Reservoir. The Upper Reservoir elevation may vary, per the FERC license, from a minimum elevation of 938 feet to a maximum elevation of 1000.5 feet constituting a 62.5 foot drawdown. FERC has allowed temporary variances to increase the maximum and minimum elevation to 1004.5 feet and 920 feet, respectively, during certain periods to meet electric grid system needs.

The intake channel directs water from the Upper Reservoir into the pressure conduit intake and eventually to the underground powerhouse. The electrical capacity of each of the four (4) reversible pump-turbines is 291.7 MW for a total station nameplate capacity of 1,166.8 MW. When operating at maximum pumping mode, the approximate hydraulic capacity is 15,200 cfs. Alternatively, when operating at maximum generation mode, the approximate hydraulic capacity is 20,000 cfs.

Because many studies needed to inform a FirstLight proposal are incomplete[2], FirstLight's relicensing proposal set forth in this Final License Application (FLA) is limited to changes in the operation of the Upper Reservoir, minor changes to the Project Boundary, the support of public recreation at the Project through a Recreation Management Plan (RMP), and the management of historic properties through a Historic Properties Management Plan (HPMP). FirstLight is proposing to file an Amended FLA on April 30, 2017 which would include a more complete proposal for future Project operations and Protection, Mitigation and Enhancement (PM&E) measures. FirstLight is proposing to utilize more of the Upper Reservoir storage capacity year round. As noted above and again in Exhibit A, the current FERC license allows the Upper Reservoir to operate between 1000.5 feet to 938 feet, for a 62.5 foot drawdown. FirstLight proposes to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown.

1.2 Purpose of Action and Need for Power

1.2.1 Purpose of Action

FERC must decide whether to issue a new hydropower license to FirstLight for the Project and what conditions should be placed on any license issued. In deciding whether and under what conditions to issue a license for a hydroelectric project, pursuant to Section 10(a)(1) of the Federal Power Act (FPA), FERC must determine that the Project will be best adapted to a comprehensive plan for improving or developing the waterway. In addition to the power and developmental purposes for which licenses are issued, FERC is required under Section 4 (e) of the FPA to give equal consideration to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of, fish and wildlife (including related spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality.

Issuing a new license for the Project would allow FirstLight to continue to generate and transmit electricity at the Project for the term of the new license, making electric power from a renewable resource available to serve regional demand.

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[1]The Project datum is the National Geodetic Vertical Datum of 1929 (NGVD29). All elevations in the license application are based on the NGVD29 datum unless otherwise noted.

[2] Due to the closure of the Vermont Yankee Nuclear Power Station in December 2014, FERC delayed the start of 13 fish and aquatic and water quality studies until 2015 (11 studies) and 2016 (2 studies).

Exhibit E of this license application has been prepared in accordance with 18 CFR § 5.18(b) and in general conformance with the Commission's Preparing Environmental Assessments: Guidelines for Applicants, Contractors and Staff (FERC, 2008). Exhibit E is designed to support FERC's required analysis under the National Environmental Policy Act of 1969 (NEPA), as amended. The Exhibit, when finalized as part of an amended FLA to be filed on April 30, 2017, will analyze the environmental and economic effects associated with the continued operation of the Project, as proposed by FirstLight. This Exhibit, again when finalized, will include additional measures proposed by FirstLight for the PM&E of resources that would potentially be affected by FirstLight's proposed Project. The effects of a no-action alternative will also be considered.

1.2.2 Need for Power

The Project is located within the ISO-New England (ISO-NE) power system, which is responsible for dispatch and movement of wholesale power in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. ISO-NE prepares a 10-year load projection in energy demand, which it utilizes to plan improvements to the existing transmission system. ISO-NE currently predicts that the New England region, peak summer energy usage demand for the 10-year period from 2014 through 2023 will increase annually by 1.3%[3]. Over the term of the license, the Project will provide power and ancillary services to help meet this growing demand.

The Turners Falls Development is operated as a baseload, voltage control, and reserve capacity facility within the regional electrical system. The Turners Falls Development consists of Cabot and Station No. 1 having a total electrical capacity of 67.699 MW and an average annual generation of 328,022 MWh (based on period 2000-2014).

The Northfield Mountain Pumped Storage Development is vitally important to the reliability and efficient operation of the New England electric grid. With the Upper Reservoir at its current maximum elevation of 1000.5 ft, it can operate at full generating capacity output from its four (4) generating units for approximately 8.5 hours and produce 8,729[4] MWH of power. The Northfield Mountain Pumped Storage Development has a total electrical capacity of 1,166.80 MW and an average annual generation of 1,053,891 MWh (based on period 2000-2014, excluding 2010). During high electrical demand periods, such as excessively warm periods in the summer, the Northfield Mountain Pumped Storage Development is called upon by ISO-NE to meet electrical demands, including significant ramping demands, or held for quick start contingency response as needed to meet the circumstances.

ISO-NE is an independent, non-profit, Regional Transmission Organization, responsible for reliably operating New England's approximately 32,000 MW bulk electric power generation and transmission system. During many periods of the year, ISO-NE calls upon the Northfield Mountain Pumped Storage Development to balance the system to accommodate both changes in load and generation. In the last 12 years, FirstLight has obtained five (5) temporary amendments from FERC to utilize additional Upper Reservoir storage that the Project was designed to provide for generation during periods of high electrical demand in New England. During these times, possessing reliable energy supplies and significant operating flexibility at the Northfield Mountain Pumped Storage Development to address both load and supply changes (e.g. changing interchange schedules, accommodating block loading of other units' commitment and decommitment) is critical to ISO-NE's reliable operation of the power system. The Northfield Mountain Pumped Storage Development provides critical energy, operating reserves and operational flexibility to ISO-NE system operation.

[3]ISO-NE Regional System Plan for 2014 at Section 1.3.1.1 (page 9) – *(Comment – the section states "The ISO forecasts the 10-year growth rate to be 1.3% per year for the summer peak demand, 0.6% per year for the winter peak demand, and 1.0% per year for the annual use of electric energy. The annual load factor (i.e., the ratio of the average hourly load during a year to peak hourly load) continues to decline from 56.1% in 2014 to 54.7% in 2023.")*

[4] This number was historically published as 8,475 MWH, but with the completion of work on Unit 1, the new value is 8,729 MWH between elevations 1000.5 and 938 feet and 10,779 MWH between elevations 1004.5 and 920 feet.

In December 2014, the Vermont Yankee Nuclear Power Station (619 MW), located in Vernon, VT was permanently taken off-line. In addition, the owners of the Pilgrim Nuclear Power Station (680 MW), located in Plymouth, MA have announced this it will close no later than May 31, 2019. Several of the region's older generators—and some of its largest—have already ceased operations or plan to exit the markets by 2018. They take with them over 3,500 MW of regional capacity including: Braydon Point Station (1,535 MW from oil and coal), Mount Tom Station (143 MW from coal), Norwalk Harbor Station (342 MW from oil), Salem Harbor Station (749 MW from oil and coal) and Vermont Yankee (609 MW from nuclear). In addition to these facilities, ISO-NE notes several other facilities at risk.

The value of the Northfield Mountain Pumped Storage Development was demonstrated following the August 14, 2003 major blackout in the New York ISO (NY-ISO) grid. On August 15, ISO-NE parted all electrical ties to the New York electrical system to prevent the blackout from spreading further. When it was time to rejoin the two power grids, ISO-NE requested the connection be made at the Northfield Mountain Pumped Storage Development. Once the lines were energized, final adjustments were made by having the Northfield Mountain Pumped Storage Development reduce generation to allow for a smooth synchronization of the two systems. The interconnection of the two systems allowed NY-ISO to begin restoration of the north portion of the NY power grid.

The Turners Falls Development and the Northfield Mountain Pumped Storage Development provide power that displaces generation that would likely be obtained from non-renewable sources. It displaces the operation of fossil-fueled thermal electric facilities and reduces power plant emissions, thus creating an environmental benefit.

1.3 Applicable Statutory and Regulatory Requirements

Issuance of a new license for the Project is subject to numerous requirements under the FPA and other applicable statutes. The major acts and related requirements are described below. Actions undertaken by FirstLight or the agency with jurisdiction related to each requirement also are described.

1.3.1 Clean Water Act

Section 401 of the Clean Water Act (CWA) requires FirstLight to obtain certification from the state in which the Project discharges water of the Project's compliance with applicable provisions of the CWA, or a waiver of certification from the appropriate state agency, which for the Project is the Massachusetts Department of Environmental Protection (MADEP). FERC regulations require that a request for CWA Section 401 certification be filed within 60 days of FERC's issuance of a notice of acceptance of the final license application and ready for environmental analysis (REA). FirstLight has consulted with the MADEP throughout the relicensing. FirstLight is prepared to file its application for CWA Section 401 certification with the MADEP in a timely manner.

1.3.2 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires Federal agencies to consult with the USFWS and NMFS to ensure that their actions are not likely to jeopardize the continued existence of any threatened or endangered species, or result in the destruction or adverse modification of critical habitat for these listed species. FirstLight has been designated as FERC's non-federal representative for purposes of informal consultation with the USFWS and NMFS under Section 7 of the ESA, which is ongoing.

Several species listed as threatened or endangered under the ESA occur or may occur in the Project area. FirstLight will develop a draft Biological Assessment to evaluate the impacts of relicensing the Project on such species once relicensing studies are complete and FirstLight files an amended FLA on April 30, 2017.

1.3.3 Magnuson-Fishery Conservation and Management Act

The Magnuson-Fishery Conservation and Management Act requires Federal agencies to consult with the Secretary of Commerce with respect to any action it undertakes that may adversely affect Essential Fish

Habitat (EFH). Although NMFS has designated EFH for Atlantic salmon on the Connecticut River, the designation only applies to the mixing water and brackish salinity zone and tidal freshwater salinity zone of the Connecticut River; it does not apply to the Project area. The CRASC has ceased its Atlantic salmon restoration efforts due to low return rates and the shifting focus to other migratory fish (including the catadromous American Eel). Accordingly, FirstLight does not anticipate that relicensing the Project will adversely affect EFH for Atlantic salmon. EFH has not been designated for any other species in the Project area.

1.3.4 Coastal Zone Management Act of 1972

Under § 307(c)(3)(A) of the Coastal Zone Management Act of 1972, as amended, (CZMA), (16 U.S.C. § 1456(3)(A)), the Commission cannot issue a license for a Project within or affecting a state's coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program or waives its concurrence.

The official Massachusetts coastal zone includes the lands and waters within an area defined by the seaward limit of the state's territorial sea, extending from the Massachusetts-New Hampshire border south to the Massachusetts-Rhode Island border, and landward to 100 feet inland of specified major roads, rail lines, other visible rights-of-way. The Project is not located within the state's coastal zone boundary and does not affect any land or water use or natural resource of the state's coastal zone. Therefore, the Project is not subject to Massachusetts coastal zone program review. In correspondence dated June 9, 2015, the Massachusetts Office of Coastal Zone Management confirmed that the relicensing the Project is not an activity subject to the state's federal consistency review. The state's letter is attached as Appendix A of Exhibit E.

1.3.5 National Historic Preservation Act of 1966

As the lead Federal agency for hydropower relicensing, FERC is required to take into account the effects of its undertakings on historic properties under Section 106 of the National Historic Preservation Act (NHPA). FERC designated FirstLight as its non-Federal representative for prefiling consultation under Section 106 by notice issued December 21, 2012.

As part of its role as FERC's non-federal representative, FirstLight developed and executed several studies to identify and assess, in consultation with the MHC, VDHP and NHDHR, Nolumbeka Inc., and potentially affected Indian tribes, any adverse effects on historic properties resulting from continued operation of the Project, as required under 36 CFR § 800.5. The results of those studies are discussed in Section 3.3.8 and provide the basis for FirstLight's draft HPMP, which is being filed as part of this FLA.

1.4 Public Review and Consultation

The Commission's regulations (18 CFR § 5.1(d)) require an applicant to consult with appropriate Federal and state agencies, Indian tribes, and members of the public that may be interested in the proceeding before filing an application for a license. In addition, Section 5.18(b)(5)(ii)(G) requires documentation of such consultation in the form of a list of consulted entities. Confirmation of FirstLight's prefiling consultation is included in Section 6.

1.4.1 Scoping

Issuance of a license requires preparation of either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS), in accordance with the NEPA. The preparation of an EA or EIS is supported by a scoping process to ensure the identification and analysis of all pertinent issues.

On December 21, 2012, the Commission issued a notice of commencement of proceeding stating FERC intended to prepare an EIS for the Project together with three other hydroelectric projects owned and operated by TransCanada, located in series on the Connecticut River above the Turners Falls Dam. These three projects previously had the same license expiration date as the FirstLight Project (April 30, 2018).

However, on January 16, 2015, TransCanada requested a 1-year license extension, which was granted by FERC on July 22, 2015 making the new license expiration date April 30, 2019. The projects in downstream to upstream order include Vernon Hydroelectric Project (FERC No. 1904), Bellows Falls Hydroelectric Project (FERC No. 1855) and Wilder Hydroelectric Project (FERC No. 1892).

Also on December 21, 2012, the Commission issued Scoping Document 1 (SD1). SD1 provided Relicensing Participants with FERC's preliminary list of issues and alternatives to be addressed in an EIS, for the Project relicensing and enabled Relicensing Participants to more effectively participate in and contribute to the scoping process.

The Commission held three public scoping meetings as follows:

- Projects: Vernon Project, Northfield Mountain Pumped Storage Development and Turners Falls Development - Turners Falls, MA (January 30, 2013)
- Projects: Northfield Mountain Pumped Storage Development and Turners Falls Development-Turners Falls, MA (January 31, 2013)
- Projects: Cumulative River Projects' Cumulative Effects- Turners Falls, MA (January 31, 2013)

A site visit to the FirstLight Developments was conducted on October 4, 5 and 11, 2012. Though typically the site visits are held after the filing of the Pre-Application Document (PAD) and in association with the scoping process, FERC held the site visits prior to formal scoping meetings before the onset of winter limited access to the project facilities. The scoping meetings (January 30-31, 2013) and site visits (October, 4, 5, 11, 2012) were noticed in a local newspaper and the Federal Register. The scoping meetings were recorded and the transcript posted by the Commission on its Internet E-Library.

The Commission requested that written comments on SD1 and FirstLight's PAD be provided to the Commission no later than March 1, 2013. In addition to the oral comments received during the scoping meetings, the Commission received over 50 comment letters by the March 1, 2013 deadline. Table 1.4.1-1 lists Relicensing Participants that filed comments on SD1.

Based on the Commission's review of oral comments during the January 30 and 31 scoping meetings and written comments on SD1 and the PAD, on April 15, 2013, the Commission issued Scoping Document 2 (SD2), which replaced SD1.

1.4.2 Interventions

At this time, the Commission has not solicited motions to intervene.

1.4.3 Relicensing Studies

1.4.3.1 FERC's Determination on Revised Study Plan

Pursuant to 18 C.F.R. § 5.11 of the Commission's regulations, FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013, and distributed the PSP to interested resource agencies and stakeholders for review and comment. In addition, pursuant to 18 C.F.R. § 5.11(e), FirstLight held an initial meeting on all studies in the PSP at the Northfield Mountain Visitor Center at the Northfield Mountain Pumped Storage Development on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on each PSP and on studies not being proposed. On June 28, 2013, although not required by FERC regulations, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed with FERC a Revised Study Plan (RSP) on August 14, 2013, which addressed stakeholder comments.

On August 27, 2013 Entergy Corp. announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the FirstLight Project, would be closing no later than December 29, 2014. With the closure of VY, certain environmental baseline conditions were anticipated to change during the relicensing study period. On

September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which 20 studies were approved, or approved with FERC modifications. However, due to the impending closure of VY, FERC did not act on 18 proposed or requested studies pertaining to aquatic resources. The SPDL for these 18 studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013 regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPDL on the remaining 18 studies on February 21, 2014, approving the RSP with certain modifications. Table 1.4.3.1-1 lists the 38 studies included in FirstLight's RSP and the additional one (1) study emanating from the study dispute described next. Thus, the total number of FERC-approved studies is 39.

1.4.3.2 FERC's Determination Regarding Study Disputes

On March 13, 2014, the USFWS filed with FERC a notice of study dispute regarding FERC's February 21, 2014 SPDL. The USFWS dispute focused on an entrainment study of the early life stage of American Shad at the Northfield Mountain Pumped Storage Development. Table 1.4.3.2-1 summarizes the communications relative to the Study Dispute. In the end, FirstLight and the USFWS came to agreement on conducting the study and thus FERC did not act on the dispute.

On January 22, 2015, FERC issued its Determination on Requests for Study Modifications and New Studies. In it, FERC approved the ichthyoplankton study plan submitted by FirstLight on October 16, 2014, with modification.

1.4.3.3 FERC's Determination on Initial Study Report

FirstLight filed with FERC an Initial Study Report (ISR) on the 38 studies required by the FERC determination on September 16, 2014 (the ichthyoplankton study had not been approved by this date). Of the 38 required studies, FirstLight filed study reports for the following:

- Study No. 3.1.1, 2013 Full River Reconnaissance
- Study No. 3.6.2 Recreation Facilities Inventory and Assessment

FirstLight held ISR meetings on September 30, October 1 and October 15, 2014. FirstLight filed a meeting summary for the September 30 and October 1 meetings on October 15, 2014. FirstLight filed a meeting summary for the October 15 meeting on November 4, 2014. Fifteen (15) stakeholders filed letters regarding FirstLight's ISR with FERC. On January 22, 2015, FERC issued a Determination on Requests for Study Modifications and New Studies. In that letter FERC approved modifications to Study No. 3.3.9 *2D Modeling of the Northfield Mountain Pumped Storage Development Tailrace*, and Study No. 3.3.12 *TFI Littoral Zone and Spawning Habitat*. In addition FERC approved, in part, certain modifications to Study Nos. 3.1.1, 3.1.2, 3.3.4, 3.3.14 and 3.6.2[5]. Requested modifications to Study Nos. 3.3.1, 3.3.12 and 3.6.1[6], and the requested new study to identify habitat suitability parameters for state-listed mussel species were not approved by FERC. FERC required addendums to Study Nos. 3.1.1 and 3.6.2, which FirstLight filed on February 24, 2015 and June 15, 2015, respectively.

On December 31, 2014, FirstLight filed two other reports as follows:

- Study No. 3.7.1 Phase IA, IB, and Phase II Archaeological Surveys (one report for the MA portion of the Project and one report for the NH and VT portions of the Project)[7]

[5] Study Nos. 3.1.1: *2013 Full River Reconnaissance*, 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*, 3.3.4 *Evaluate Upstream Passage of American Eel*, 3.3.14 *Aquatic Habitat Mapping of the Turners Falls Impoundment* , and 3.6.2 *Recreation Facilities Inventory*.
[6] Study Nos. 3.3.1: *Instream Flow Studies in Bypass Channel and below Cabot Station*, 3.3.12 *Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Cabot Tailrace*, 3.6.1 *Recreation Use/User Contact Survey*.
[7] For the archaeological survey study, only a Phase IA report was filed.

- Study No 3.7.2 Historic Structures Inventory and National Register Evaluation

Subsequently, FirstLight filed additional reports related to Study Nos. 3.7.1 and 3.7.2.

- On May 15, 2015 FirstLight filed a revised Phase IA (Reconnaissance) Archaeological Survey report for the Massachusetts portion of the Project in response to MHPC comments on the December 2014 report.
- On November 16, 2015, FirstLight filed an Addendum to the report for Study No. 3.7.2 Historic Structures Inventory and National Register Evaluation in response to comments from the MHPC on the December 2014 report.

1.4.3.4 FERC's Determination on Updated Study Report

FirstLight filed with FERC an Updated Study Report (USR) on September 14, 2015, and held an USR meeting on September 29-30, 2015. FirstLight filed an USR meeting summary on October 14, 2015 and stakeholder comments were due by November 13, 2015. FirstLight filed a response summary to stakeholder comments on December 14, 2015. FirstLight filed study reports for the following studies:

- Study No. 3.3.2 Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot
- Study No. 3.3.4 Evaluate Upstream Passage of American Eel at Turners Falls (Year 1 results)
- Study No. 3.3.14 Aquatic Habitat Mapping of Turners Falls Impoundment
- Study No. 3.3.17 Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat
- Study No. 3.3.18 Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms
- Study No. 3.4.2 Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats
- Study No. 3.6.3 Whitewater Boating Evaluation
- Study No. 3.6.4 Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats
- Study No. 3.6.7 Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use
- Study No. 3.7.3 Traditional Cultural Properties

FERC issued its Determination on Requests for Study Modifications and New Studies on January 15, 2016. In its Determination, FERC required addendums on Study Nos. 3.2.2 and 3.3.18, which FirstLight filed on March 1, 2016.

FirstLight filed with FERC several study reports on March 1, 2016, and held a study report meeting on March 16, 2016. FirstLight filed a study report meeting summary on March 31, 2016 and stakeholder comments are due by May 2, 2016. FirstLight anticipates filing a response to stakeholder comments on May 30, 2016. The following reports were filed on March 1, 2016.

- Study No. 3.3.1 Water Quality Monitoring Study
- Study No. 3.3.4 Evaluate Upstream Passage of American Eel at Turners Falls (Year 2 results)
- Study No. 3.3.6 Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects
- Study No. 3.3.8 Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays
- Study No. 3.3.9 Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace
- Study No. 3.3.10 Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

- Study No. 3.3.11 Fish Assemblage Assessment
- Study No. 3.3.12 Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station
- Study No. 3.3.20 Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project
- Study No. 3.4.1 Baseline Study of Terrestrial Wildlife and Botanical Resources
- Study No. 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species
- Study No. 3.6.1 Recreation Use/User Contact Survey
- Study No. 3.6.5 Land Use Inventory

It is anticipated that FERC will issue its Determination on Requests for Study Modifications and New Studies on the above studies around June 29, 2016.

1.4.3.5 Study Status

Thirteen (13) of the 39 FERC studies remain to be completed. FirstLight proposes to file the remaining studies on the remaining studies as set forth in Table 1.4.3.5-1 or as directed by FERC in its process plan and schedule. Three (3) studies are slated for field work in 2016. Based on discussions between USFWS, NMFS, MADFW, FERC and FirstLight on April 25, 2016, FirstLight has committed to conducting Study No. 3.3.20 *Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project* again in 2016. The 2016 study will sample entrainment once per week without manipulating the pumping scenarios and validation sampling via boat in the river is planned each night a sample is collected. The field work is slated to be initiated in May 2016. FirstLight is targeting to complete the study report or amend the 2015 report by October 14, 2016.

1.4.3.6 Comments on the Draft License Application

On December 2, 2015, FirstLight filed with FERC and made available to stakeholders a Draft License Application (DLA). Eleven letters regarding FirstLight's DLA were field with FERC within the 90-day comment period, which ended on March 1, 2016. Table 1.4.4-1 lists the commenters and the date of their letter.

FirstLight has addressed the various comment letters that were received on the DLA, consistent with the regulatory requirements of 18 CFR § 5 and the related FERC guidance. Refer to Appendix B of this Exhibit E for a reply to comments requesting additional studies or clarification of material in the DLA.

Table 1.4.1-1: Scoping Comment Summary

Relicensing Participant	Association	Date of Letter
Jennifer Tufts	Northfield Open Space Committee	1/31/2013
Thomas and Patricia Shearer	Public	1/31/2013
Warren Ondras	Public	1/31/2013
Board of Selectman	Town of Montague	2/06/2013
Mike Bathory, Alan Wallace	Landowners and Concerned Citizens for License Compliance (LCCLC)	2/11/2013
Mary Joe Maffei, Manager	Manager of Amherst High School Nordic Ski Team	2/16/2013
Peter Conway Stanley and Geri Johnson Robert and Linda Emond Walter and Mary Ann Patenaude Michael and Diane Kane Cynthia Dale Robert Strafford and Family Leena Newcomb Vivien Venskowski Betsy and Jean Egan	The River Residents Association (RRA)	2/16/2013- 3/01/2013
Nathan L'Etoile, Co-Owner	Four Star Farms (FSF)	2/20/2013
Jeffrey Squire, President	Western Massachusetts Climbers' Coalition	2/20/2013
Board of Selectman	Town of Montague	2/21/2013
Bill Llewelyn, Chair	Town of Northfield Conservation Commission (NCC)	2/22/2013
Barbara Skuly, Chairman	Ashuelot River Local Advisory Committee (ARLAC)	2/24/2013
Karl Meyer	Public	2/25/2013
Richard Bonanno, Director	Massachusetts Farm Bureau Federation, Inc (MAFBF)	2/25/2013
River Resident (no name given)	Public	2/26/2013
Louis Chiarella, Mary Colligan	National Marine Fisheries Service (NMFS)	2/27/2013
Glen Normandeau, Executive Director	New Hampshire Fish and Game Department (NHFGD)	2/27/2013
Caleb Slater, Thomas French	Massachusetts Division of Fisheries and Wildlife (MADFW), Natural Heritage and Endangered Species Program (NHESP)	2/28/2013
Chris Curtis	Public	2/28/2013
Ken Kimball, Norm Sims	Appalachian Mountain Club (AMC)	2/28/2013
Ken Kimball, Norm Sims, Bob Nasdor, Thomas Christopher	AMC, American Whitewater Association (AWWA), New England Flow (NE FLOW)	2/28/2013
Dr. Richard Palmer	University of Massachusetts at Amherst (UMass)	2/28/2013
Carolyn Shores Ness, Vice Chair	Franklin Conservation District (FCD)	2/28/2013

Relicensing Participant	Association	Date of Letter
Ken Kimball, Norm Sims, Noah Pollock, Stephan Syz	AMC, Vermont River Conservancy (VRC), Friends of the Connecticut River Paddlers (FCRP)	2/28/2013
Kevin Mendik	National Park Service (NPS)	2/28/2013
Joseph Graveline, President	The Nolumbeka Project, Inc	2/28/2013
Bill Perlman, Jerry Lund, Tom Miner	Franklin Regional Council of Governments (FRCOG)	3/01/2013
Mike Bathory	LCCLC	3/01/2013
Gill Selectboard	Town of Gill	3/01/2013
Robert Kubit	Massachusetts Department of Environmental Protection (MADEP)	3/01/2013
Roger Noonan, President	New England Farmers Union (NEFU)	3/01/2013
Don Pugh	Deerfield River Chapter of Trout Unlimited (DRTU)	3/01/2013
Rebecca Brown, President	Connecticut River Joint Commissions (CRJC)	3/01/2013
Elizabeth Muzzey, Director and State Historic Preservation Officer	New Hampshire Division of Historical Resources (NHDHR)	3/01/2013
Brian Fitzgerald, Streamflow Protection Coordinator	Vermont Department of Environmental Conservation (VTDEC)	3/01/2013
Gregg Comstock, PE, Supervisor, Water Quality Planning	New Hampshire Department of Environmental Services (NHDES)	3/01/2013
Kim Lutz, Director, Kathryn Mickett Kennedy, Applied River Scientist	The Nature Conservancy (TNC)	3/01/2013
Howard Fairman	Public	3/01/2013
Richard Bonanno, President	Massachusetts Farm Bureau Federation Inc. (MAFBF)	3/01/2013
Andrea Donlon, River Steward	Connecticut River Watershed Council (CRWC)	3/01/2013
Stephanie Krug, President	New England Mountain Biking Association (NEMBA)	3/01/2013
Stephanie Krug, President	NEMBA	3/01/2013
Tim Welsh	FERC	3/01/2013
Thomas Chapman, Supervisor	United States Fish and Wildlife Service (USFWS)	3/01/2013
Joanne McGee	Public	3/01/2013
Kurt Heidinger, Director	BioCitizens	3/01/2013
Don Stevens, Chief	Nulhegan Band of the Coosuk- Abenaki Nation	3/18/2013

Table 1.4.3.1-1: FERC Study Determination Summary

Study No.	Study Name	Studies Proposed by FirstLight in its RSP	Studies Approved or Modified by FERC in its September 13, 2013 Determination		Studies Approved or Modified by FERC in its February 21, 2014 Determination		Study Reports where Addendum required by FERC in its January 22, 2015 Determination on Request for Study Modification and New Studies	Study Reports where Addendum required by FERC in its January 15, 2016 Determination on Request for Study Modification and New Studies
			Approved	**Modified**	**Approved**	**Modified**		
3.1.1	2013 Full River Reconnaissance	X		X			X	
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing and Potential Bank Instability	X		X				
3.1.3	Northfield Mountain Project Sediment Management Plan	X		X				
3.2.1	Water Quality Monitoring Study	X				X		
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypassed Reach and the Connecticut River below Cabot Station	X		X				X
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	X				X		
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	X				X		
3.3.3	Evaluate Downstream Passage of Juvenile Shad	X				X		
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls Project (two year study)	X	X		X			
3.3.5	Evaluate Downstream Passage of American Eel	X				X		
3.3.6	Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects	X				X		
3.3.7	Fish Entrainment and Turbine Mortality Study	X				X		
3.3.8	Computational Fluid Dynamics Modeling of the Fishway Entrances and Powerhouse Forebays	X		X				
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace	X		X				
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	X				X		
3.3.11	Fish Assemblage Assessment	X				X		
3.3.12	Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station	X			X			
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	X				X		
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	X			X			
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas	X				X		
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station	X				X		
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary Backwater Area Access and Habitat	X			X			
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	X				X		X
3.3.19	Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	X	This study plan was formally approved by FERC on February 25, 2016			X		
3.3.20	Entrainment of American Shad Ichthyoplankton at the Northfield Mountain Pumped Storage Project	Based on discussions between USFWS, NMFS, MADFW, FERC and FirstLight on April 25, 2016, FirstLight has committed to a second year of field work in 2016.						
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, in the Bypass Reach and below Cabot Station within the Project Boundary	X	X					
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitat	X	X					
3.5.1	Baseline Inventory of Wetland, Riparian, and Littoral Habitat in Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species	X		X				
3.6.1	Recreation Use/User Contact Survey	X		X				
3.6.2	Recreation Facilities Inventory and Assessment	X		X			X	
3.6.3	Whitewater Boating Evaluation	X		X				

Study No.	**Study Name**	**Studies Proposed by FirstLight in** its RSP	**Studies Approved or Modified by FERC in its September 13, 2013 Determination**		**Studies Approved or Modified by FERC in its February 21, 2014 Determination**		**Study** Reports where Addendum required by FERC in its January 22, 2015 Determination on Request for Study Modification and New Studies	**Study** Reports where Addendum required by FERC in its January 15, 2016 Determination on Request for Study Modification and New Studies
			Approved	**Modified**	**Approved**	**Modified**		
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats	X		X				
3.6.5	Land Use Inventory	X	X					
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use	X	X					
3.6.7	Recreation Study of Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use	X		X				
3.7.1	Phase 1A Archaeological Survey	X		X				
3.7.2	Reconnaissance-Level Historic Structures Survey	X		X				
3.7.3	Traditional Cultural Properties Study	X		X				
3.8.1	Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation	X		X				

Table 1.4.3.2-1: Summary of Communications Regarding Study Dispute

Date	Action
March 26, 2014	Teleconference held with USFWS, FERC and FirstLight regarding the study dispute.
March 28, 2014	FirstLight files letter with FERC including: Attachment A- graph of MWh pumping for the months of May, June and July for 1991-1993 and 2011-2013, Attachment B: Excel files for developing the Attachment A figures, and Attachment C: discharge comparison between the original and upgraded pumps at the Northfield Mountain Pumped Storage Development.
March 31, 2014	FERC issues notice of Dispute Resolution Panel Meeting and Technical Conference.
April 1, 2014	Teleconference held with USFWS, FERC and FirstLight regarding the study dispute.
April 7, 2014	FirstLight submits comments and information regarding the study dispute.
April 8, 2014	FERC holds Dispute Resolution Panel Meeting and Technical Conference at the Northfield Mountain Visitors Center.
April 15, 2014	As requested by the USFWS FirstLight submits a) drawings and photographs of the Northfield tailrace/intake and b) dye testing information.
April 22, 2104	Teleconference held with USFWS, FERC and FirstLight regarding the study dispute.
May 2, 2014	USFWS submits response to FirstLight's April 7, 2014 filing (above).
May 2, 2014	USFWS files conceptual framework for assessing ichthyoplankton entrainment at the Northfield Mountain Pumped Storage Development.
May 2, 2014	FirstLight submits letter supporting USFWS's proposed ichthyoplankton entrainment study at the Northfield Mountain Pumped Storage Development.
May 2, 2014	FERC issues notice of suspending the Dispute Resolution Panel until further notice.
September 3, 2014	FERC issues notice that FirstLight must develop a more detailed ichthyoplankton study plan by October 15, 2014.
October 16, 2014	FirstLight filed a detailed ichthyoplankton study plan with FERC.

Table 1.4.3.5-1: Proposed Study Report Filing Dates

Study No.	Title	Proposed FERC Filing Date
3.1.1	2013 Full River Reconnaissance	Already filed
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability	10/14/2016
3.1.3	Sediment Monitoring Study	10/14/2016
3.2.1	Water Quality Monitoring Study	Already filed
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot	Already filed
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	10/14/2016
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	10/14/2016
3.3.3	Evaluate Downstream Passage of Juvenile American Shad	10/14/2016
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls	Already filed
3.3.5	Evaluate Downstream Passage of American Eel (2015 & 2016 study)	3/1/2017
3.3.6	Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects	Already filed
3.3.7	Fish Entrainment and Turbine Passage Mortality Study	10/14/2016
3.3.8	Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays	Already filed
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace	Already filed
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	Already filed
3.3.11	Fish Assemblage Assessment	Already filed
3.3.12	Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station	Already filed
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	10/14/2016
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	Already filed
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area	10/14/2016
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station	Already filed
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat	Already filed
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	Already filed
3.3.19	Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	3/1/2017
3.3.20	Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project	2015 Study filed 2016 Study to be filed on 10/14/2016
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources	Already filed
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats	Already filed
3.5.1	Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species	Already filed
3.6.1	Recreation Use/User Contact Survey	Already filed
3.6.2	Recreation Facilities Inventory and Assessment	Already filed
3.6.3	Whitewater Boating Evaluation	Already filed

Study No.	Title	**Proposed** FERC Filing Date
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats	Already filed
3.6.5	Land Use Inventory	Already filed
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use	10/14/2016
3.6.7	Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use	Already filed
3.7.1	Phase 1A, 1B and II Archaeological Surveys	Already filed (Phase 1A only)
3.7.2	Survey and National Register Evaluation of Historic Architectural Resources	Already filed
3.7.3	Traditional Cultural Properties Study	Already filed
3.8.1	Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation and Hydropower Generation	3/1/2017

Table 1.4.4-1: List of Comment Letters Filed with FERC on FirstLight's Draft License Application

Commenter	Date of Letter
United States Fish and Wildlife Service	02/22/2016
Massachusetts Division of Fish and Wildlife	02/25/2016
Town of Montague, MA	02/29/2016
Karl Meyer	02/29/2016
Massachusetts Department of Environmental Protection	03/01/2016
The Nature Conservancy	03/01/2016
National Marine Fisheries Service	03/01/2016
Connecticut River Watershed Council	03/01/2016
United States Department of the Interior, National Park Service	03/01/2016
American Whitewater, Appalachian Mountain Club, New England Flow	03/01/2016
Federal Energy Regulatory Commission	03/01/2016

2 PROPOSED ACTIONS AND ALTERNATIVES

This section describes the existing Project (i.e., the No-Action Alternative) and FirstLight's proposed changes to the existing Project (i.e., proposed Project). Section 2.1 describes the No-Action Alternative, the baseline from which to compare all action alternatives. Section 2.2 describes FirstLight's proposed Project. Section 2.3 describes any other action alternatives proposed at this time. Section 2.4 describes alternatives considered but not analyzed in detail in this document.

2.1 No Action Alternative

Under the No-Action Alternative, the Project would continue to operate under the terms of the current license, including maintaining the current Project Boundary, facilities and operation and maintenance procedures.

2.1.1 Existing Project Facilities

The Turners Falls Development consists of: a) two individual concrete gravity dams, referred to as the Gill Dam and Montague Dam connected by a natural rock island, b) an approximate 20-mile long TFI serving as the lower reservoir for the Northfield Mountain Pumped Storage Development, c) a gatehouse, d) a power canal, e) two hydroelectric projects located on the power canal including Station No. 1 and Cabot Station, f) three fish passage facilities and g) a downstream fish passage facility located at the downstream terminus of the power canal. The Turners Falls Development also includes recreation facilities and use areas.

The Northfield Mountain Pumped Storage Development consists of a) an Upper Reservoir dams and dikes, b) an intake channel, c) pressure shaft, d) tailrace tunnel, e) powerhouse and d) tailrace. The Northfield Mountain Pumped Storage Development also includes recreation facilities and use areas.

The location of major Turners Falls Development and Northfield Mountain Pumped Storage Development facilities is shown in Figure 2.1.1-1 and 2.1.1-2, respectively.

Detailed descriptions of the above facilities are provided in Exhibit A of this license application.

2.1.2 Existing Project Boundary

The existing Project Boundary contains 7,246 acres of land and 2,238 acres of flowed land (Figure 2.1.2-1). These lands are located in three states- Massachusetts, New Hampshire and Vermont. The majority of the Project Boundary (6,150 acres) is located in Franklin County, MA in the towns of Erving, Gill, Greenfield, Montague and Northfield. The northern reaches of the Project Boundary extend into the towns of Hinsdale, in Cheshire County, NH (727 acres) and the town of Vernon, in Windham County, VT (369 acres).

2.1.3 Existing Project Safety

The Turners Falls Development has been operating for more than 36 years under its existing license and the Northfield Mountain Pumped Storage Development has been operating for more than 48 years under its existing license. During this time FERC staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the licenses and proper maintenance. In addition, both developments have been inspected and evaluated every five (5) years by an independent consultant and a consultant's safety report has been submitted for FERC's review.

2.1.4 Existing Project Operations

The Turners Falls Development consists of two facilities- Cabot Station and Station No. 1. Cabot Station is used at all river flows. During low flow periods, Cabot Station is operated as a peaking plant; during high flows in excess of 13,728 cfs (its approximate maximum hydraulic capacity), it operates as a base load plant. Station No. 1 is a base load plant and typically operates when inflows to the TFI are less than Station No. 1's hydraulic capacity of approximately 2,210 cfs or when inflows exceed the hydraulic capacity of Cabot Station.

The Northfield Mountain Pumped Storage Development is a pumped storage hydroelectric facility. Water is pumped from the TFI to the Upper Reservoir which has 12,318 acre-feet of useable storage available for pumped storage operations. Typically, pumping occurs during low-load periods, while generation occurs during high-load periods.

2.1.5 Existing Environmental Measures

Water Level and Flow Management

- Under the FERC license for the Turners Falls Development, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow (equivalent to 0.2 cfs x the drainage area in square miles), whichever is less below the Project. FirstLight typically maintains the minimum flow requirement through discharges at Cabot and/or Station No. 1.
- Under the FERC license, a continuous minimum flow of 200 cfs is maintained in the bypass reach starting on May 1, and increases to 400 cfs when fish passage starts by releasing flow through a bascule gate. The 400 cfs continuous minimum flow is provided through July 15, unless the upstream fish passage season has concluded early in which case the 400 cfs flow is reduced to 120 cfs to protect Shortnose Sturgeon. The 120 cfs continuous minimum flow is maintained in the bypass reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15th.
- Under the FERC license, the TFI elevation may fluctuate between 176.0 feet msl and 185.0 feet msl, as measured at the Turners Falls Dam.
- Under the FERC license, the Northfield Mountain Upper Reservoir elevation may fluctuate between 1,000.5 feet msl and 938 feet msl.

Upstream and Downstream Fish Passage

- The Turners Falls Development includes three fishways- Cabot fishway, Spillway fishway and Gatehouse fishway.
- The Turners Falls Development includes a downstream fish passage system located near the downstream terminus of the power canal adjacent to Cabot Station.

Recreation

- FirstLight maintains several public recreation facilities within the Project Boundary as described in detail in Section 3.3.6.

2.1.6 Measures in Current FERC Licenses

The following is a description of key license requirements for the Turners Falls Project (now Development) and Northfield Project (now Development).

Turners Falls Project (now Development)

Article 30 requires the Licensee to pay reasonable annual charges to the United States for the cost of administration of Part I of the FPA, based on the authorized installed capacity.

Article 31 requires the Licensee to implement, and modify when appropriate, an emergency action plan to provide early warning to upstream and downstream inhabitants and property owners in the event of an impending or actual sudden release of water caused by an accident or failure of the Turners Falls Project works.

Article 32 requires the Licensee to operate the Turners Falls Project in accordance with its agreement with the United States Army Corps of Engineers (USACE) for the coordinated operation of the Turners Falls Project for flood control.

Article 33 requires the Licensee to provide public recreation at the Turners Falls Project in accordance with the Turners Falls Project's approved Recreation Plan.

Article 34 requires the Licensee to maintain a continuous minimum flow of 1,433 cfs (0.20 cubic feet per second per square mile of drainage basin) or a flow equal to the inflow of the reservoir, whichever is less, from the project into the Connecticut River. These flows may be modified temporarily: (1) during and to the extent required by operating emergencies beyond the control of the Licensee; and (2) in the interest of recreation and protection of the fisheries resources, upon mutual agreement between the Licensees for Projects Nos. 1889 and 2485 and the Massachusetts Division of Fisheries and Wildlife. During the period of each year from May 1 until there are no substantial numbers of juvenile or adult shad in the reach of the river where the project is located, but in any event no later than October 1, the following portion of that total minimum flow shall be released from the Turners Falls Dam: until the Montague spillway fishway begins operating, 200 cfs; after that fishway begins operating, 400 cfs..

Article 35 describes the Licensee's obligations with respect to unrecorded archeological or historical sites discovered during construction or development of project works or other facilities at the Turners Falls Project, and in the event any such sites are discovered, requires the Licensee to consult with the State Historic Preservation Officer to develop a mitigation plan for the protection of significant archeological or historic resources.

Article 36 requires the Licensee to install and operate signs, lights, sirens, barriers or other necessary devices to warn the public of fluctuations in flow and protect recreation users of the Turners Falls Project.

Article 38 requires the Licensee to file annual reports with FERC detailing operation of the Turners Falls Project's fish passage facilities, problems in design or operation, and listing the number, by species, of all fish passed upstream.

Article 40 requires the Licensee to coordinate operation of the Turners Falls Project with operation of the Northfield Mountain Project.

Article 42 requires the Licensee to coordinate operation of the Turners Falls Project, electrically and hydraulically, with other power systems as the Commission may direct in the interest of power and other beneficial public uses of water resources.

Article 43 authorizes the Licensee to grant permission for certain types of use and occupancy of Turners Falls Project lands, and requires the Licensee to consult with federal and state agencies prior to conveying certain interests, pursuant to FERC's standard use and occupancy article.

<u>Northfield Mountain Pumped Storage Project (now Development)</u>

Article 19 requires the License to allow free public access, to project waters and adjacent project lands owned by the Licensee.

Article 20 requires the license to be responsible for and minimize soil erosion and siltation on lands adjacent to the stream from the construction and operation of the project.

Article 39 requires the Licensee to make modifications to the Northfield Mountain Project works, operate the Northfield Mountain Project, and take such steps as ordered by the Commission, in the interest of boating safety, upon recommendation by the Commission, the USACE, the U.S. Coast Guard, or an interested agency of the Commonwealth of Massachusetts.

Article 40 requires the Licensee, following consultation with the USFWS and fishery agencies of the Commonwealth of Massachusetts, to study or pay for the cost of studies relating to fish protection at the Northfield Mountain Project, and undertake further study if the Commission finds that changed conditions or changed use of the Connecticut River fishery so warrant.

Article 41 requires the Licensee to develop recreational resources at the Northfield Mountain Project.

Article 43 requires the Licensee to enter into an agreement with the USACE for coordinated operation of the Turners Falls and Northfield Projects during flood conditions on the Connecticut River.

Article 45 requires the Licensee to coordinate operation of the Northfield Mountain Project with operation of the Turners Falls Project.

Article 48 requires the Licensee to pay reasonable annual charges to the United States for the cost of administration of Part I of the FPA, based on the authorized installed capacity.

Article 50 requires the Licensee to implement a cooperative land and water management plan for the Bennett Meadow Wildlife Management Area.

Article 51 requires the Licensee to report to the Commission and the MHC any fossils or archeological artifacts discovered during construction, operation, or maintenance of recreation developments at the Northfield Mountain Project, and authorizes the Commission to require archeological or paleontological surveys or salvage operations deemed necessary to prevent the destruction or loss of such findings.

Article 52 authorizes the Licensee to grant permission for certain types of use and occupancy of Northfield Mountain Project lands, and requires the Licensee to consult with federal and state agencies prior to conveying certain interests, pursuant to FERC's standard use and occupancy article.

2.2 FirstLight's Proposal

At the time of this filing, several of the FERC-approved aquatic studies have not been completed. In addition, three additional studies (Study No. 3.3.5 *Evaluate Downstream Passage of American Eel,* Study No. 3.3.19 *Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace, and Study No. 3.8.1 Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation and Hydropower Generation*) are to be filed with FERC by March 1, 2017 or as directed by FERC in its process plan and schedule, nearly one year after the FLA is filed. The delay in conducting the aquatic studies and water quality study was requested by the resource agencies as a result of the decommissioning of the Vermont Yankee Nuclear Power Plant and expected water quality improvements.

In addition, on January 16, 2015 TransCanada filed a letter with FERC requesting an extension of the license term for its Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855) and Vernon (FERC No. 1904) Hydroelectric Projects. Specifically, TransCanada sought a one year license term extension that would move the license expiration date from April 30, 2018 to April 30, 2019. On July 22, 2015, FERC granted TransCanada a one year extension requiring it file its FLA by April 30, 2017. Given the above, one of the unknowns at this juncture is how future project operations at the TransCanada facilities could impact the flow regime passed below the Vernon Hydroelectric Project and into FirstLight's TFI.

At this time, FirstLight's relicensing proposal includes modifications to the Project boundary, using more Upper Reservoir storage capacity at the Northfield Mountain Pumped Storage Development year round, managing recreation resources as set forth in the RMP, and managing historic properties as set forth in the HPMP. Since many of FirstLight's studies are not yet final it would be premature for FirstLight to develop a complete licensing proposal for operating the Project in the new license term at this time. Once FirstLight's studies and TransCanada's studies are complete and FirstLight has had an opportunity to discuss the study results with resource agencies and other stakeholders, FirstLight will be in a better position to develop a comprehensive proposal for relicensing the Project. As noted earlier, FirstLight proposes to file an amended FLA on April 30, 2017, which would include a more complete proposal for future project operations and PME measures.

2.2.1 Proposed Project Facilities

2.2.1.1 <u>Generation Facilities</u>

At this time, FirstLight is not proposing any changes to existing developmental (i.e., generation) facilities. FirstLight is, however, proposing to increase the useable storage of the Upper Reservoir from 1004.5 feet to 920 feet year-round, for an 84.5 foot drawdown. Pending the magnitude of any future minimum flow releases from the Turners Falls Dam, FirstLight may evaluate installing a minimum flow turbine-generator in the future.

2.2.1.2 <u>Non Generation Facilities</u>

Proposed Project Boundary

As described in Exhibit G, FirstLight is proposing two changes to the Project Boundary.

- Removal of a 20.1 acre parcel of land currently occupied by the United States Geological Survey's (USGS) Silvio Conte Anadromous Fish Laboratory located at One Migratory Way, P.O Box 796, in Turners Falls, MA 01376. The Conte Lab lands are located just north of Cabot Station.
- Removal of an 8.1 acre parcel of land referred to as Fuller Farm located near 169 Millers Falls Road in Northfield, MA.

2.2.2 Proposed Project Safety

FirstLight anticipates that, as part of the relicensing process, FERC staff will evaluate the continued safety of the proposed Project facilities under the new license. FirstLight anticipates FERC will continue to inspect the Project during the new license term to assure continued adherence to FERC-approved plans and specifications, any special license articles pertaining to construction, operation and maintenance, and accepted engineering practices and procedures.

2.2.3 Proposed Project Operations

FirstLight is proposing to modify the operations of the Upper Reservoir to utilize more of its storage capacity to allow for additional operational flexibility. FirstLight proposes to reduce the minimum elevation from 938 feet msl to 920 feet msl, and increase the maximum elevation from 1,000.5 feet msl to 1,004.5 feet msl, year-round. This would increase the Upper Reservoir's useable storage capacity from 12,318 acre-feet to 15,327 acre-feet, an increase of 3,009 acre-feet, and allow an increase in generation at full load for 1.8 hours. The additional storage capacity increases the Development's maximum daily generation from 8,729 MWh (formerly 8,475 MWh) to 10,779 MWh (formerly 10,465 MWh), or an increase of 2,050 MWh per day (formerly 1,990 MWh per day).

2.2.4 Proposed Environmental Measures

FirstLight is proposing to manage recreation and historic properties in the new license term as set forth in the draft RMP and HPMP.

2.3 Alternatives Considered But Eliminated From Further Analysis

FirstLight considered but eliminated from further analysis the following alternatives:

- Retire the Project
- Issue a Non-Power License
- Federal Agency Takeover of the Project

- Construction of a New Lower Reservoir to Create a Closed Loop System for the Northfield Mountain Pumped Storage Development

2.3.1 Retire the Project

Project retirement would involve surrender or termination of the existing license with appropriate conditions. No relicensing participant has suggested that removal of the Project dams would be appropriate in this case; therefore, FirstLight has not analyzed it as a reasonably foreseeable alternative to relicensing the Project with appropriate resource management measures.

In SD2, FERC stated:

> *Decommissioning some or all of Connecticut River projects would require denying the relicense applications and surrender or termination of the existing licenses with appropriate conditions. There would be significant costs involved with decommissioning the projects and/or removing project facilities. The projects provide a viable, safe, and clean renewable source of power to the region. Based on the 17 factors (to be considered when determining whether a more thorough analysis of decommissioning is warranted), outlined in The Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing,*[8] *we do not consider decommissioning to be a reasonable alternative for the Connecticut River projects, at this time.*

2.3.2 Issue a Non-Power License

A non-power license is a temporary license that FERC issues when it determines that a project should no longer be used for power purposes. FERC's statement from SD2 regarding a non-power license analysis follows:

> *A non-power license is a temporary license the Commission would terminate whenever it determines that another governmental agency is authorized and willing to assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this time, no governmental agency has suggested a willingness or ability to take over any of these five projects. No party has sought a non-power license, and we have no basis for concluding that the TransCanada and FirstLight projects should no longer be used to produce power. Thus, we do not consider a non-power license a reasonable alternative to relicensing the projects.*

Because the Project power is needed and FirstLight believes that a new license can be issued that will satisfy the FPA's public interest/comprehensive development standard, FirstLight believes there is no basis for the Commission to conclude that the Project should no longer be used for power generation. Thus, issuance of a non-power license is not a reasonable alternative to issuance of a new license with appropriate PM&E measures.

2.3.3 Federal Agency Takeover of the Project

Federal takeover of the Project is not a reasonably foreseeable alternative. As FERC stated in SD2:

> *We do not consider federal takeover to be a reasonable alternative. Federal takeover of the project would require congressional approval. While that fact alone would not preclude further consideration of this alternative, there is currently no evidence showing that federal takeover should be recommended to Congress. No party has suggested that federal takeover would be appropriate, and no federal agency has expressed interest in operating any of these five projects.*

Therefore, FirstLight has not analyzed federal takeover of the Project as a reasonably foreseeable alternative to relicensing.

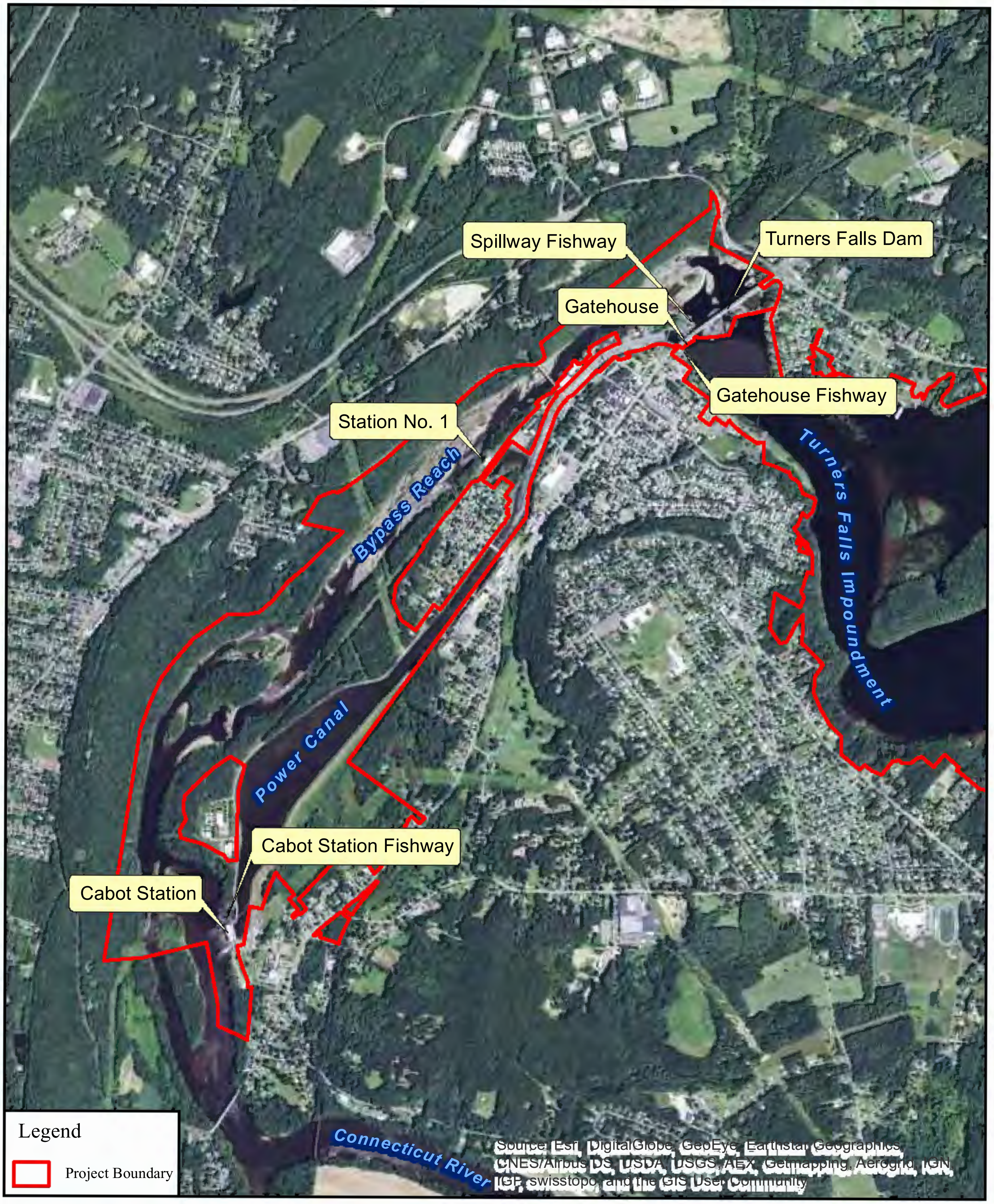
[8] http://www.ferc.gov/industries/hydropower/indus-act/itf/nepa_final.pdf

2.3.4 Construction of a New Lower Reservoir to Create a Closed Loop System for the Northfield Mountain Pumped Storage Development

In comments received on SD1 some stakeholders recommended that development and implementation of a closed loop system for the operation of the Northfield Mountain Pumped Storage Development should be evaluated as part of the NEPA implementation process. In response, in SD2 FERC stated:

> *Construction of a new lower reservoir would likely have significant impacts on the environment and a high cost. Therefore, we will not commit to conducting a detailed analysis of such an alternative until we better understand the environmental effects of the existing project.*

FirstLight does not believe that construction of a new lower reservoir is a reasonable alternative to relicensing the Project and therefore has not conducted further analysis of this alternative.



FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

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0 1,000 2,000 4,000 Feet

Figure 2.1.1-1:
Turners Falls Development
Features

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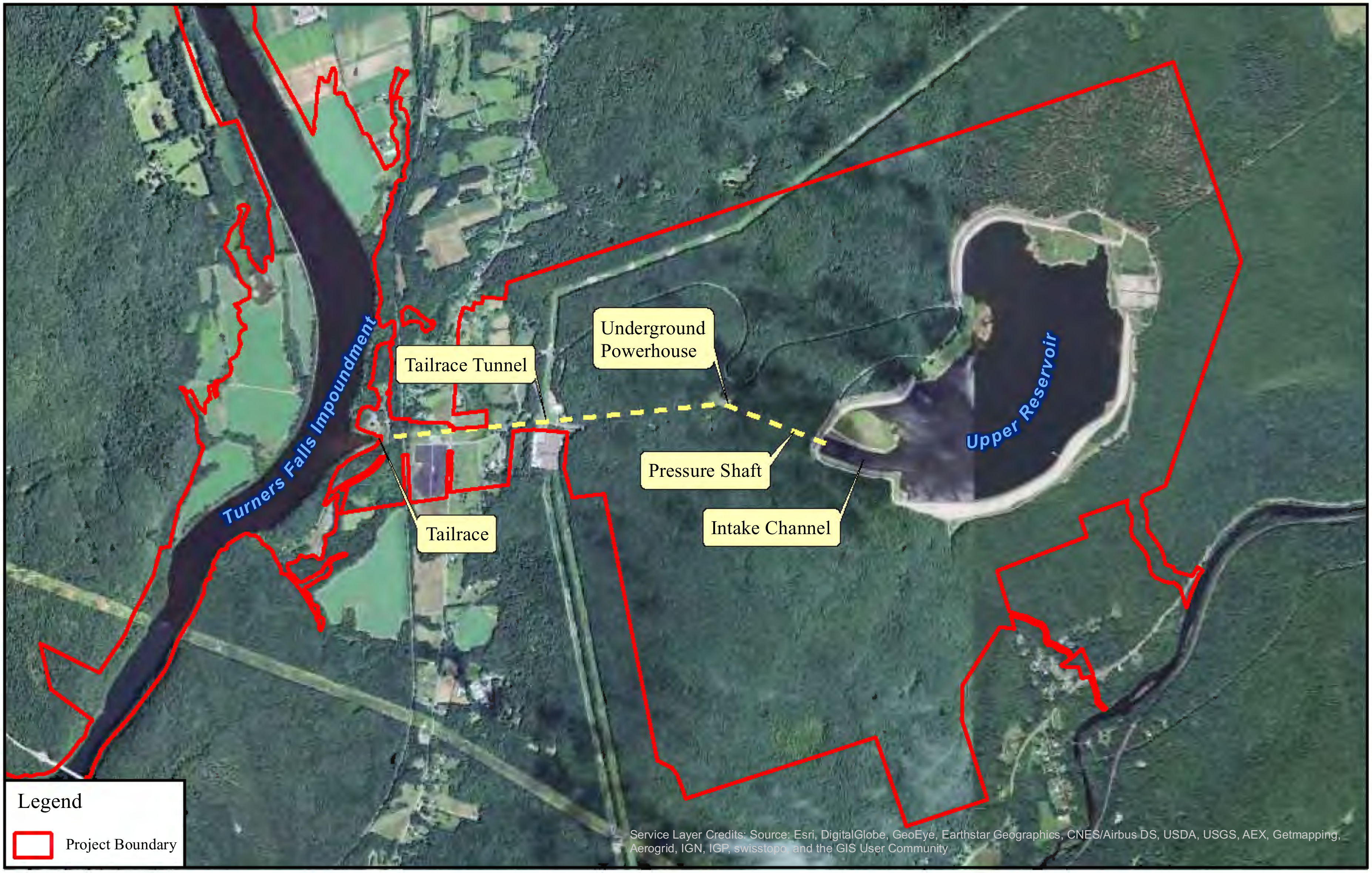

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Northfield Mountain Pumped Storage Project No. 2485
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Figure 2.1.1-2:
Northfield Mountain
Pumped Storage Development

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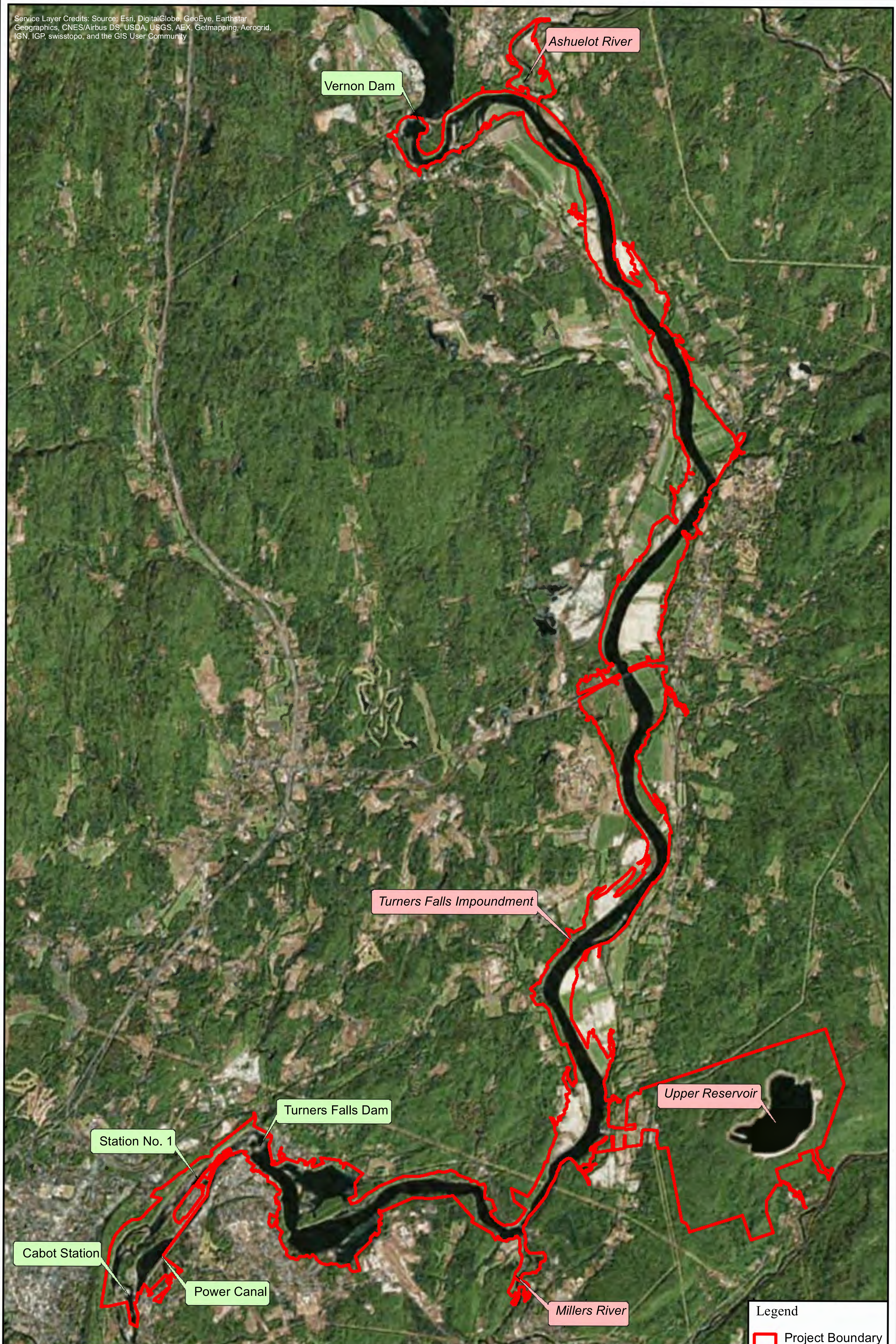

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

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Exhibit E

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Figure 2.1.2-1
Project Boundary Map

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3 ENVIRONMENTAL ANALYSIS

3.1 General Description of River Basin

The Connecticut River and its tributaries drain an area of about 11,250 mi^2, constituting the largest river drainage system in New England. From its origin in the Connecticut Lakes Region near the Canadian border, the 410-mile-long Connecticut River flows southward to form the boundary between New Hampshire and Vermont, then through Massachusetts and Connecticut to Long Island Sound (Carr & Kennedy, 2008).

According to the USGS's Watershed Boundary Dataset, the Connecticut River subregion, which is part of the New England region, is divided into two basins at Vernon Dam in Vermont—the Upper Connecticut basin and the Lower Connecticut basin. (For the purposes of this document, the Connecticut River subregion may also be referred to as a basin or watershed.) The Project boundary falls within the Middle Connecticut subbasin of the Lower Connecticut basin, and almost entirely within the Fall River-Connecticut River watershed within that subbasin (USGS, 2010). Figure 3.1-1 provides an overview of the entire Connecticut River subregion and its major tributaries and mainstem dams, while Figure 3.1-2 shows a close-up of the Middle Connecticut subbasin and tributaries and dams in the Project area.

In Massachusetts, the Lower Connecticut River basin covers an area of approximately 2,728 mi^2, occupying all of Franklin and Hampshire Counties, most of Hampden County, the eastern third of Berkshire County, and the western half of Worcester County. In this region, tributary streams entering the Connecticut River from the west originate in the Berkshire Mountains and have steeper gradients than tributary streams originating in the Central Highlands to the east (Simcox, 1992). The Middle Connecticut River subbasin in Massachusetts is bordered by the Deerfield River subbasin to the northwest, the Millers River subbasin to the northeast, the Westfield River subbasin to the southwest, and the Chicopee River subbasin to the southeast (Carr & Kennedy, 2008).

3.1.1 Topography

The Turners Falls Development and Northfield Mountain Pumped Storage Development are located in the New England Upland section of the New England physiographic province of Massachusetts. The Connecticut River Valley is a dominant feature within this section. The Connecticut River Valley is generally narrow in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development, with some areas of the floodplain characterized by river and stream terrace silt, sand, and gravel. Other areas are characterized by steep rocky banks, especially the French King Gorge area, immediately downstream of the Northfield Mountain Pumped Storage Development's tailrace (FirstLight, 2007).

The topography of the Connecticut River Valley is mostly level to rolling, with some higher hills. One such hill is Northfield Mountain, where the Northfield Mountain Pumped Storage Development is located. The Northfield Mountain Pumped Storage Development's Upper Reservoir is man-made and was formed using impervious core rock fill structures, a concrete gravity dam, natural features, and excavation of a conveyance channel into bedrock.

3.1.2 Climate

The climate in the Project area is a humid continental climate, with warm summers and cold, snowy winters. This climate type is found over large areas of land masses in the temperate regions of the mid-latitudes where there is a zone of conflict between polar and tropical air masses. The humid continental climate is marked by variable weather patterns and a relatively large seasonal temperature variance. Shown in Table 3.1.2-1 is the long term monthly average air temperature and precipitation amounts as recorded in Springfield, MA approximately 40 miles south of Turners Falls, MA.

Average annual precipitation totals approximately 43.9 inches in Springfield, MA.

3.1.3 Land and Water Use

3.1.3.1 Major Land Uses

Land use in the Connecticut River watershed is approximately 77% forested, 9% agricultural, 7% wetlands, and 7% developed. Land use is generally rural agrarian and undeveloped at the headwaters in northern Vermont and New Hampshire, transitioning to densely populated urban areas in the south-central river valley in Connecticut. Down-river from the City of Hartford, CT, the basin is again largely undeveloped, making the Connecticut River as the only major river in the northeastern United States without a significant port, harbor, or urban area at its mouth (Zimmerman, 2006).

The portion of the Connecticut River basin above the USGS stream gaging station in Thompsonville, CT (near the Massachusetts border) encompasses approximately 9,660 mi^2 in New Hampshire, Vermont, and Massachusetts. This region has a population of approximately one million people distributed amongst densely populated urban areas in the southernmost section in Massachusetts to sparsely populated rural and agricultural regions in the northern areas in New Hampshire and Vermont. The agricultural land use in New Hampshire and Vermont is predominantly related to dairy farm operations, while that in Massachusetts primarily consists of orchards, row crops, and some dairy operations. The land use in this portion of the basin is about 80% forested, 9% agricultural, 6% wetlands, and 5% developed (Deacon *et al*., 2006).

Figure 3.1.3.1-1 shows land use and land cover in the vicinity of the Project.

3.1.3.2 Major Water Uses

Water uses in the Connecticut River watershed include water supply, dilution of treated or untreated municipal or industrial discharges, contact and non-contact cooling water, water for agricultural irrigation and snow making, and water for power generation (CRJC, 2009). Other than for hydropower, the primary purpose of water withdrawals from the TFI is for agricultural irrigation.

3.1.3.3 Basin Dams and other Energy Producers

The USACE's National Inventory of Dams (NID) contains 990 dams in the Connecticut River watershed. More than half of these dams (553) are primarily used to support recreation; in many cases "recreation" is designated as the primary purpose, but in fact, many of the impoundments are the result of older mill dams that are no longer used for a specific purpose. Dams used primarily for water supply (131) are the second-most common type of dam, followed by those used for hydroelectric power generation (123) and flood control (75). Water supply dams store water in the Connecticut River watershed—particularly the Quabbin Reservoir in the Chicopee subbasin which serves as the primary source of drinking water for the City of Boston and several municipalities in the Greater Boston area. Hydroelectric dams are found at many locations along the Connecticut River and its major tributaries. Flood control dams are mostly found on smaller rivers throughout the watershed (USGS, 2011).

Of the dams in the Connecticut River watershed, approximately 64 are considered large, defined as those with the capacity to hold 10% of the mean annual streamflow volume during any particular day (or, in the absence of streamflow information, have a large water storage capacity in relation to their drainage area). Classification of large dams was determined by The Nature Conservancy (TNC) through analysis of streamflow data provided by the USGS (USGS, 2011).

There are 12 hydropower dams along the mainstem Connecticut River, including the Turners Falls Dam. The upstream end of the Project Boundary is the base of Vernon Dam, approximately 20 miles upstream of the Turners Falls Dam. The next hydropower dam downstream of the Turners Falls Dam is Holyoke Dam, approximately 35 miles downstream. Table 3.1.3.3-1 lists hydropower projects up to Moore Dam and their characteristics. Figure 3.1-1 depicts all dams along the mainstem Connecticut River, while Figure 3.1-2 shows selected dams in the Project area.

3.1.3.4 Tributary Streams

Major tributaries to the TFI include the Ashuelot River in New Hampshire, which drains 420 mi^2 from the east and enters the Connecticut River just below Vernon Dam, and the Millers River, which drains 392 mi^2 from the east and enters downstream of the Northfield Mountain tailrace. Additionally, the Deerfield River, which drains 665 mi^2 from the west, enters the Connecticut River just downstream of the Cabot Station tailrace.

Smaller named streams entering the TFI, from upstream to downstream, include Newton Brook, Pauchaug Brook, Bottom Brook, Mill Brook, Mallory Brook, Millers Brook, Bennett Brook, Merriam Brook, Otter Run, Ashuela Brook, Dry Brook, Pine Meadow Brook, and Fourmile Brook (Wandle, 1984).

Figure 3.1-1 depicts major tributaries in the entire Connecticut River watershed, while Figure 3.1-2 shows tributaries in the vicinity of the Project.

Table 3.1.2-1: Average Climate Conditions in Springfield, MA

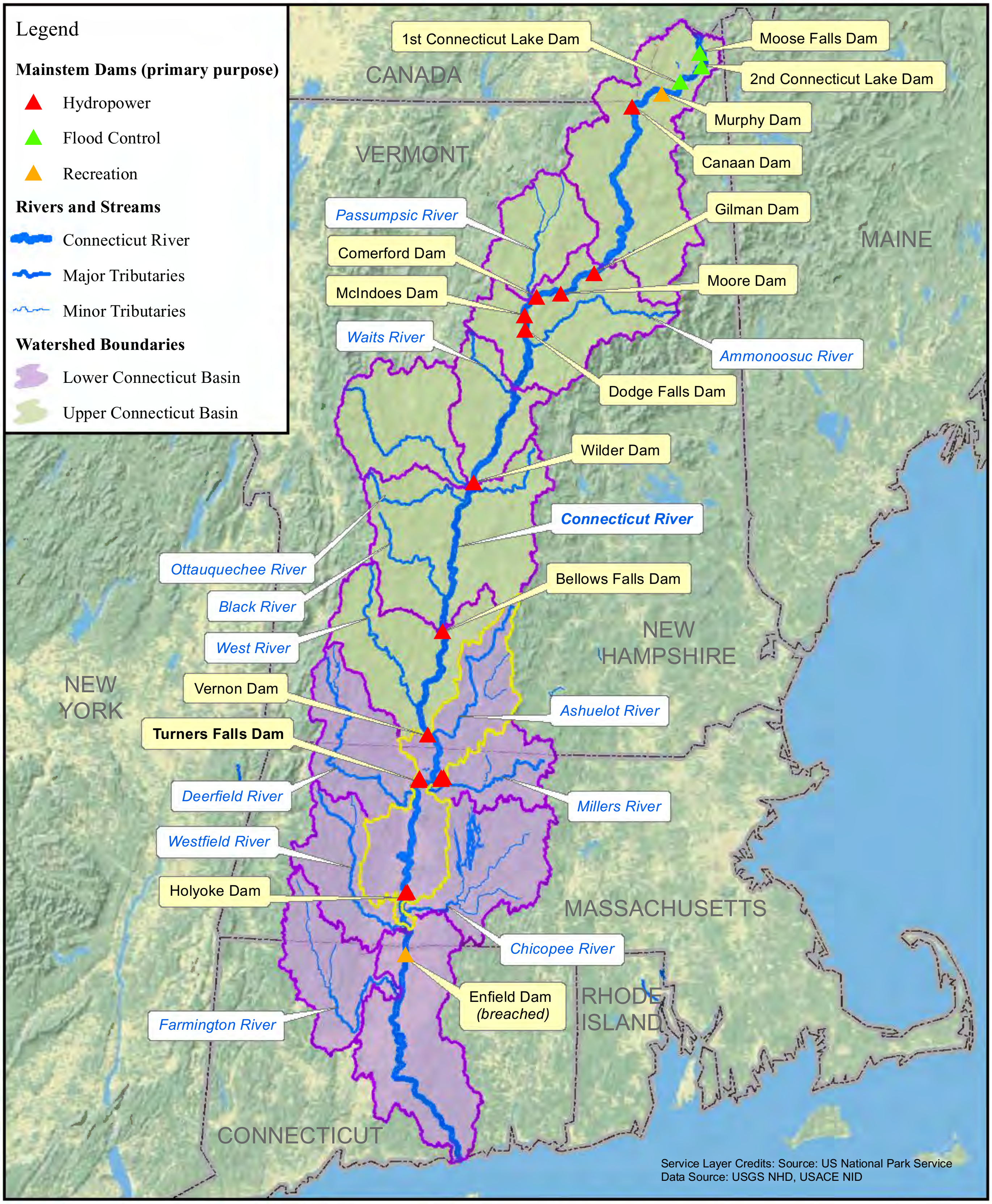
Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temperature (°F)	27	30	38	50	60	69	74	73	65	54	44	31
Average Precipitation (in)	3.2	3.0	3.5	3.9	4.1	4.1	3.6	3.5	3.5	3.6	4.1	3.8

Source: http://www.explore-massachusetts.com/massachusetts-climate.html

Table 3.1.3.3-1: Hydropower Projects on the Connecticut River

FERC Project No.	Project Name	River Mile *(above Long Island Sound)*	Licensee	License Expiration
2004	Holyoke	87	City of Holyoke Gas & Electric Co.	08/31/2039
1889	Turners Falls	122	FirstLight Hydro Generating Co.	04/30/2018
2485[1]	Northfield Mountain Pumped Storage	127	FirstLight Hydro Generating Co.	04/30/2018
1904	Vernon	142	TransCanada Hydro Northeast, Inc.	04/30/2019
1855	Bellows Falls	174	TransCanada Hydro Northeast, Inc.	04/30/2019
1892	Wilder	217	TransCanada Hydro Northeast, Inc.	04/30/2019
8011	Dodge Falls	270	Dodge Falls Hydro Co.	Exempt
2077	Fifteen Mile Falls (McIndoes, Comerford, and Moore Dams)	274 281 288	TransCanada Hydro Northeast, Inc.	03/31/2042
2392	Gilman	302	Ampersand Gilman Hydro, L.P.	03/31/2024
7528	Canaan	373	Public Service Co. of NH	07/31/2039

[1]The Northfield Mountain Pumped Storage Development does not “dam” the Connecticut River; rather it pumps from, and discharges to, the Connecticut River.



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

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Exhibit E

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Figure 3.1-1
Connecticut River Watershed, Major Tributaries, and Mainstem Dams

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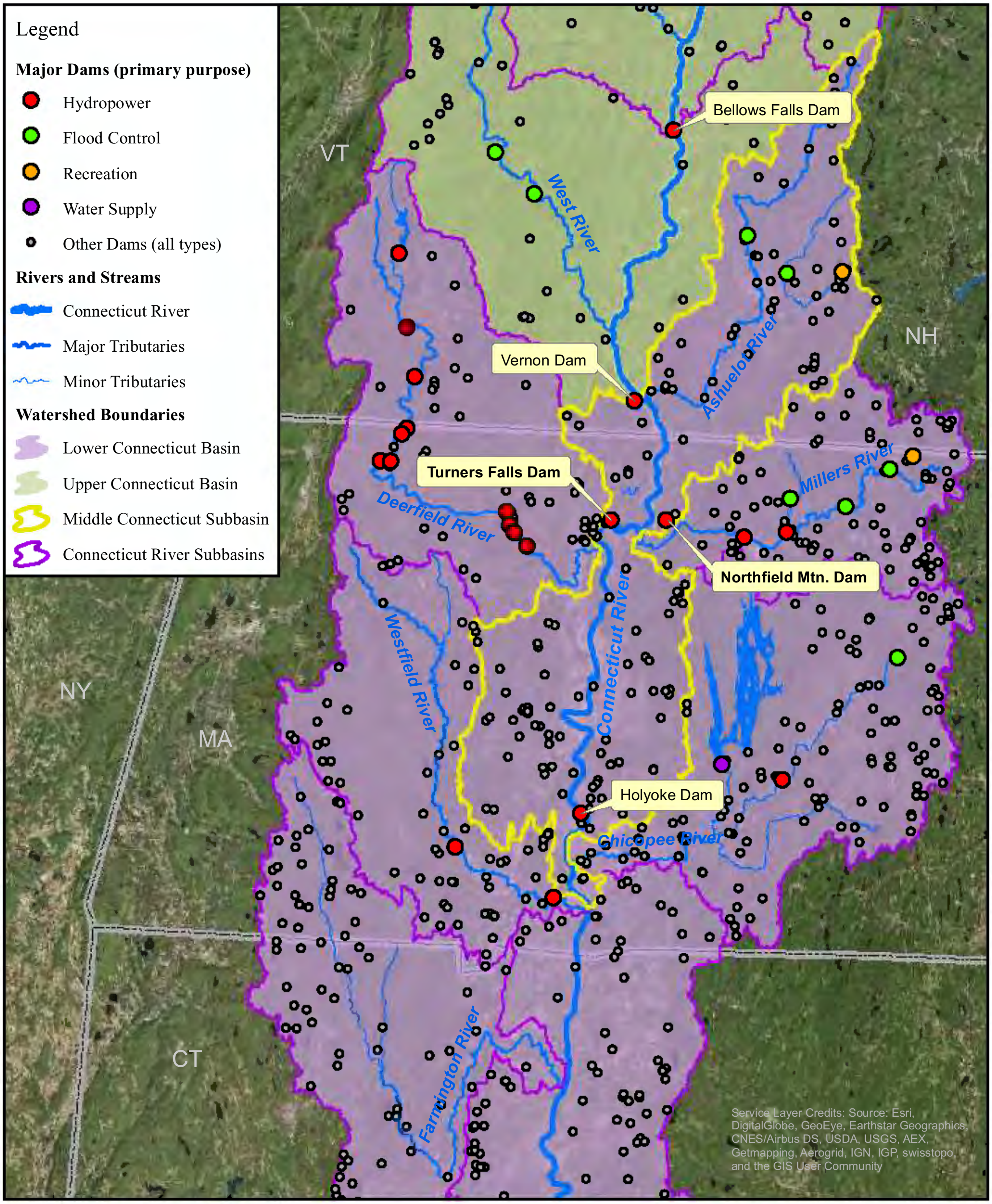

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

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Exhibit E

Figure 3.1-2:
Connecticut River Subbasins, Tributaries, and Dams in the Project Area

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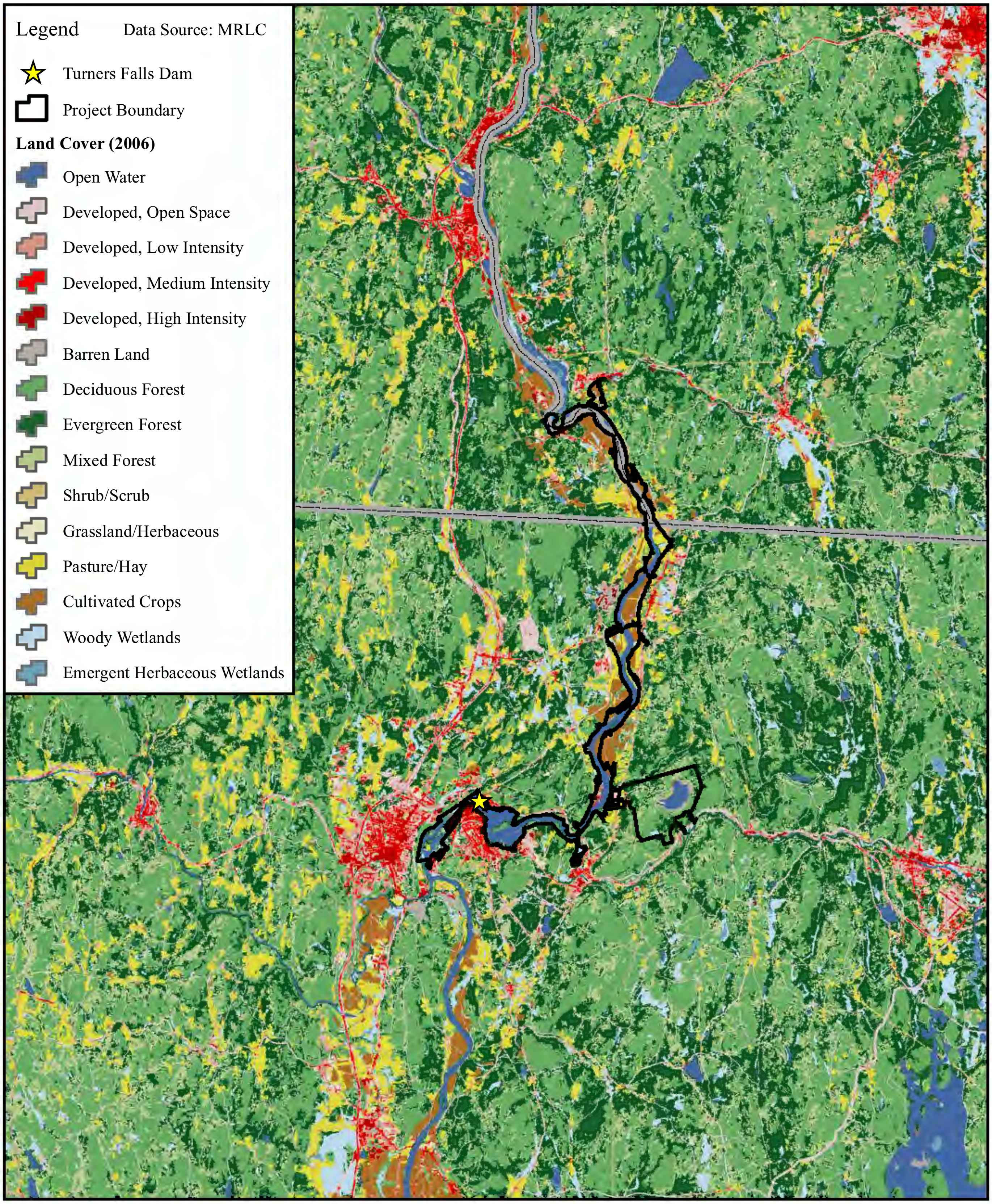

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FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

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Exhibit E

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Miles

Figure 3.1.3.1-1
Land Cover in the
Project Vicinity

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3.2 Cumulative Effects

3.2.1 Cumulatively Affected Resources

According to § 1508.7 of the Council on Environmental Quality's regulations for implementing NEPA, an action may cause cumulative impacts on the environment if its impacts overlap in space and time with the impacts of other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

FERC noted the following in SD2 relative to cumulative effects, which includes the effects of the three (3) TransCanada Projects and FirstLight's Turners Falls Development and Northfield Mountain Pumped Storage Development:

> *Based on information in the Pre-Application Documents and staff analysis of the written comments submitted from agencies and other stakeholders on the SD1 document and comments from the January 2013 public scoping meetings, we identified the following resources that may be cumulatively affected by the proposed operation and maintenance of the five Connecticut River Projects: water quality and quantity[9] (including power generation), fishery resources (including anadromous and catadromous fish and fish passage), floodplain communities, freshwater mussels, sediment movement, recreational uses and rare, threatened and endangered species.*

Provided below is the geographic and temporal scope of the cumulative effects analysis for these resources, and past, present and reasonably foreseeable future actions considered in the analysis.

3.2.2 Geographic Scope of Analysis for Cumulatively Affected Resources

The geographic scope of the cumulative effects analysis defines the physical limits or boundaries of the proposed action's effect on the resources. Because the proposed action would affect the resources differently, the geographic scope for each resource may vary. FERC's SD2 described the geographic scope for cumulative effects as follows:

> Due to the extensive seasonal storage capacity at Moore reservoir, we have identified the geographical extent of cumulative effects on water quantity and water quality *to include the Connecticut River from the base of Moore dam to the mouth of the Connecticut River at Long Island Sound. We chose this geographic area to recognize the cumulative operational influences of the upstream water storage, and the operations of the five Connecticut River projects on water quantity throughout this area and subsequently on water quality that could occur downstream to mouth of the Connecticut River at Long Island Sound.*
>
> Because hydroelectric dams influence both upstream and downstream fish migration within river systems, we have identified the geographical extent of potential cumulative effects on *anadromous, catadromous, and diadromous fish species to include the Connecticut River from Long Island Sound upstream to each species' historical habitat range.*
>
> We have identified the geographical extent of cumulative effects on *resident fish species, freshwater mussels, and sediment movement to include the upper extent of the Wilder reservoir downstream to the Route 116 Bridge in Sunderland,[10] Massachusetts. We chose this geographic area because the operation of the five projects could be a contributing factor to sediment movement*

[9] *Water quantity is defined as flow magnitude, flow frequency, flow duration, flow timing, and rate of change.*

[10] The Route 116 Bridge is located at the approximate upstream extent of the Holyoke Project (FERC No. 2004) impoundment.

within the river and cumulative effects on resident fisheries and freshwater mussel habitat in this area.

We have identified the geographic scope of cumulative effects on *terrestrial and floodplain communities* *to include the 100-year floodplain (as defined by the Federal Emergency Management Agency) adjacent to the project-affected areas from the upstream extent of the Wilder reservoir downstream to the Route 116 Bridge in Sunderland, Massachusetts. We chose this geographic area because the operation of the projects, in combination with other land uses in the Connecticut River Basin, may cumulatively affect floodplain communities adjacent to project reservoirs and downstream riverine reaches in this area.*

The presence of multiple dams on the Connecticut River may cumulatively affect multi-day paddle trips. *Based on our independent review and stakeholder comments, we find the geographic scope of the cumulative effects on recreation for multi-day paddling trips on the Connecticut River may extend as far upstream as Murphy Dam (RM 383) in Pittsburg, New Hampshire, where the natural riverine reaches become navigable (CRWC, 2007; American Whitewater, 2013)*[11] *and downstream to the Holyoke dam (FERC No. 2004), the most downstream dam, in Holyoke, Massachusetts.*

FirstLight has included this geographic area in the cumulative effects analysis for the resources identified by FERC.

3.2.3 Temporal Scope of Analysis for Cumulatively Affected Resources

The temporal scope of the cumulative effects analysis addresses past, present, and future actions and their effects on each affected resource. Based on the expected term of a new license, the temporal scope of analysis addresses reasonably foreseeable actions for 30-50 years into the future.

3.2.4 Past, Present and Reasonably Foreseeable Future Actions

The cumulative effects of past and present actions on the resources listed below are addressed in the Affected Environmental Section of this Exhibit E.

- Sediment Movement (Section 3.3.1 Geology and Soils)
- Water Quantity and Quality (Section 3.3.2, Water Resources),
- Anadromous, Catadromous, and Diadromous fish species (Section 3.3.3 Aquatic Resources)
- Resident Fish Species, Freshwater Mussels, (Section 3.3.3 Aquatic Resources)
- Terrestrial and Floodplain Communities (Section 3.3.4 Terrestrial Resources)
- Recreation for Multi-day Paddling Trips (Section 3.3.6, Recreation Resources)

[11] The Connecticut River Watershed Council (2007). The Connecticut River boating guide: Source to sea (3rd ed.). The Globe Pequot Press: Guilford, Connecticut. American Whitewater (2013). Retrieved on 4/11/2013 from http://www.americanwhitewater.org/content/River/detail/id/10545

3.3 Proposed Action and Action Alternative

3.3.1 Geology and Soils

3.3.1.1 Affected Environment

3.3.1.1.1 Geology

Bedrock Geology

The Connecticut River Valley was formed by erosion of sedimentary rocks before the glacial period. These sedimentary rocks, largely sandstone, shale, and conglomerate, interspersed with volcanic rocks, were formed about 190 to 200 million years ago in the Jurassic and Triassic period. The bordering uplands are underlain by older, less erodible metamorphic and igneous rocks (Simcox, 1992).

The bedrock geology in the vicinity of the Project is illustrated in Figure 3.3.1.1.1-1 and described further below.

Turners Falls Development

The bedrock geology surrounding the Turners Falls Development is based on a USGS characterization of near-surface bedrock in the New England region (Robinson & Kapo, 2003). Although the dominant bedrock geology surrounding the Turners Falls Development is sedimentary (such as arkose, siltstone, sandstone, shale, and conglomerate), tilted basalt layers have formed distinctive ridges in many parts of the river valley. The Jurassic-age Holyoke basalt results in a prominent north-south trending ridge from southern Connecticut into central Massachusetts, which then curves to trend east-west in the Holyoke Range.

Northfield Mountain Pumped Storage Development

At the Northfield Mountain Pumped Storage Development, the pressure shaft, powerhouse, and tailrace were excavated through the bedrock of Northfield Mountain. Several geological investigations were conducted as part of the initial licensing and construction of the Project (CL&P *et al*., 1966). These investigations show that Northfield Mountain is the northwest flank of a broad dome structure having a northeast-southwest axis. The rocks comprising this dome are hard, crystalline metasediments of mid-Paleozoic age. In geologic studies, these have been grouped into two formations, the Dry Hill granite gneiss and the Poplar Mountain gneiss. The Dry Hill granite gneiss has a maximum thickness of about 800 feet and is about 460 feet thick at the powerhouse site. This formation forms the crest of Northfield Mountain. It is overlain and underlain by the Poplar Mountain gneiss, which crops out near the discharge portal of the tailrace tunnel. The Dry Hill granite gneiss consists of massive beds or layers of evenly foliated granite gneiss, ranging in thickness up to 150 feet, separated by relatively thinner members of biotite-rich gneiss. The Poplar Mountain gneiss consists of medium to coarse, feldspathic, biotite-rich granite gneiss interbedded with biotite schists and quartzitic members. While these are hard, durable, crystalline rocks, the Poplar Mountain gneiss is more micaceous and thinly foliated than the Dry Hill granite gneiss. The cover over the bedrock in the Upper Reservoir area is very thin. Bedrock is exposed in many areas at the ground surface and in other areas covered by a thin mantle of glacial outwash.

Faulting within the area of Northfield Mountain appears to be minimal. The major fault of the area is the Border Fault between the Triassic sandstones of the Connecticut Valley and the meta-sediments. Within the vicinity of the Northfield Mountain Pumped Storage Development, the fault lies west of the Connecticut River and well away from structures of the facility.

Surficial Geology

Surficial geology of the Connecticut River Valley region in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development is illustrated in Figure 3.3.1.1.1-2.[12] Surficial geologic units in the Northfield Mountain Pumped Storage Development Upper Reservoir area predominantly consist of thin glacial till and shallow bedrock. In the vicinity of the Northfield Mountain Pumped Storage Development tailrace, surficial geologic units consist of coarse and fine glacial stratified deposits (sorted and stratified sediments composed of gravel, sand, silt, and clay deposited in layers by glacial meltwater) and floodplain alluvium closer to the river.

Most of the surficial deposits in the general region of the TFI are deposits of the last two continental ice sheets that covered all of New England in the latter part of Pleistocene Ice Age. These deposits can be categorized into three groups: glacial tills, glacial stratified deposits, and post-glacial deposits (FirstLight, 2014a):

> *Glacial till* – Glacial till is the most widespread glacial deposit, and was laid down directly by glacier ice. It consists of non-sorted, generally non-stratified mixtures of particles ranging in grain size from clay to large boulders in a matrix of predominantly fine sand and silt. Till blankets the bedrock surface in variable thicknesses, ranging from a few inches to more than 200 feet. The Upper Till was deposited during the last glaciations (Wisconsin Ice Age), and the Lower Till was deposited during the older Illinoian Ice Age. In the Connecticut Valley area, the till was derived mainly from the Triassic sedimentary rocks. The Lower Till contains relatively high percentages of silt- and clay-size particles, and the Upper Till are better sorted and contain less fine-grained materials (FirstLight, 2014a).

> *Glacial stratified deposits* – During retreat of the last ice sheet, materials in the glacier were deposited in glacial streams, lakes and marine environments that occupied the valleys and lowlands. Because these materials were deposited in water, they tend to be stratified and well-sorted gravel, sand, silt and clay. Glacial stratified deposits are the predominant surficial materials in the Connecticut River Valley. These deposits generally overlie till; however in some places till is not present and the stratified deposits lie directly on bedrock. The largest glacial lake in the region was Lake Hitchcock which occupied the Connecticut Valley area. Lake Hitchcock was dammed behind a mass of earlier deltaic sediments in the Cromwell-Rocky Hill area of central Connecticut. The lake lengthened northward into northern Vermont and New Hampshire as the ice sheet retreated. The principal bottom sediments of Lake Hitchcock are varved clay, silt, and fine sand at least 300 feet in maximum thickness, which are overlain by a continuous blanket of sand 2 to 25 feet thick (FirstLight, 2014a).

> *Post-glacial deposits* – The two principal post-glacial deposits are floodplain alluvium and aeolian deposits. Floodplain alluvium consists of sand, gravel, and silt, stratified and well sorted to poorly sorted. The grain size distribution of alluvium generally varies over short distances, both vertically and laterally. Along smaller streams, alluvium is commonly less than 5 feet thick. The most extensive deposits of alluvium in the region are along the Connecticut River, where the materials are predominantly sand, fine gravel, and silt, with thickness up to about 25 feet. Alluvium typically overlies thicker glacial stratified deposits. The aeolian deposits in the region consist of windblown silt and sand that form a discontinuous but widespread blanket, about 5 feet in maximum thickness over bedrock and glacial deposits (FirstLight, 2014a).

The French King Gorge area along the TFI consists of bedrock outcrops, thin glacial till, and areas of coarse stratified glacial deposits. Further downstream in the area of the Turners Falls Dam, bypass reach and power canal, surficial geologic units include coarse stratified glacial deposits, stream terrace deposits, floodplain alluvium and bedrock outcrops.

[12] Surficial geology information is not available for New Hampshire.

Terrace and Floodplain Surfaces

A description of the stream terrace deposits along the river was provided in a geomorphic characterization of the TFI (Field Geology Services, 2007). This characterization is relied on to describe the geologic history of the terrace and floodplain formations adjacent to the Connecticut River in the TFI area.

While the width and orientation of the valley through which the Connecticut River flows is the result of ancient geological processes, the valley bottom is composed of a series of terraces stepping up from the river with the highest and, therefore, oldest geomorphic surface formed since the last Ice Age (i.e., < 15,000 years). These terrace surfaces are seen throughout the TFI area. The width of the valley is narrowest through the French King Gorge where the river encounters bedrock nearly continuously. However, only 10% of the channel through the TFI encounters bedrock, with most of the channel flowing against glacial, lacustrine, or alluvial sediments.

When glacial ice retreated from the Connecticut River Valley at the end of the last Ice Age great quantities of sediment were washed into the valley from the tributaries and from the glacial ice melting to the north, forming large deltas. One such delta in Rocky Hill, CT naturally damned the width of the valley and created a long narrow lake, known as Lake Hitchcock, that extended as far north as West Burke, VT. The lake's water surface in the TFI area was likely more than 150 feet higher than the current level of the Connecticut River (Field Geology Services, 2007). Tributaries built deltas at the lake's margins that are today the highest terraces in the valley. These areas provide an excellent source of sand and gravel, as evidenced by the gravel pits excavated below their surfaces. The delta front sloped down to the lake bottom, which itself was over 75 feet above the current river level; the terrace on which the town of Northfield rests is a remnant of the old lake bottom surface. Eventually the natural dam holding back Lake Hitchcock was broken and the Connecticut River was able to erode through the old lake sediments.

The river's downcutting was stopped when hard bedrock was encountered as was the case at the deep areas within Barton Cove, where a large waterfall previously existed and carved large plunge pools downstream. Upstream, the river was graded to the top of this bedrock barrier and began eroding laterally into the old lake bottom sediments, creating a wide floodplain. This higher floodplain level was abandoned when the river resumed downcutting. Once reaching a new graded level, the river eroded laterally to create its current floodplain in a process that continues until this day.

3.3.1.1.2 Soils

The two dominant soil types associated with abandoned and active floodplains in the TFI area are the Hadley very fine sandy loam and the Suncook loamy sand (Field Geology Services, 2007). The stratigraphy of sediments underneath these floodplain surfaces is characterized by poorly consolidated alternating fine sand and silt layers.

The Agawam fine sandy loam is the dominant soil type associated with the older and higher terraces, but several other soil types also occur. The stratigraphy underlying each terrace depends largely on the depositional environment in which the terrace surface formed (e.g., deltaic, lacustrine). In most instances the uppermost sediments exposed in these high banks are well stratified sands with the underlying sediments at river level varying between well sorted sand, cobbly to gravelly sand, or varved lacustrine clays. Given the close proximity in which the varied depositional environments were found, the type of sediment exposed at the base of the high banks along the river can vary over short distances. Bedrock ledge is also intermittently seen at the base of the banks and buried in the sediment above.

The recently updated soil survey maps for Franklin County, MA were obtained to describe the soil resources in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development. Soil survey data were also obtained for Windham County, Vermont and Cheshire County, New Hampshire. Figure 3.3.1.1.2-1 (eight pages) depicts the soils types within 2,000 feet of the shoreline in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development, or within the Project boundaries. Note that the legend for these figures is located at the end of Figure 3.3.1.1.2-1. The top ten soil series, in terms of areal coverage, in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development are listed in Table 3.3.1.1.2-1.

3.3.1.1.3 Shoreline and Streambank Characterization

The Northfield Mountain Pumped Storage Development Upper Reservoir shoreline is composed of constructed dikes created with fill material from excavation areas during the construction of the Project. Additional bank types include steep areas cut into bedrock, particularly at the intake canal, and gently sloping unvegetated areas that are alternately exposed and inundated in response to changing water levels.

Starting in 1998, Full River Reconnaissance (FRR) surveys were conducted every 3-5 years to document TFI streambank characteristics, such as steepness, material type, degree of vegetative cover, and severity of erosion. The most recent FRR was conducted in 2013 (Study No. 3.1.1) (FirstLight, 2014a). The 2013 FRR (Study No. 3.1.1) reported that riverbanks in the TFI generally consist of an upper bank that is often above water except during high flow conditions, and a lower bank that is frequently submerged. These banks consist of a range of materials from silt or sand to solid rock.

The results of the 2013 FRR indicated that the majority of the upper riverbanks in the TFI were found to have moderate or steep slopes, heights greater than 12 ft., be comprised of silt/sand, and have heavy vegetation. The majority of the lower riverbanks were found to have flat/beach to moderate slopes, be comprised of silt/sand, and have none to very sparse vegetation. Erosion conditions in the TFI were found to be generally stable with None/Little current erosion occurring through much of this reach.

As noted in the 2013 FRR report (FirstLight, 2014a), 84.8% of the total length of the TFI riverbanks were found to have None/Little erosion[13], 14.1% Some erosion, 0.5% Some to Extensive erosion, and 0.6% Extensive erosion. Furthermore, 5.5% of the total length of TFI riverbanks were found to have Potential Future Erosion, 0.6% Active Erosion, 9.1% Eroded, 83.5% Stable, and 1.3% in the Process of Stabilization. Table 3.3.1.1.3-1 presents summary statistics of the TFI streambank features and characteristics as noted during the 2013 FRR, while Table 3.3.1.1.3-2 provides definitions for each classification. Figure 3.3.1.1.3-1 depicts the extent of current erosion found along the streambanks of the TFI.

3.3.1.1.4 Suspended Sediment

TFI suspended sediment values have been observed to have a strong correlation to flow. That is, the highest suspended sediment concentration (SSC) values are often observed during the highest periods of flow while the lowest SSC values are often observed during the lowest period of flows. During a three year observation period (2013-2015), three mainstem flow thresholds were observed in regard to SSC values: <12,000 cfs, 12,000-35,000 cfs, and >35,000 cfs. Median SSC values for mainstem flows below 12,000 cfs observed during this period (as measured in the vicinity of the Route 10 Bridge) were 2.9 mg/L while flows between 12,000-35,000 cfs and greater than 35,000 cfs had observed median SSC values of 12.45 mg/L and 144.61 mg/L, respectively (FirstLight, 2015a). Figure 3.3.1.1.4-1 demonstrates this relationship.

Furthermore, the flow and SSC levels of the Connecticut River in the Project boundary are very much correlated with the season. The seasonal hydrology pattern in this area is typically defined by: 1) a spring freshet typically occurring in late March and into May when the highest annual flows and SSC values are normally observed (barring a significant basin wide rain event or Hurricane in the summer or fall); 2) moderate flows and SSC values throughout the early summer as the spring freshet subsides; 3) low flows and SSC values throughout the summer and early fall; and 4) low to moderate flows and SSC values during

[13] Riverbanks consist of an irregular surface and include a range of natural materials, above ground vegetation, and below ground roots of different densities and sizes. Due to these characteristics, there are small areas of disturbance which often occur at interfaces between materials, particularly in the vicinity of the water surface. These small disturbed areas can be considered as erosion, or sometimes can result from deposition or even eroded deposition. No natural riverbank exists which does not have at least some relatively small degree of disturbance or erosion associated with the natural combination of sediment types/sizes and vegetation. As such, the extent of erosion for generally stable riverbanks that included these relatively small disturbed areas was characterized as None/Little during the 2013 FRR.

the fall. Significant basin wide or local rain events occasionally cause spikes in flow and SSC values during the summer and fall before conditions return to a lower, more steady state. SSC values observed during typical high, moderate, and low flow periods are shown in Figures 3.3.1.1.4-2 – 3.3.1.1.4-4. Table 3.3.1.1.4-1 demonstrates the seasonal range of flows and SSC values observed during the three year observation period (2013-2015).

3.3.1.2 Environmental Effects

Potential geology and soils Project related effects could include shoreline erosion within the TFI and the entrainment of sediment into the Northfield Mountain Pumped Storage Development works during Project operations.

Numerous studies have been conducted since 1979 to characterize streambank conditions of the TFI to understand the causes of erosion and to identify the most appropriate approaches for bank stabilization. In addition to studies conducted in the 1970s, 1980s, and 1990s, the Erosion Control Plan (ECP) was developed in 1998 (S&A, 1999) to address stabilization and preventative maintenance of erosion sites in the TFI, regardless of cause.

As part of the ECP a reconnaissance level survey of the length of the TFI streambanks was conducted to identify and rank erosion sites without regard to the cause of erosion and whether it appeared to be related to the Project. From this survey a list of the 20 most severely eroded sites was developed. Following completion of this list, the Licensee began stabilizing these sites using various techniques including bio-engineering. The 1998 list of sites has served as the basis for the construction of 18,150 linear feet of stabilization efforts from 1999 through 2014. As of the 2013 FRR, 15 of the 20 sites identified in 1998 had been stabilized. Of the five (5) sites not stabilized, two are located in areas where extreme hydraulic conditions exist that are proximate to non-Project related manmade structures (just below Vernon Dam and just upstream of the Route 10 Bridge), one site is located on an island (island locations have typically not been as high priority to repair as streambank locations), and two other sites were not selected for stabilization based on feedback from stakeholders and landowners.

Table 3.3.1.2-1 denotes the current status of the twenty most severely eroded sites identified during the 1998 FRR while Figure 3.3.1.2-1 denotes the locations where stabilization efforts associated with the ECP have occurred.

In addition to the 18,150 linear feet of TFI riverbanks that have been stabilized since 1998 through implementation of the ECP, previous stabilization work associated with construction of the Northfield Mountain Pumped Storage Development totaled 25,900 feet of rip-rap or rip-rap with vegetation with an additional 2,600 feet of grading and planting. Furthermore, an additional 2,000 feet of experimental stabilization was constructed by the USACE in the 1970s. Overall stabilization work (not including grading and planting) associated with construction of the Northfield Mountain Pumped Storage Development and other work such as that constructed by the USACE along with implementation of the ECP totals approximately 48,980 linear feet of riverbanks (9.28 miles).

Over the past 15 years, TFI riverbank conditions with respect to erosion have improved. The 1998 FRR identified 3.4% of TFI riverbanks as being severely eroded while the 2013 FRR found that only 0.6% of riverbanks were classified as having Extensive erosion.[14] The majority of the 20 most severely eroding sites identified in 1998 have successfully been treated, are now stable and supporting heavy vegetation, and have not experienced any significant erosion. Moreover, erosion sites in 1998 were quite large in magnitude and stark in appearance with very little vegetation and significant potential for ongoing erosion and sediment production. By contrast, in 2013, eroding sites were found to be generally smaller in magnitude with a greater degree of vegetation. In addition, based on the findings of the 2013 FRR it was observed that from

[14] Due to classification differences between the 1998 and 2013 FRR's "Severely Eroded" and "Extensive Erosion" were the most severe erosion classifications for the 1998 and 2013 FRR, respectively.

2008 to 2013 there has been an increase in riverbank stability, and therefore a corresponding decrease in eroding banks, of approximately 1.5% (FirstLight, 2014a).

To put the current health of the TFI streambanks with respect to erosion processes into context and to better understand the current condition of the TFI, the results of the 2013 FRR were compared with the conclusions of the Connecticut River bank erosion comparison study conducted by Simons and Associates (S&A) in 2012 (FirstLight, 2012a). The 2012 report examined and compared riverbank erosion in the TFI to other reaches of the Connecticut River including impoundments upstream and downstream of the TFI and free flowing stretches of the river. Key conclusions from this report, which were reinforced by the results of the 2013 FRR, found that:

- The segment of river with the greatest extent of eroding riverbanks is the un-impounded northern reach (Pittsburg, NH down to Gilman Dam). At the time of the available study (Field Geology Services, 2004), 48.4% of the riverbanks were experiencing moderate or more significant erosion. Riverbanks that had been rip-rapped covered 17.1% of the length of the river.[15]
- Despite the fact that similar percentages of riverbank have been stabilized in the northern, free-flowing reach and in the TFI; the percentage of erosion in the TFI is only about one-third the extent of erosion that is occurring in the northern, un-impounded reach of the Connecticut River (16.7% compared to 48.4%).
- Several erosion sites were identified and photographed in the Bellows Falls, Vernon, Turners Falls, and Holyoke Impoundments in 1997. These erosion sites were photographed again in 2008. All of the erosion sites in 1997 in the Bellows Falls and Holyoke Impoundments, and all but one of the 1997 erosion sites in the Vernon Impoundment, remain in essentially the same state of erosion when photographed in 2008. Many of these sites are significant in both size and severity. In contrast, most of the erosion sites in the TFI in 1998 have been stabilized and are no longer eroding as of 2008 (when previously identified erosion sites were re-photographed in 3 impoundments and when the most recent FRR was conducted in the TFI), with several additional erosion sites scheduled to be stabilized as part of the "Erosion Control Plan for the Turners Falls Pool of the Connecticut River" (S&A, 1999) by 2012.
- In addition to the direct stabilization of many of the erosion sites in the TFI that were identified in the 1998 Erosion Control Plan (ECP), there is evidence of some natural stabilization processes including increased upper bank vegetation and areas of dense low bank aquatic vegetation that are helping provide a degree of additional stability in some areas.
- Based on the state of erosion in the northern un-impounded reach as well as the state of continued erosion in the Bellows Falls, Vernon and Holyoke impoundments, the riverbanks in the TFI are in the best condition (more stable and less eroding) than in any other part of the Connecticut River.

The causes of erosion in the TFI are currently being evaluated in Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* (Study No. 3.1.2). Study No. 3.1.2 will evaluate and identify the causes of erosion, and the forces associated with them, in the TFI and determine to what extent they are related to Project operations. Based on past experience conducting FRRs and other geomorphic evaluations of the Connecticut River, it is anticipated that potential causes of erosion could include:

- Hydraulic shear stress due to flowing water;
- Water level fluctuations due to hydropower operations;
- Boat waves;
- Land management practices and anthropogenic influences to the riparian zone;
- Animals;
- Wind waves;

[15] The study reach along the Connecticut River from Pittsburg, NH to Gilman Dam is 85 miles.

- Seepage and piping;
- Freeze-thaw; and
- Ice or debris

The potential primary causes of erosion that are being examined in greater detail include:

- Hydraulic shear stress due to flowing water;
- Water level fluctuations due to hydropower operations;
- Boat waves;
- Land management practices and anthropogenic influences to the riparian zone; and
- Ice

As of the date of this filing, Study No. 3.1.2 is still ongoing. It is anticipated to be complete and filed with FERC by October 14, 2016.

In regard to the entrainment of suspended sediment into the Northfield Mountain Pumped Storage Development works and the Connecticut River, FirstLight is conducting Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan* (Study No. 3.1.3). As of the date of this filing, Study No. 3.1.3 is still ongoing; however, a sizeable report (*Northfield Mountain Pumped Storage Project Sediment Management Plan 2015 Summary of Annual Monitoring*) was filed by FirstLight with FERC on September 14, 2015. In the report, FirstLight noted that it will file a final report that will include sediment management measures to minimize the entrainment of sediment into Project works and the Connecticut River during drawdown and dewatering activities. Preliminary results from Study No. 3.1.3 indicate that during high (>35,000 cfs) and moderate (12,000-35,000 cfs) flow conditions, SSC values observed in the River during generation were found to be lower than those observed during pumping; that is, SSC values observed at the tailrace were lower than those observed in the mainstem. This indicates: 1) that net deposition is occurring in the Upper Reservoir over time, and 2) there are no correlations between typical Project operations and increased mainstem SSC values. These observations are further supported by the results of the annual Upper Reservoir bathymetry surveys which demonstrated a net accumulation of sediment over time.

In addition to suspended sediment monitoring, various modeling efforts are underway as part of Study No. 3.1.3 to better understand the potential entrainment of sediment into the Northfield Mountain Pumped Storage Development works and Connecticut River during drawdown or dewatering activities. The results of the modeling efforts, combined with the other elements of Study No. 3.1.3, will be used to inform management measures to minimize potential environmental effects. It is anticipated to be complete and filed with FERC by October 14, 2016.

3.3.1.3 Cumulative Impacts

The Council of Environmental Quality (CEQ) regulations define "cumulative effects" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR §1508.7).

For this analysis, the action is the relicensing and continued operation of the Turners Falls Development and Northfield Mountain Pumped Storage Development, as well as the upstream projects owned by TransCanada, which is also conducting relicensing studies on erosion. The cumulatively affected resource is the Connecticut River Basin. The cumulative impact of the Project on the affected resource is still being evaluated as part of Relicensing Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* and Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan*. Study No. 3.1.2 will evaluate and identify the causes of erosion, and the forces associated with them, in the TFI and determine to what extent they are related to Project operations. The results of Study No. 3.1.3 will be used to help inform sediment management measures that will avoid or minimize the entrainment of sediment in the Northfield Mountain Pumped Storage Development works and the Connecticut River. Final reports for Study No. 3.1.2 and 3.1.3 will be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

3.3.1.4 Proposed Environmental Measures

No environmental measures are proposed at this time. Proposed environmental measures will be reviewed upon completion of Studies No. 3.1.2 and 3.1.3.

3.3.1.5 Unavoidable Adverse Impacts

Northfield Mountain Pumped Storage Development operations, under FirstLight's proposed action, would continue to alter water levels on an intra-daily time step in the TFI.

Relicensing Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* is still ongoing with the final report to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule. The results of this study will identify the causes of erosion in the TFI and the impact of fluctuating water levels, if any, on TFI streambank erosion.

Relicensing Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan* is also still ongoing with the final report to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule. The results of Study No. 3.1.3 will be used to inform management measures to minimize the entrainment of sediment into the Northfield Mountain Pumped Storage Development works and discharge to the Connecticut River during drawdown or dewatering activities.

Table 3.3.1.1.2-1: Description of Common Soil Types in the Vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development

Series	Percent Areal Coverage	Description
Windsor	21%	The Windsor series consists of very deep, excessively drained soils formed in sandy outwash or eolian deposits. They are nearly level through very steep soils on glaciofluvial landforms.
Agawam	10%	The Agawam series consists of very deep, well drained soils formed in sandy, water deposited materials. They are level to steep soils on outwash plains and high stream terraces.
Unadilla	9%	The Unadilla series consists of deep and very deep, well drained soils formed in silty, lacustrine sediments or old alluvial deposits. These soils are on valley terraces and lacustrine plains.
Hadley	9%	The Hadley series consists of very deep well drained soils formed in silty alluvium. They are nearly level soils on flood plains.
Chatfield	7%	The Chatfield series consists of well drained and somewhat excessively drained soils formed in till derived from parent materials that are very low in iron sulfides. They are moderately deep to bedrock. They are nearly level through very steep soils on glaciated plains, hills, and ridges.
Yatesville-Holyoke complex	7%	The Yatesville series consists of moderately deep, well drained soils formed in a loamy till. Nearly level to moderately steep soils on hills and ridges. The Holyoke series consists of shallow, well drained and somewhat excessively drained soils formed in a thin mantle of till derived mainly from basalt and red sandstone, conglomerate, and shale. Nearly level to very steep soils on bedrock controlled ridges and hills.
Udorthents	6%	Disturbed soils; cut and fill areas, urban land.
Poocham	3%	The Poocham series consists of very deep well drained soils formed in wind or water deposited silts and very fine sands. They are on terrace escarpments and along deeply dissected drainageways.
Merrimac	2%	The Merrimac series consists of very deep, somewhat excessively drained soils formed in outwash. They are nearly level through very steep soils on outwash terraces and plains and other glaciofluvial landforms.
Tunbridge	2%	The Tunbridge series consists of moderately deep, well drained soils on glaciated uplands. They are formed in loamy till.

Table 3.3.1.1.3-1: Summary Statistics of Riverbank Features and Characteristics – Turners Falls Impoundment

Riverbank Features	Characteristics					
Upper Riverbank Slope	Overhanging 1.8%	Vertical 1.6%	Steep 28.0%	Moderate 59.8%	Flat 8.8%	
Upper Riverbank Height	Low 15.5%	Medium 5.7%	High 78.8%			
Upper Riverbank Sediment	Clay -	Silt/Sand 95.6%	Gravel -	Cobbles -	Boulders 0.9%	Bedrock 3.5%
Upper Riverbank Vegetation	None to Very Sparse 1.9%	Sparse 1.3%	Moderate 17.1%	Heavy 79.7%		
Lower Riverbank Slope	Vertical 0.8%	Steep 2.3%	Moderate 27.5%	Flat/Beach 69.4%		
Lower Riverbank Sediment	Clay <0.1%[16]	Silt/Sand 59.6%	Gravel 7.9%	Cobbles 8.7%	Boulders 11.9%	Bedrock 11.9%
Lower Riverbank Vegetation	None to Very Sparse 88.3%	Sparse 3.5%	Moderate 3.2%	Heavy 5.0%		
Type of Erosion	Falls-Undercut 43.4%	Falls-Gullies 0.03%	Topples 1.1%	Slide or Flow 6.2%	Planar Slip 1.1%	Rotational Slump 1.5%
Potential Indicators of Erosion	Tension Cracks <0.10[17]%	Exposed Roots 38.1%	Creep/Leaning Trees 62.7%	Overhanging Bank 12.7%	Notch 5.0%	Other 1.1%
Stage of Erosion	Potential Future Erosion 5.5%	Active Erosion 0.6%	Eroded 9.1%	Stable 83.5%	In Process of Stabilization 1.3%[18]	

[16] Clay was found in few segments of the river but where some clay was found the sediment was dominated by another type of sediment either vertically or horizontally within a segment. When this occurred the segment was classified using the dominant sediment type. For example, some clay was observed in segment 342 (just downstream of Vernon Dam on the left bank) but the segment was classified using the dominant sediment type.
[17] Tension cracks can only be observed from land-based observations. Some tension cracks were observed during the land-based survey and are reported at those sites as indicated in the notes for the land-based work. Tension cracks were not observed to be significant in the more general top of bank observations when walking along the length of the Impoundment.
[18] While originally not one of the RSP erosion condition classifications, one riverbank segment was classified as being "In the Process of Stabilization" due to the fact that riverbank stabilization work was being constructed at this

Riverbank Features	Characteristics				
Extent of Current Erosion	None/Little 84.8%	Some 14.1%	Some to Extensive 0.5%	Extensive 0.6%	

particular segment (421, Bathory/Gallagher 2013) during the 2013 FRR. A gravel beach at the top of the lower riverbank had been placed along with large woody debris. Vegetation was then being planted to provide additional stabilization on the gravel beach as well as extending other vegetation onto portions of the upper riverbank.

Table 3.3.1.1.3-2: Riverbank Classification Definitions

RIVERBANK CHARACTERISTICS *(Upper and Lower)*[19]	
Riverbank Slope	**Overhanging** – any slope greater than 90º
	Vertical – slopes that are approximately 90º
	Steep – exhibiting a slope ratio greater than 2 to 1
	Moderate – ranging between a slope ratio of 4 to 1 and 2 to 1
	Flat – exhibiting a slope ratio less than 4 to 1[20]
Riverbank Height	**Low –** height less than 8 ft above normal river level[21]
	Medium – height between 8 and 12 ft above normal river level
	High – height greater than 12 ft above normal river level
Riverbank Sediment	**Clay –** any sediment with a diameter between .001 mm and 2 mm
	Silt / Sand – any sediment with a diameter between .062 mm and 2 mm
	Gravel – any sediment with a diameter between 2 mm and 64 mm
	Cobbles – any sediment with a diameter between 64 mm and 256 mm
	Boulders – any sediment with a diameter between 256 mm and 2048 mm
	Bedrock – unbroken, solid rock
Riverbank Vegetation	**None to Very Sparse –** less than 10% of the total riverbank segment is composed of vegetative cover
	Sparse – 10-25% of the total riverbank segment is composed of vegetative cover
	Moderate – 25-50% of the total riverbank segment is composed of vegetative cover
	Heavy – 50 % or greater of the total riverbank segment is composed of vegetative cover
Sensitive Receptors	Important wildlife habitat located at or near the riverbank.
EROSION CLASSIFICATIONS	
Type(s) of Erosion[22]	**Falls –** Material mass detached from a steep slope and descends through the air to the base of the slope. Includes erosion resulting from transport of individual particles by water.
	Topples – Large blocks of the slope undergo a forward rotation about a pivot point due to the force of gravity. Large trees undermined at the base enhance formation.
	Slides – Sediments move downslope under the force of gravity along one or several discrete surfaces. Can include planar slips or rotational slumps.
	Flows – Sediment/water mixtures that are continuously deforming without distinct slip surfaces.
Indicators of Potential Erosion	**Tension Cracks –** a crack formed at the top edge of a bank potentially leading to topples or slides (FGS, 2007)
	Exposed Roots – trees located on riverbanks with root structures exposed, overhanging.
	Creep – defined as an extremely slow flow process (inches per year or less) indicated by the presence of tree trunks curved downslope near their base (FGS, 2007)
	Overhanging Bank – any slope greater than 90º
	Notching – similar to an undercut, defined as an area which leaves a vertical stepped face presumably after small undercut areas have failed.
	Other – Indicators of potential erosion that do not fit into one of the four categories listed above will be noted by the field crew.[23]

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[19] All quantitative classification criteria (e.g. slope, height, vegetation, extent, etc.) were based on approximate estimates made during field observations of riverbanks. The FRR is a reconnaissance level survey that does not include quantitative analysis.
[20] Beaches are defined as a lower riverbank segment with a flat slope
[21] For the purpose of this report, Normal Water Level was defined as water levels within typical pool fluctuation levels, but below Ordinary High Water (186').
[22] FGS, 2007
[23] Segments with features classified as "Other" exhibited various erosion processes that did not fit in one of the existing classification categories.

Stage(s) of Erosion	**Potential Future Erosion –** riverbank segment exhibits multiple or extensive indicators of potential erosion
	Active Erosion – riverbank segment exhibits one or more types of erosion as well as evidence of recent erosion activity
	Eroded – riverbank segment exhibits indicators that erosion has occurred (e.g. lack of vegetation, etc.), however, recent erosion activity is not observed. A segment classified as Eroded would typically be between Active Erosion and Stable on the temporal scale of erosion.
	Stable – riverbank segment does not exhibit types or indicators of erosion
Extent of Current Erosion	**None/Little**[24] **–** generally stable bank where the total surface area of the bank segment has approximately less than 10% active erosion present.
	Some – riverbank segment where the total surface area of the bank segment has approximately 10-40% active erosion present
	Some to Extensive – riverbank segment where the total surface area of the bank segment has approximately 40-70% active erosion present
	Extensive – riverbank segment where the total surface area of the bank segment has approximately more than 70% active erosion present

[24] Riverbanks consist of an irregular surface and include a range of natural materials (silt/sand, gravel, cobbles, boulders, rock, and clay), above ground vegetation (from grasses to trees), and below ground roots of different densities and sizes. Due to these characteristics, there are small areas of disturbance which often occur at interfaces between materials, particularly in the vicinity of the water surface. These small disturbed areas can be considered as erosion, or sometimes can result from deposition or even eroded deposition. No natural riverbank exists which does not have at least some relatively small degree of disturbance or erosion associated with the natural combination of sediment types/sizes and vegetation. As such, the extent of erosion for generally stable riverbanks that include these relatively small disturbed areas is characterized as little/none.

Table 3.3.1.1.4-1: Seasonal Range of Flows and SSC (2013-2015) [25]

Season	Months	Flow Range (cfs)	Median Flow (cfs)	SSC Range (mg/L)	Median SSC (mg/L)
Spring 2013	April - June	2,251-55,570	14,751	0.17-163.46	5.28
Summer 2013	July & August	1,318-61,733	8,750	0.29-149.62	5.20
Fall 2013	September-November	1,423-18,769	5,931	0.37-4.40	2.12
Spring 2014	April - June	1,731-68,338	20,080	0.05-449.76	11.47
Summer 2014	July & August	1,535-26,481	6,762	0.49-86.51	3.67
Fall 2014	September-November	1,360-25,450	5,160	0.14-157.3979	6.36
Spring 2015	April - June	1,668-66,725	15,340	2.00-43.02	10.68
Summer 2015	July	1,661-42,859	8,062	0.19-19.62	7.28

[25] SSC values were measured in the vicinity of the Rt. 10 Bridge

Table 3.3.1.2-1: Twenty Sites with Highest Erosion Rank from the Erosion Control Plan (1998) and Current Status

Site #	Site Name	Length in feet 1998	Status as of 2013 FRR
1	Vernon Dam	827	Base of Vernon dam. Left Bank - Not selected for stabilization due to extreme hydraulic conditions associated with Vernon spillway
2	Rod &Gun Club	20	Restored - 240 ft stabilized in 2004 – Turners Falls Rod & Gun Club
3	Bennett Meadow	100	Restored - 50 ft stabilized in 2005 – Bennett Meadows
4	Urgiel Upstream	1150	Restored - 1200 ft stabilized in 2001 – Urgiel Upstream
5	RT. 10	730	Upstream of RT 10 Bridge Left Bank - Not selected for stabilization due to unique hydraulic conditions in the vicinity of the Route 10 Bridge
6	Skalski	1640	Restored - 1600 ft stabilized in 2004 – Skalski
7	Flagg Farm	2180	Restored - 2500 ft stabilized 1999-2000 – Flagg
8	West bank	630	Not selected for stabilization – opposite great meadow
9	Old VT bridge west bank	260	Restored - 915 ft stabilized in 2007 – Kendall
10	River Road	500	Restored - 980 ft stabilized in 2003 – River Road
11	Urgiel Downstream	690	Restored - 980 ft stabilized in 2005 – Urgiel Downstream
12	Durkee Point	20	Restored - 500 ft stabilized in 2003 – Durkee Point
13	Across from River Road	20	Restored - Stabilized in 2009 – 1725 ft, Split River
14	Country Road (south)	2300	Restored - 850 ft stabilized in 2006 – Country Road (includes site #20)
15	NH island	210	Point of island. Not recommended for restoration, except for possible Preventative Maintenance work
16	Kaufold/Split River farm	4000	Restored – Stabilized in 2010-2012 – 1360 ft, Upper Split River 1; 1000 ft, Upper Split River 2; 1250 ft, Bathory-Gallagher; Wallace-Watson, 1000 ft. (Note: The combination of these sites was formerly known as the Kaufold site)
17	Rod & Gun Club at Narrows East Bank	560	Restored - 1000 ft stabilized by preventative maintenance in 2008 – Montague
18	Narrows	700	Restored - 1000 ft stabilized by preventative maintenance in 2008 – Campground Point
19	VT	450	Not selected for stabilization – below Davenport Island
20	Country Road (North)	480	Restored - 850 ft stabilized in 2006 – Country Road (included as part of site # 14)

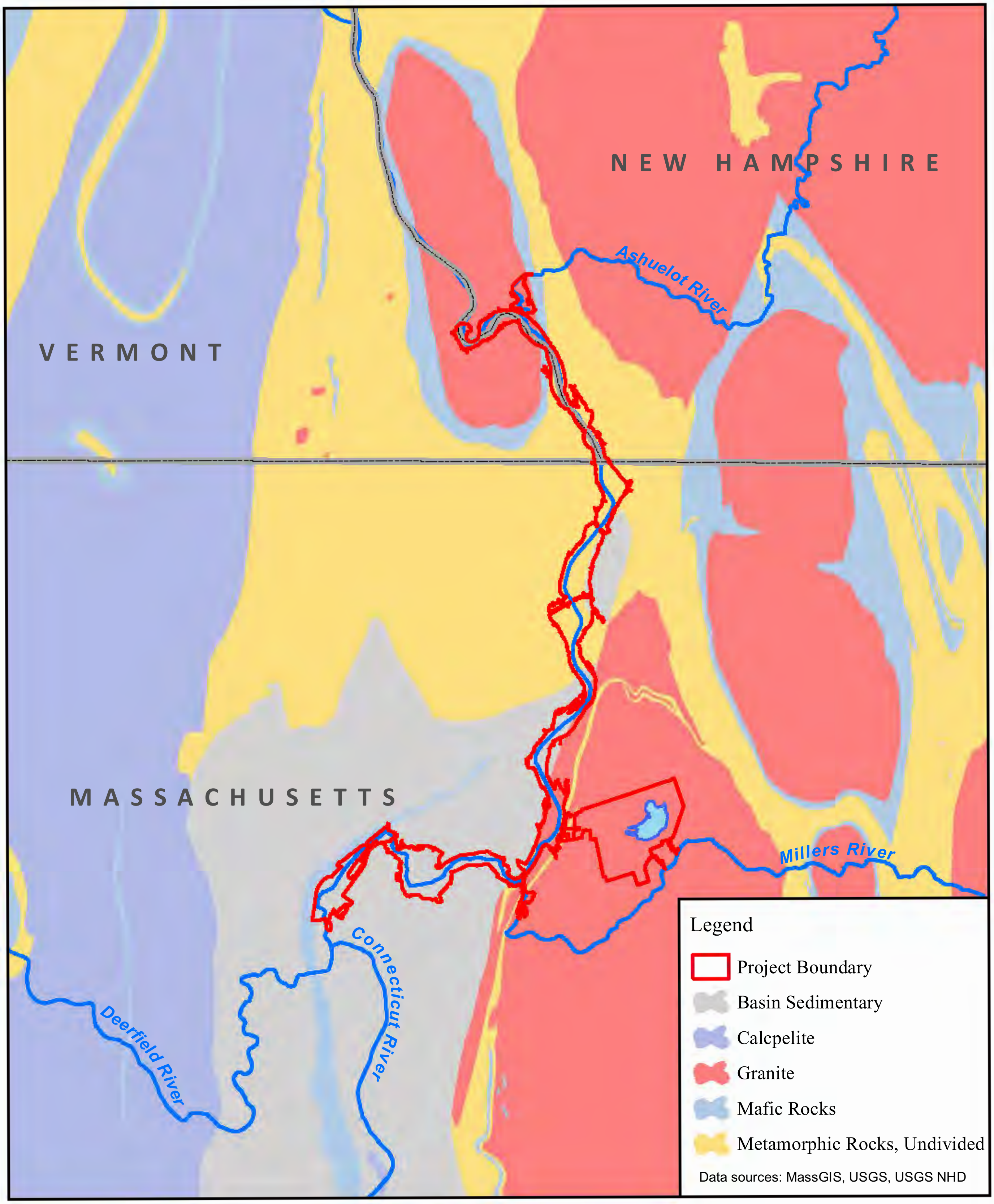

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Figure 3.3.1.1.1-1 Bedrock Geology in the Vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development

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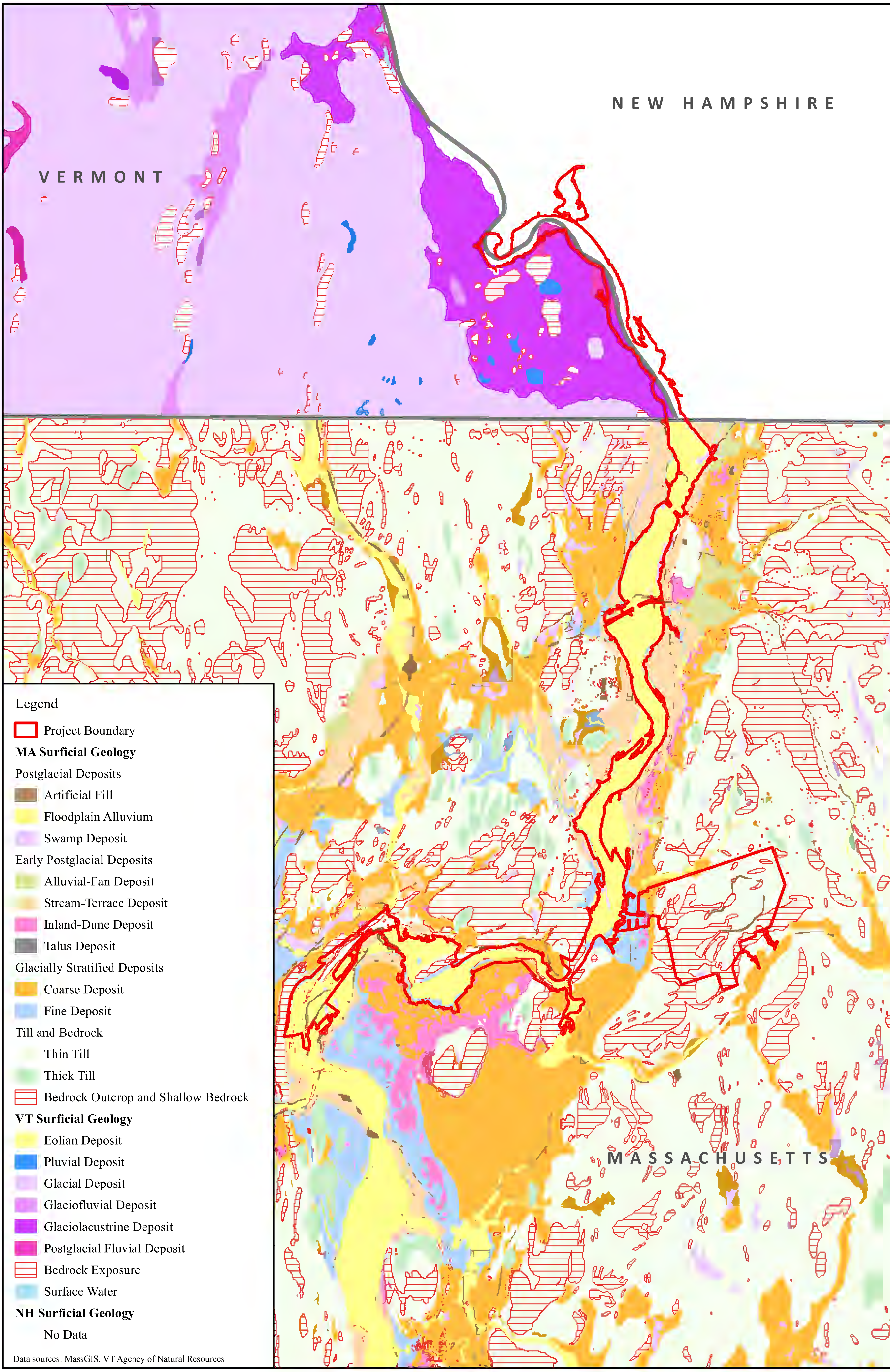

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0 0.75 1.5 3 Miles

Figure 3.3.1.1.1-2: Surficial Geology in the Vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development

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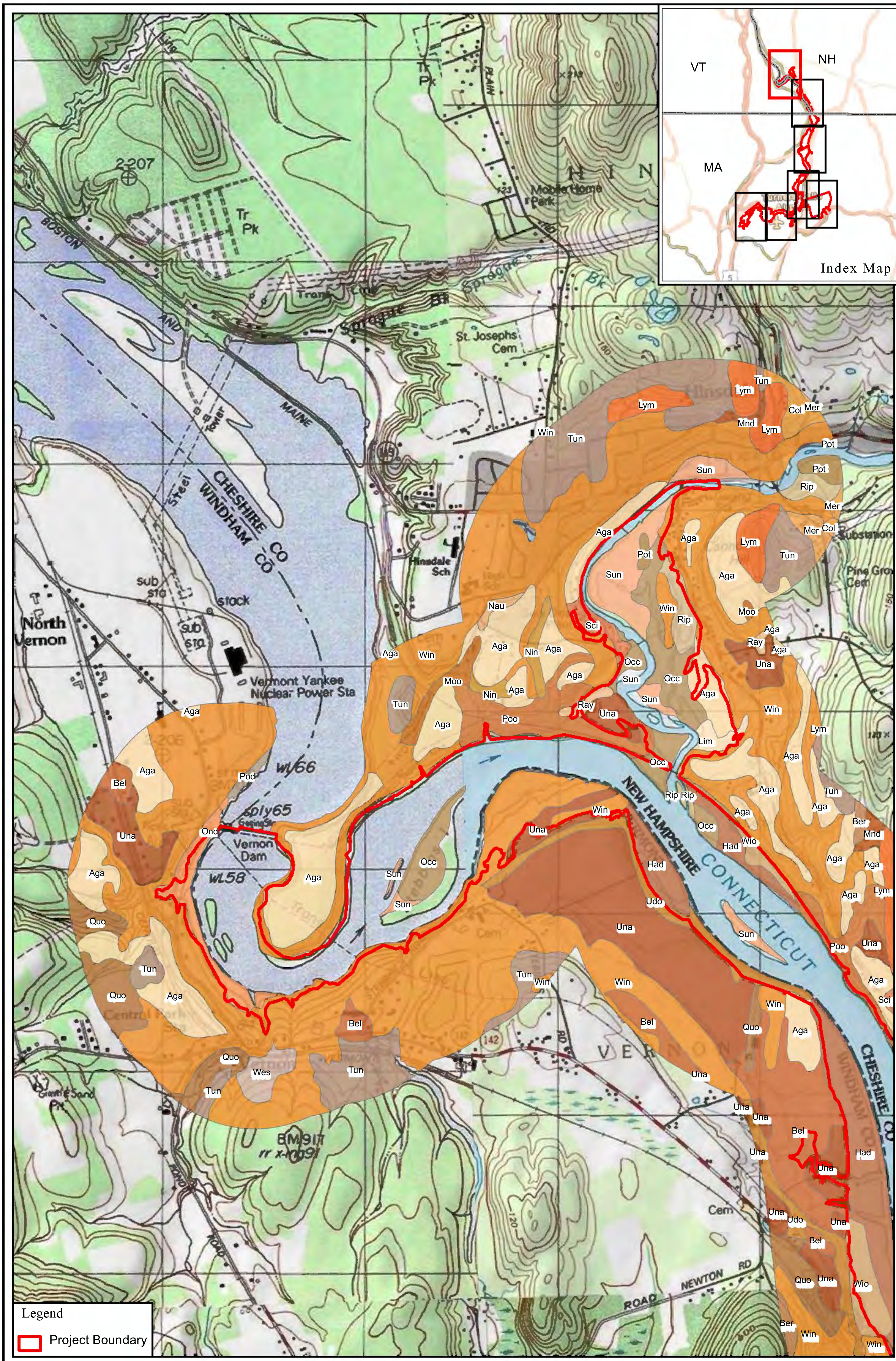

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0 750 1,500 3,000 Feet

N

Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 1

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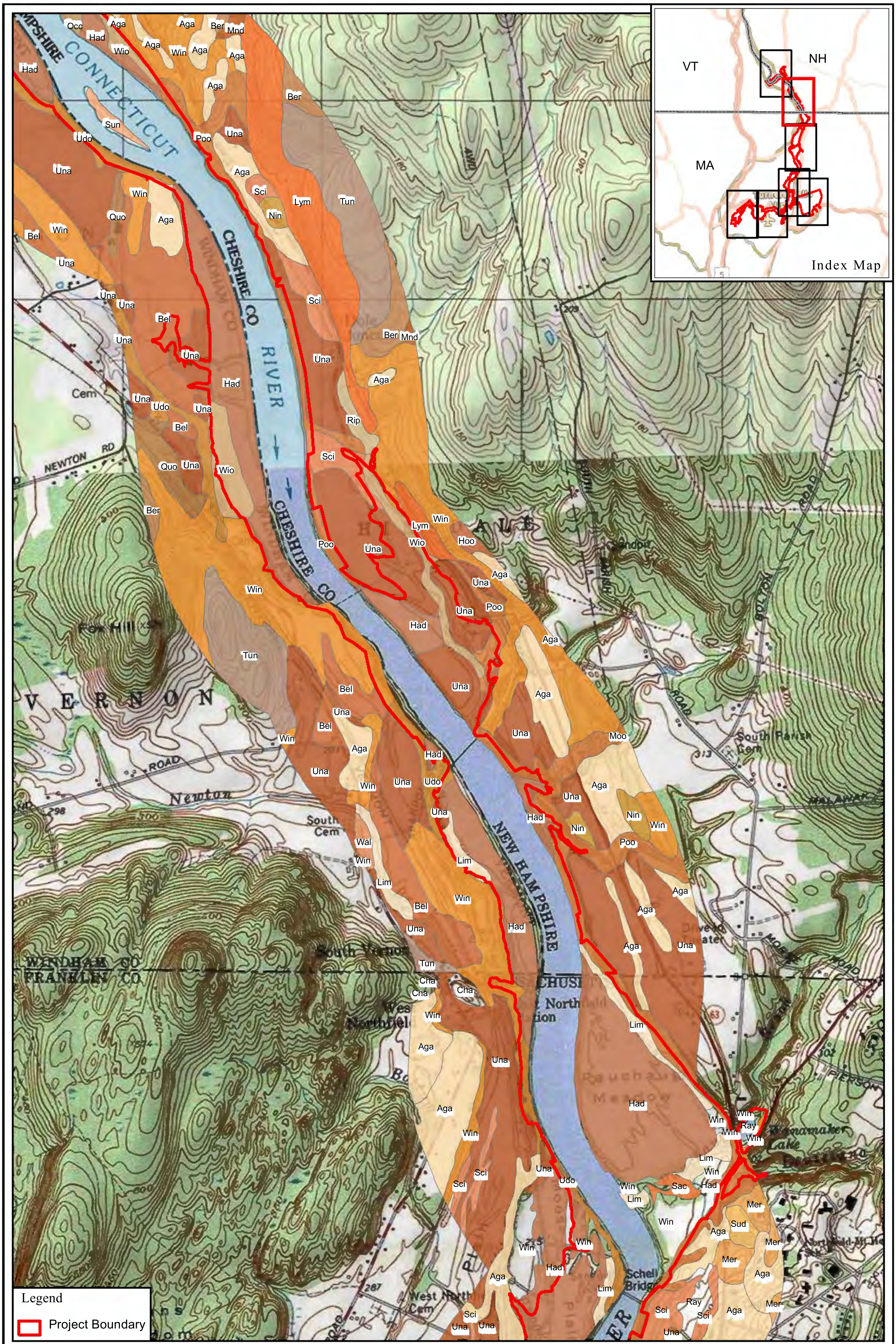

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0 750 1,500 3,000 Feet

Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 2

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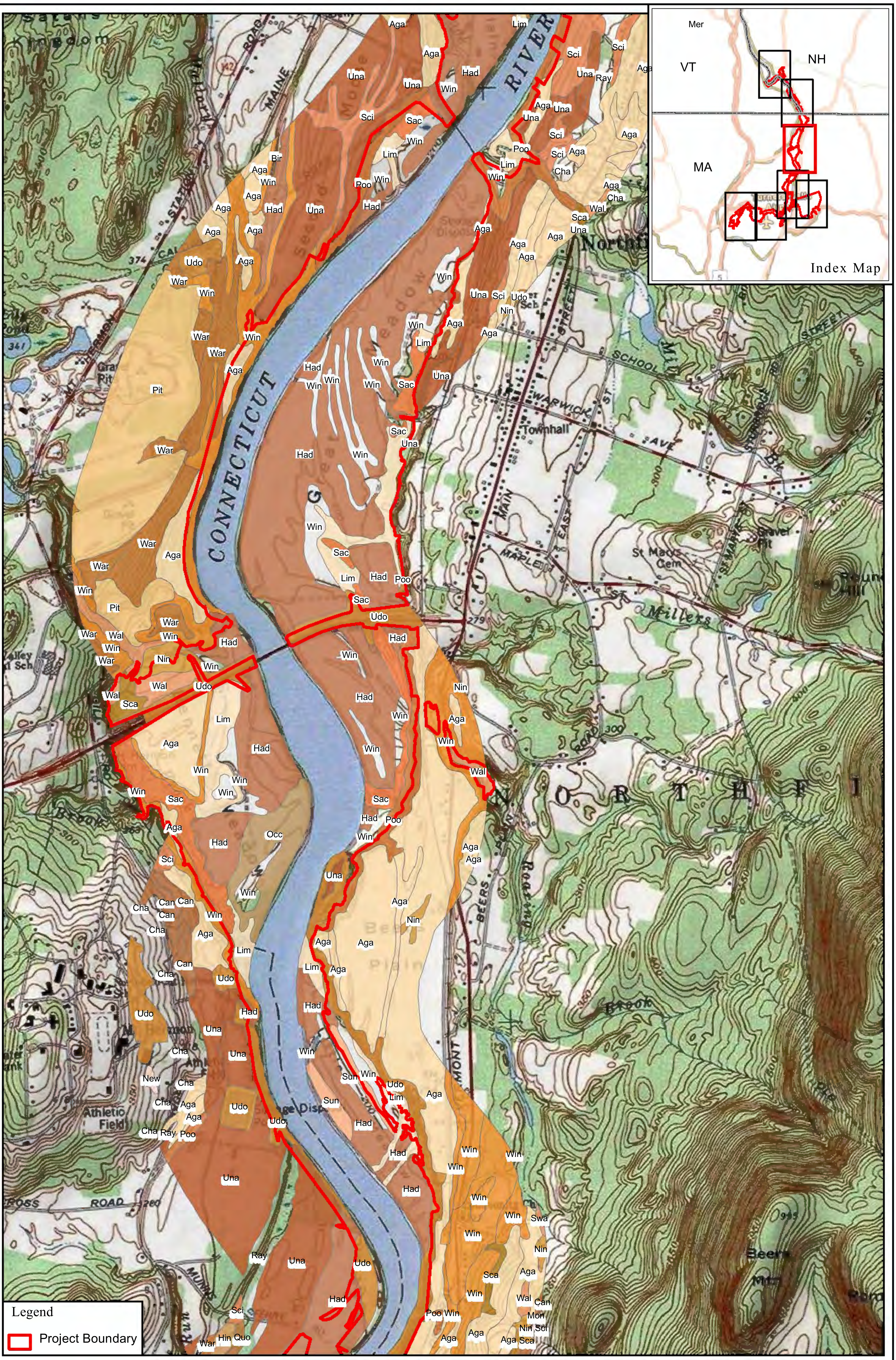

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0 750 1,500 3,000 Feet

Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 3

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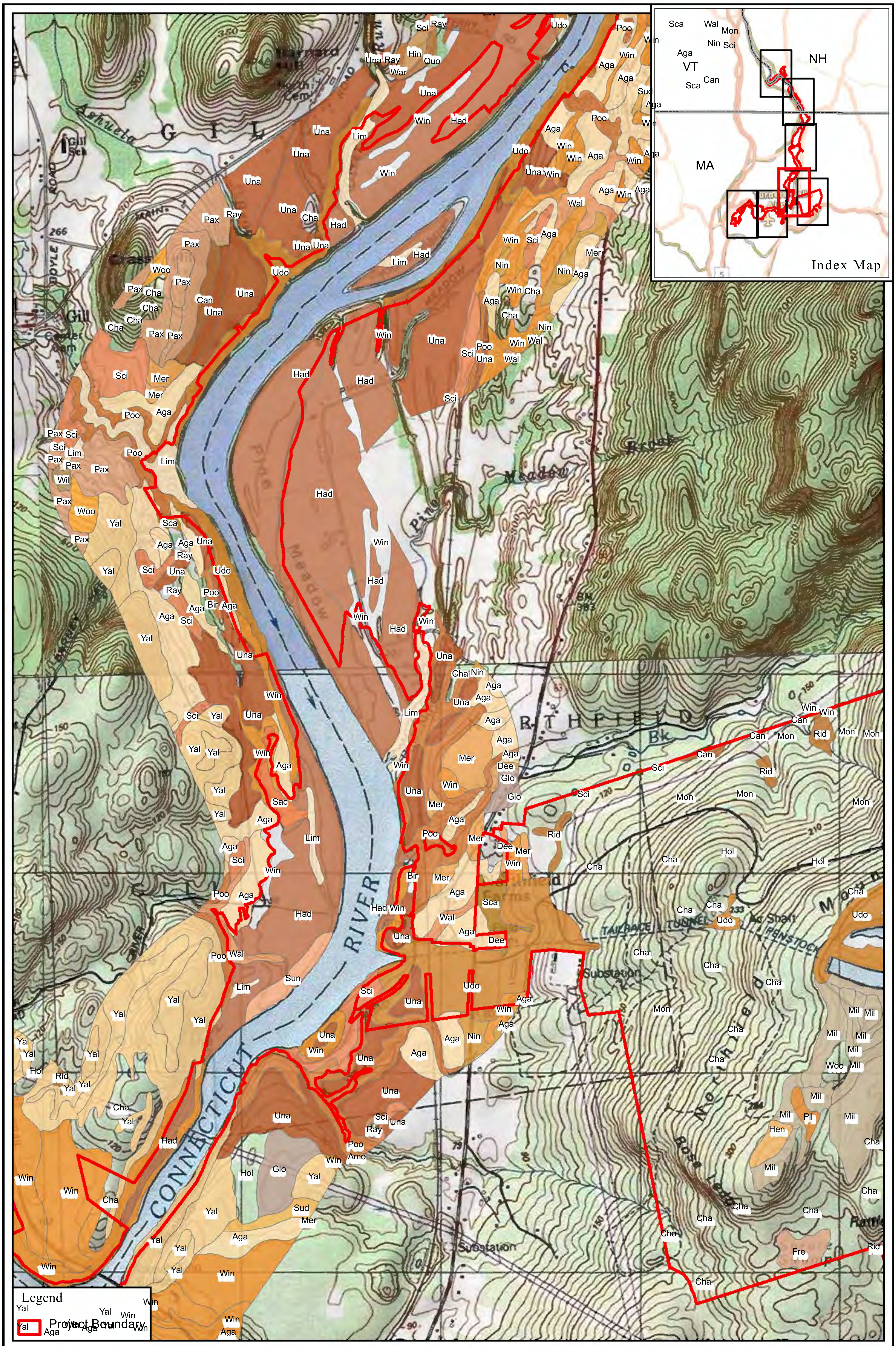

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 4

0 750 1,500 3,000 Feet

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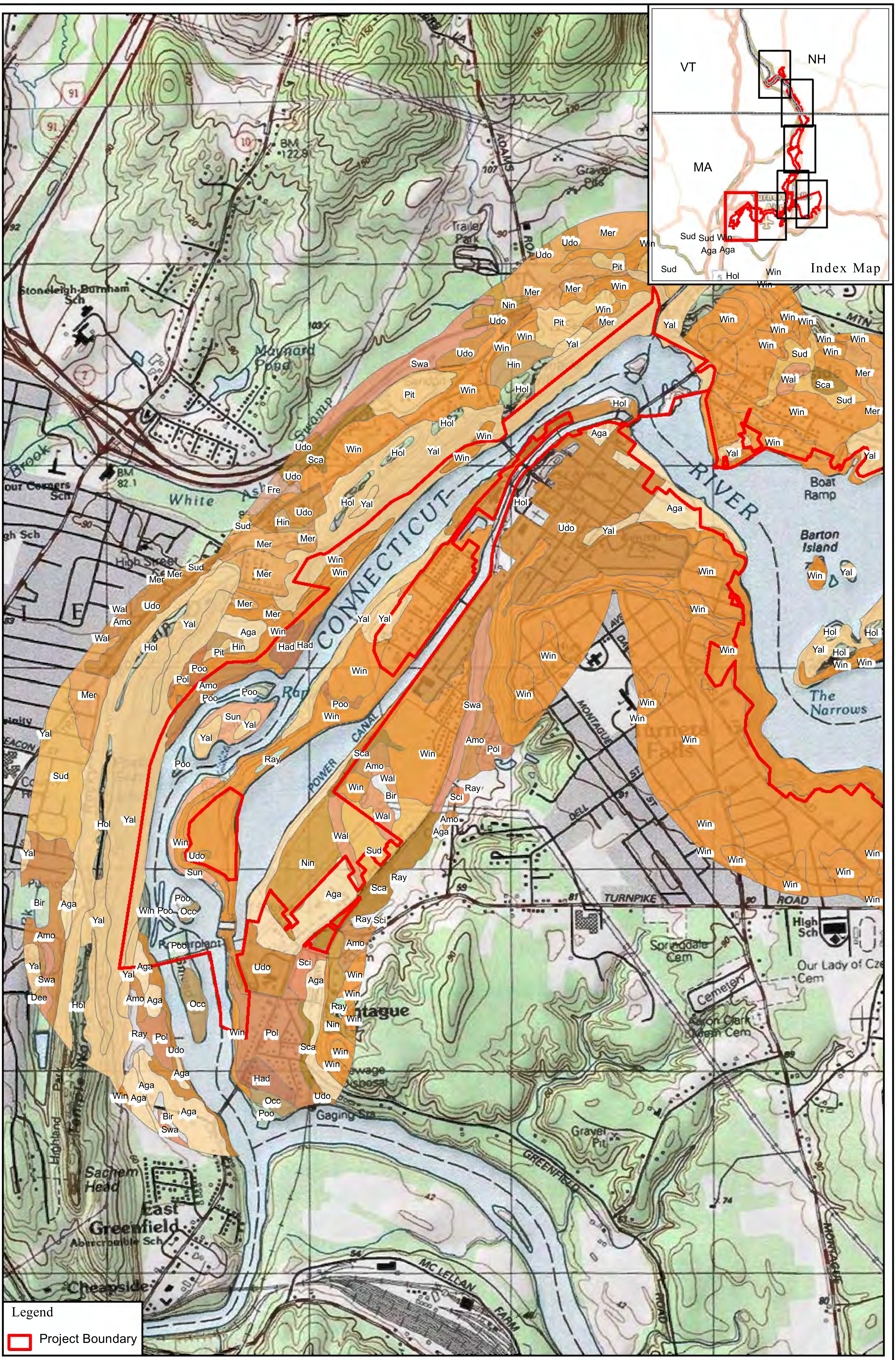

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 5

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0 750 1,500 3,000 Feet

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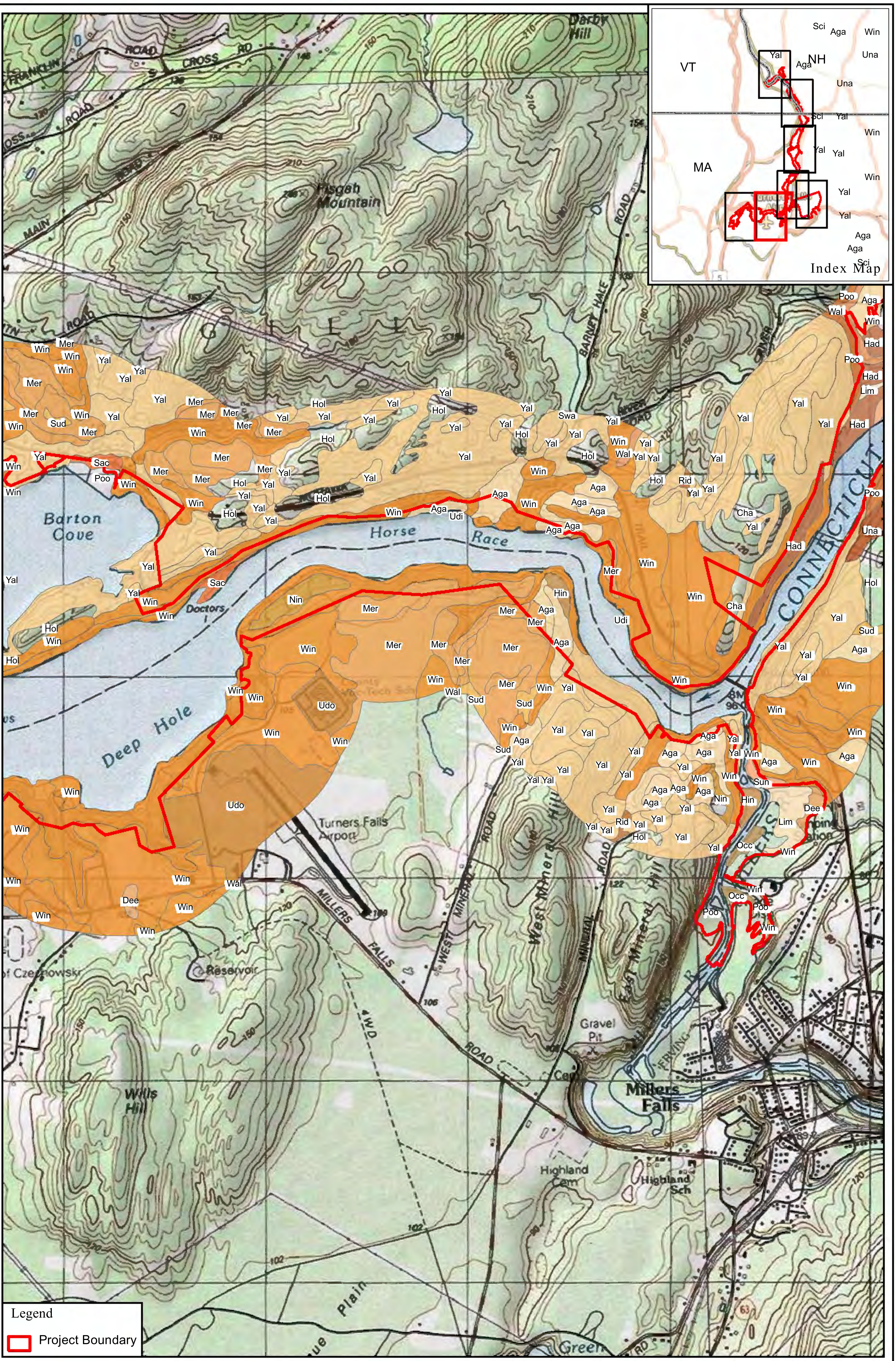

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0 750 1,500 3,000 Feet

Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 6

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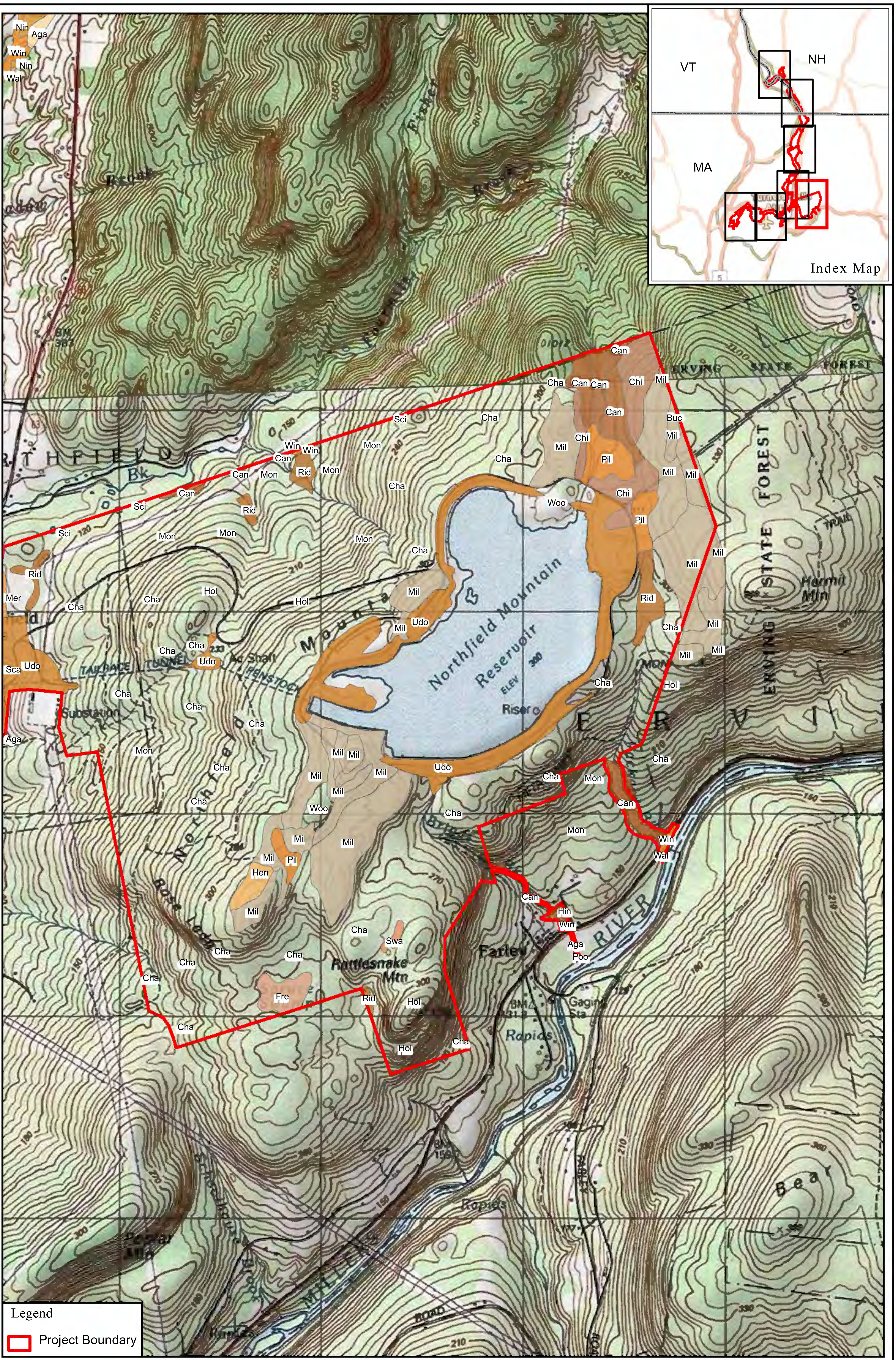

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0 750 1,500 3,000 Feet

N

Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls and Northfield Mountain Projects
Map 7

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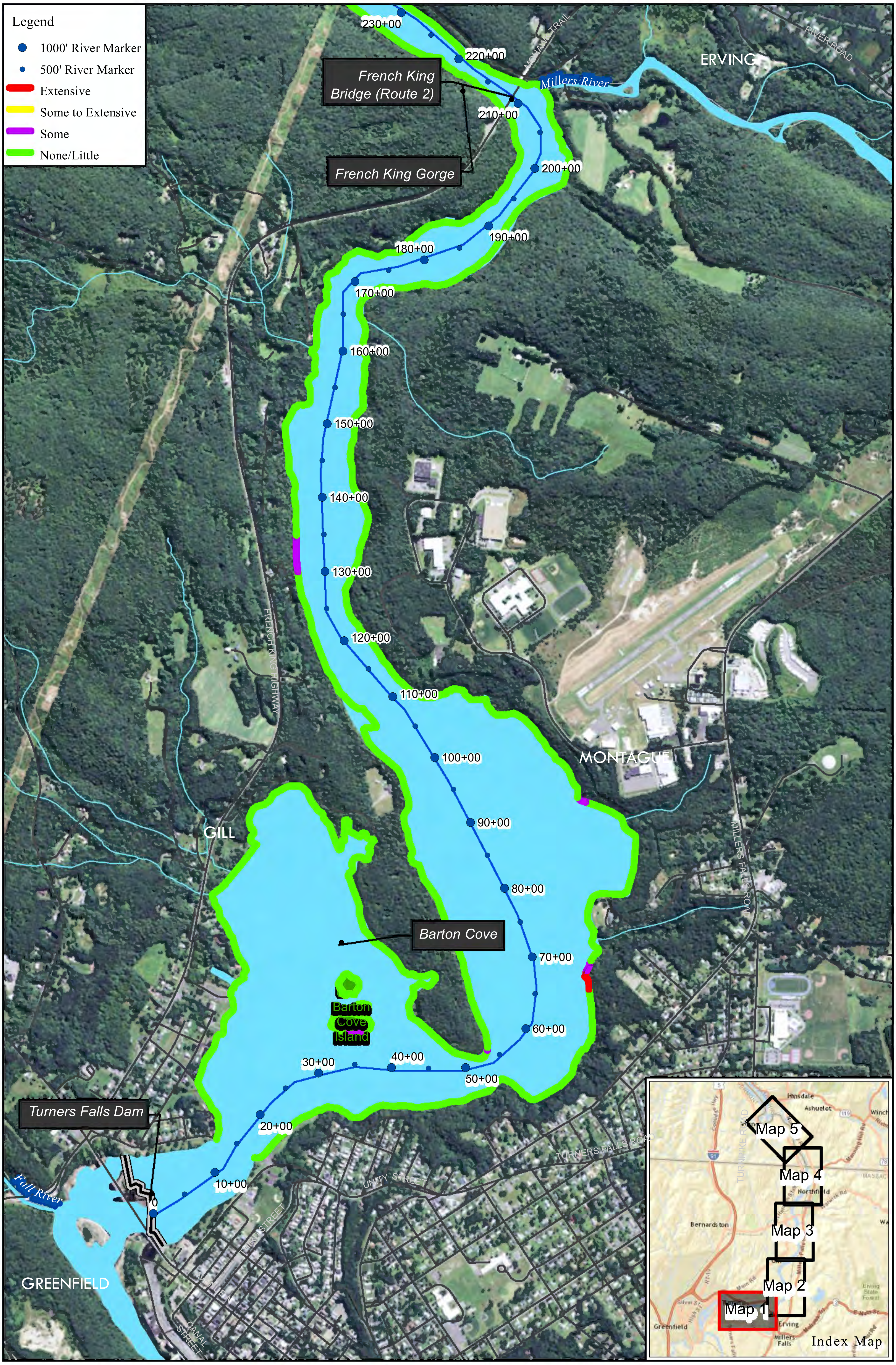
Figure 3.3.1.1.2-1:
Legend for Soils in the Vicinity of the
Turners Falls and Northfield Mountain Projects
(Page 8 of 8)

- Aga -- Agawam
- Amo -- Amostown
- Bel -- Belgrade
- Ber -- Berkshire
- Bir -- Birdsall
- Buc -- Bucksport
- Can -- Canton
- Chi -- Chichester
- Chr -- Charlton
- Cht -- Chatfield
- Col -- Colton
- Dee -- Deerfield
- Fre -- Freetown
- Glo -- Gloucester
- Had -- Hadley
- Hen -- Henniker
- Hin -- Hinckley
- Hls -- Hollis
- Hly -- Holyoke
- Hoo -- Hoosic
- Lim -- Limerick
- Lym -- Lyman
- Mer -- Merrimac
- Mil -- Millsite
- Mnd -- Monadnock
- Mnt -- Montauk
- Moo -- Moosilauke
- Nau -- Naumburg
- New -- Newfields
- Nin -- Ninigret
- Occ -- Occum
- Ond -- Ondawa
- Pax -- Paxton
- Pil -- Pillsbury
- Pit -- Pits, gravel
- Pod -- Podunk
- Pol -- Pollux
- Poo -- Poocham
- Pot -- Pootatuck
- Quo -- Quonset
- Ray -- Raynam
- Rid -- Ridgebury
- Rip -- Rippowam
- Riv -- Riverwash
- Sac -- Saco
- Sca -- Scarboro
- Sci -- Scio
- Sct -- Scituate
- Sud -- Sudbury
- Sun -- Suncook
- Swa -- Swansea
- Tun -- Tunbridge
- Udo -- Udorthents
- Una -- Unadilla
- Wal -- Walpole
- War -- Warwick
- Wds -- Woodstock
- Wes -- Westbury
- Wil -- Wilbraham
- Win -- Winsdor
- Wio -- Winooski
- Woo -- Woodbridge
- Yal -- Yalesville-Holyoke complex



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0 650 1,300 2,600
Feet

Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 1

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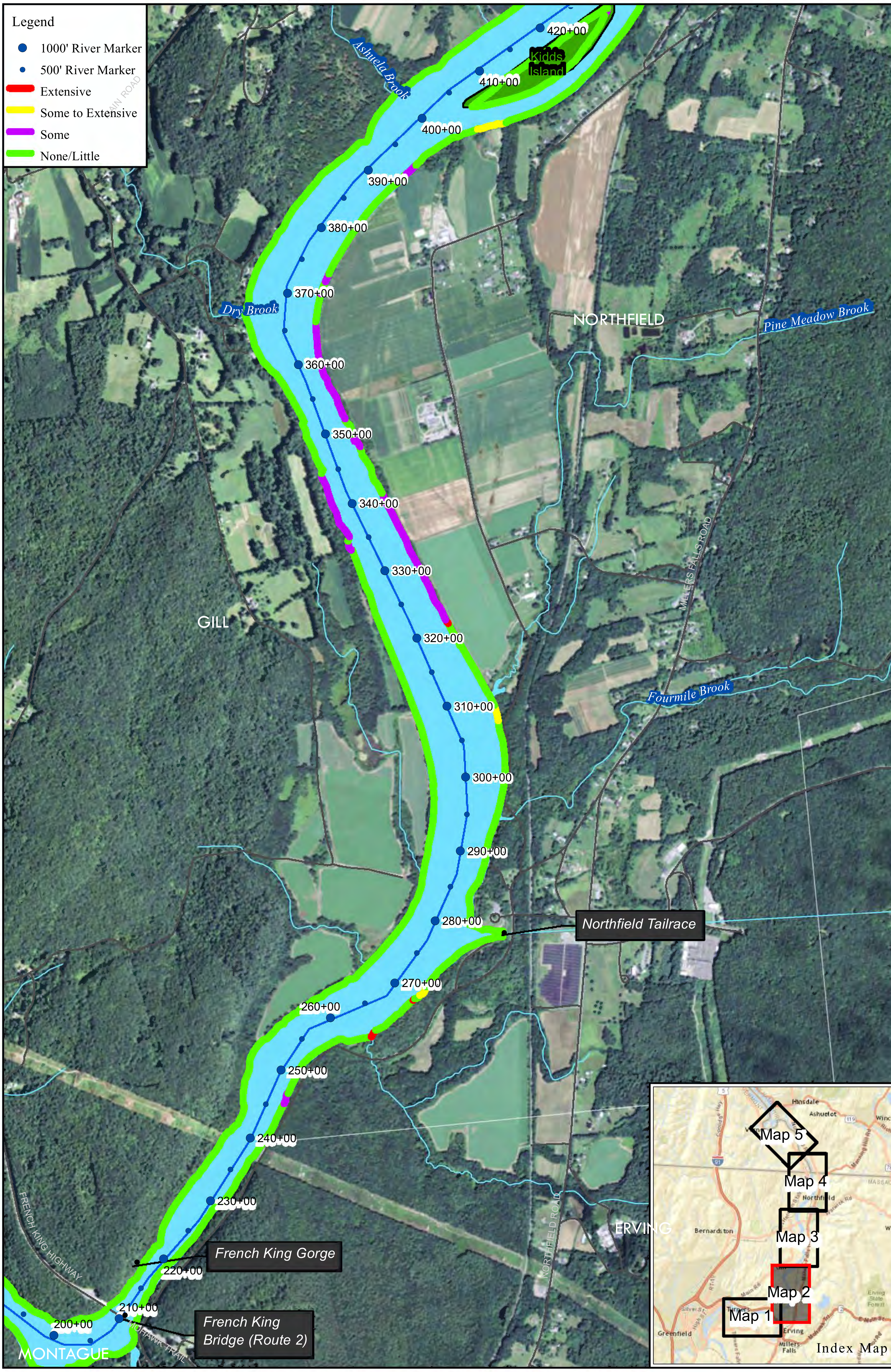

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0 650 1,300 2,600 Feet

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 2

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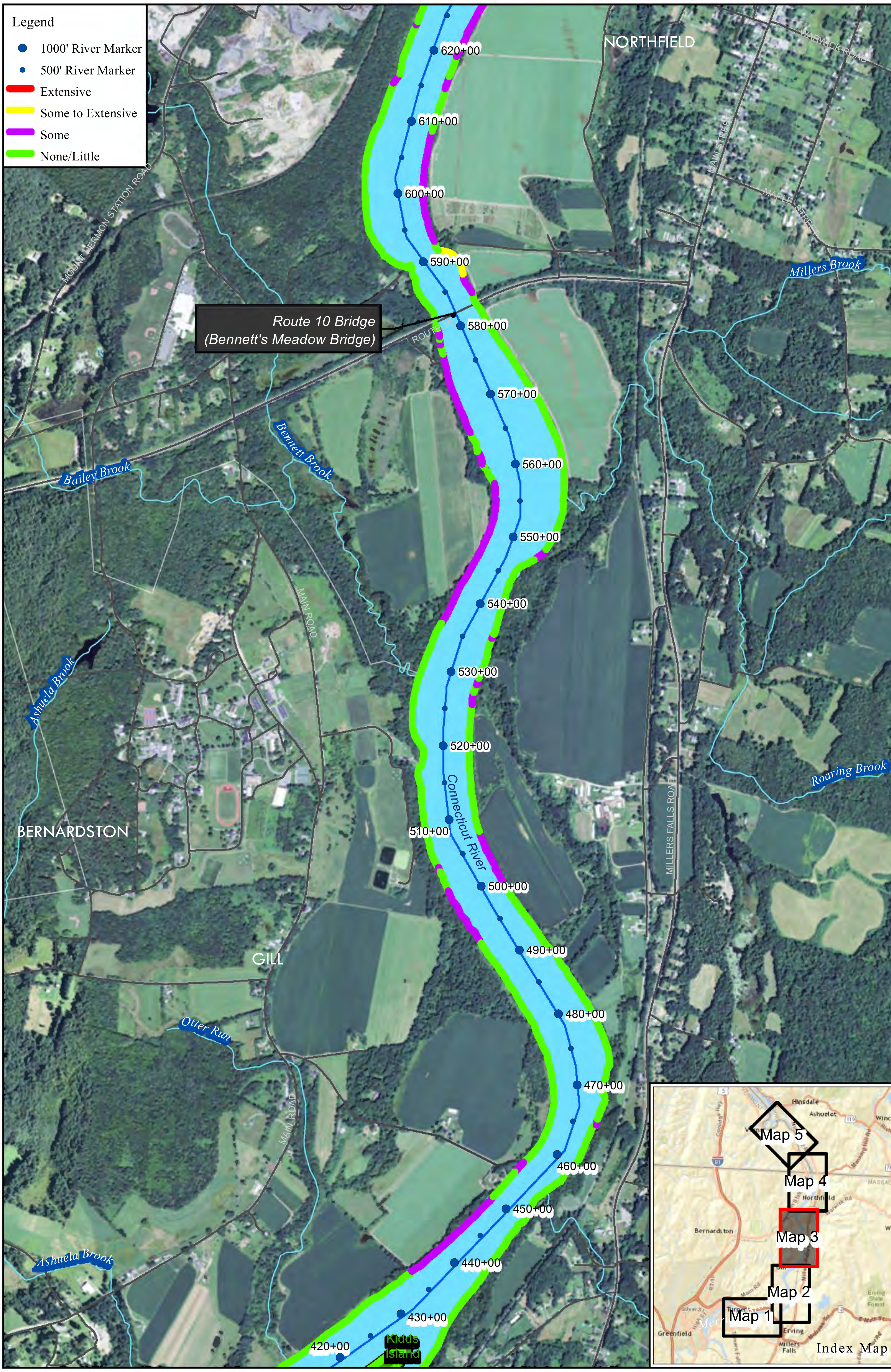

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 3

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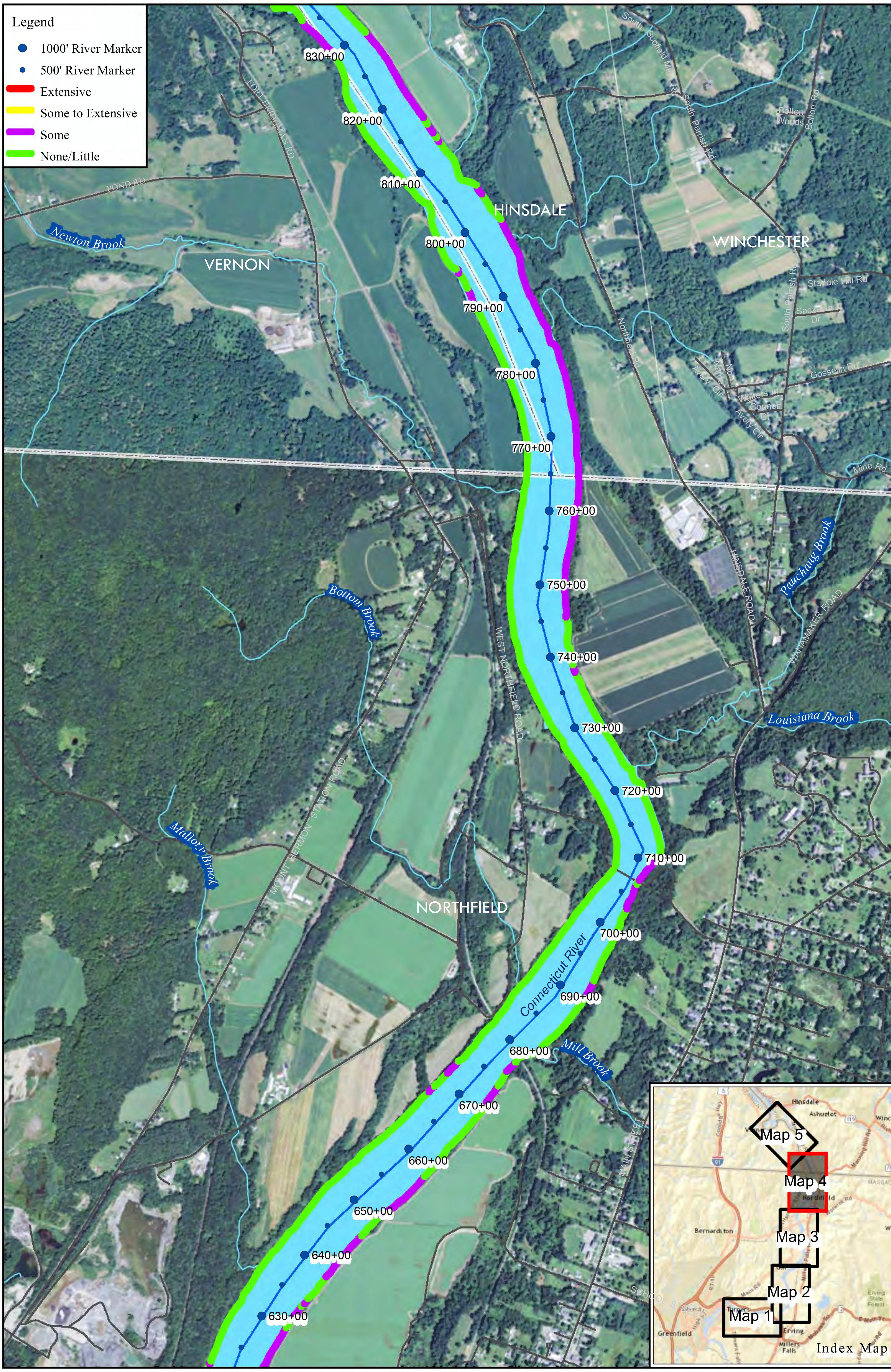

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Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 4

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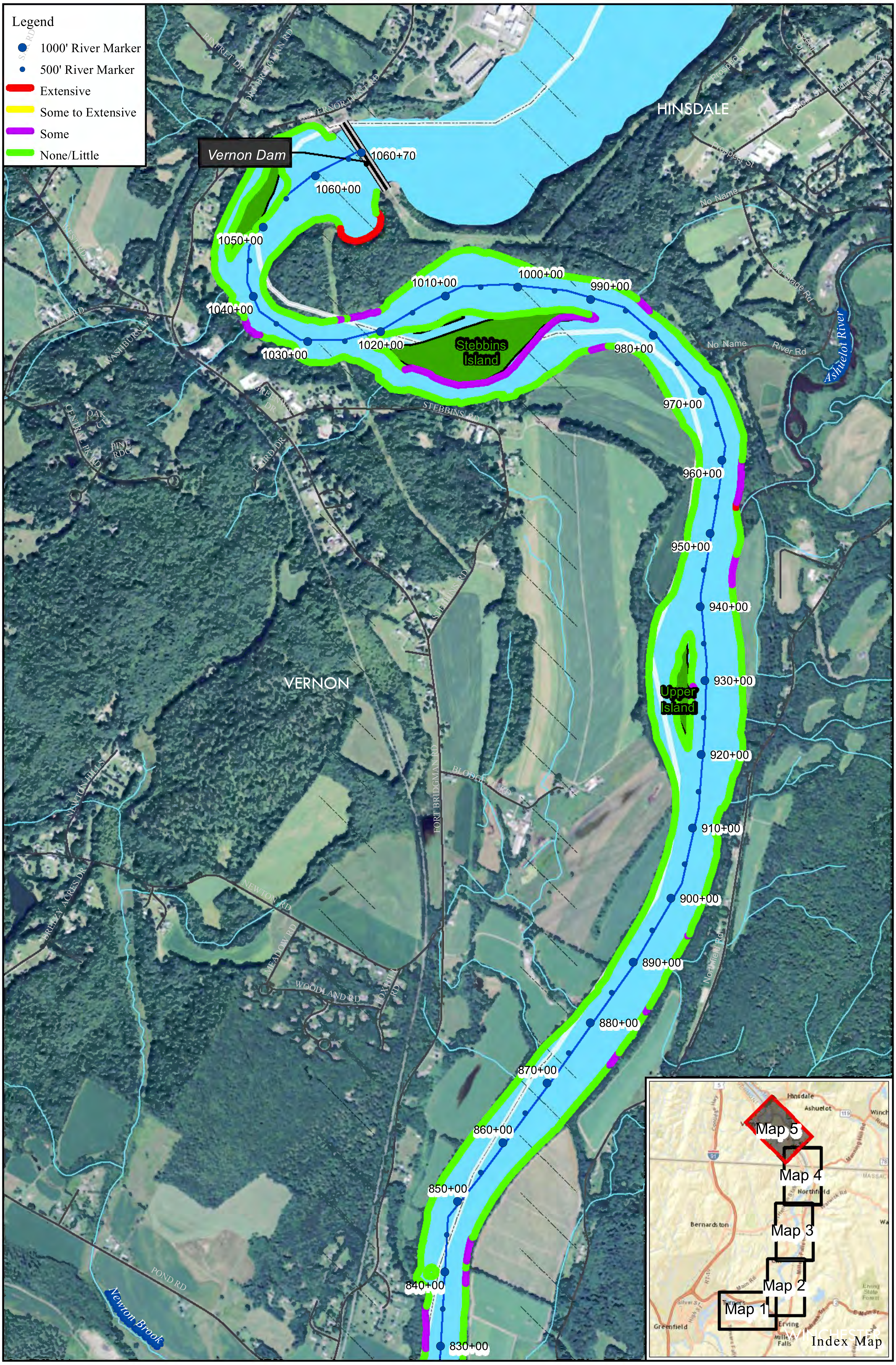

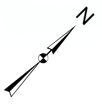

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0 650 1,300 2,600 Feet

Figure 3.3.1.1.3-1:
Turners Falls Impoundment
Extent of Current Erosion (2013)
Map 5

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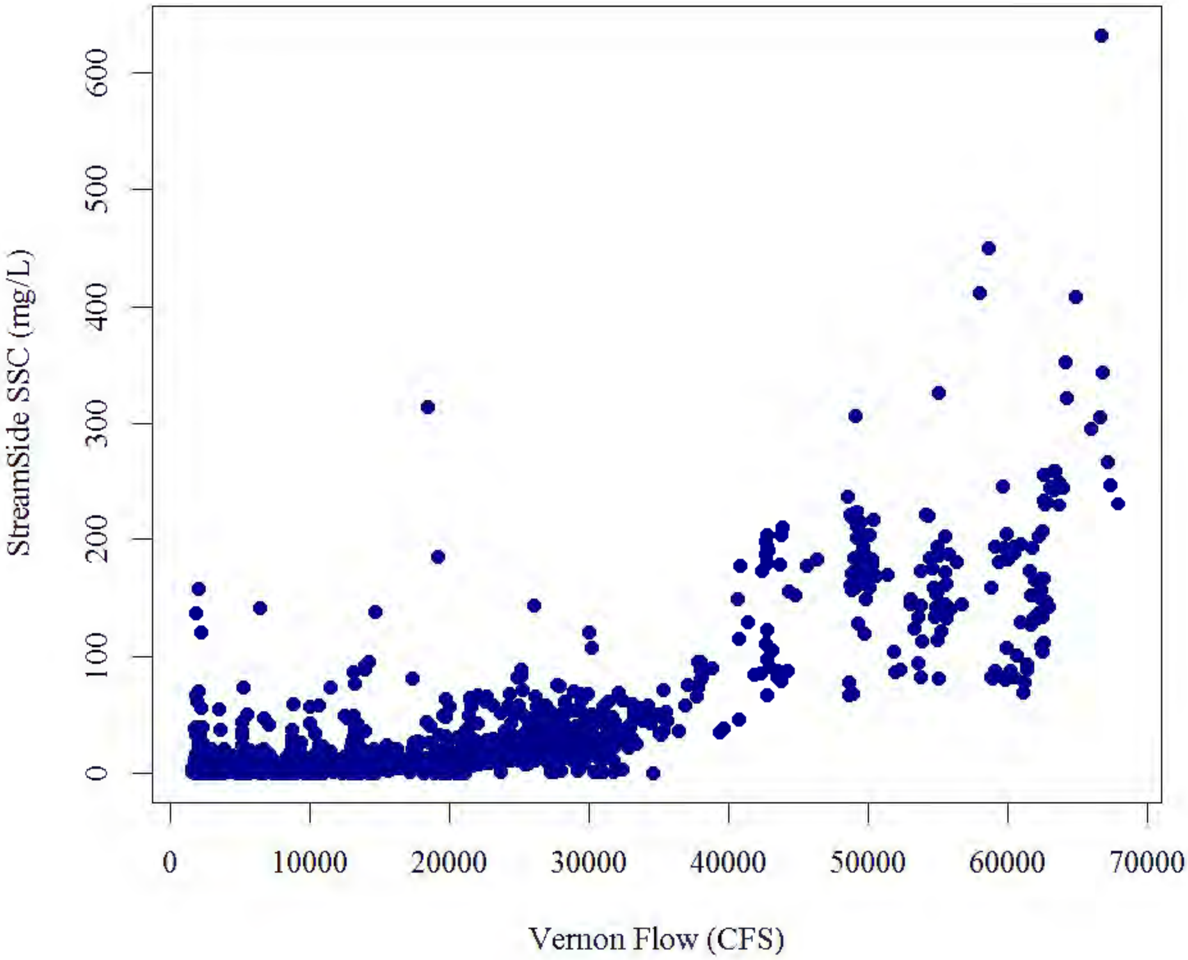

Figure 3.3.1.1.4-1: Connecticut River SSC vs. Vernon Discharge (2013-2015)[26]

[26] As measured in the vicinity of the Rt. 10 Bridge

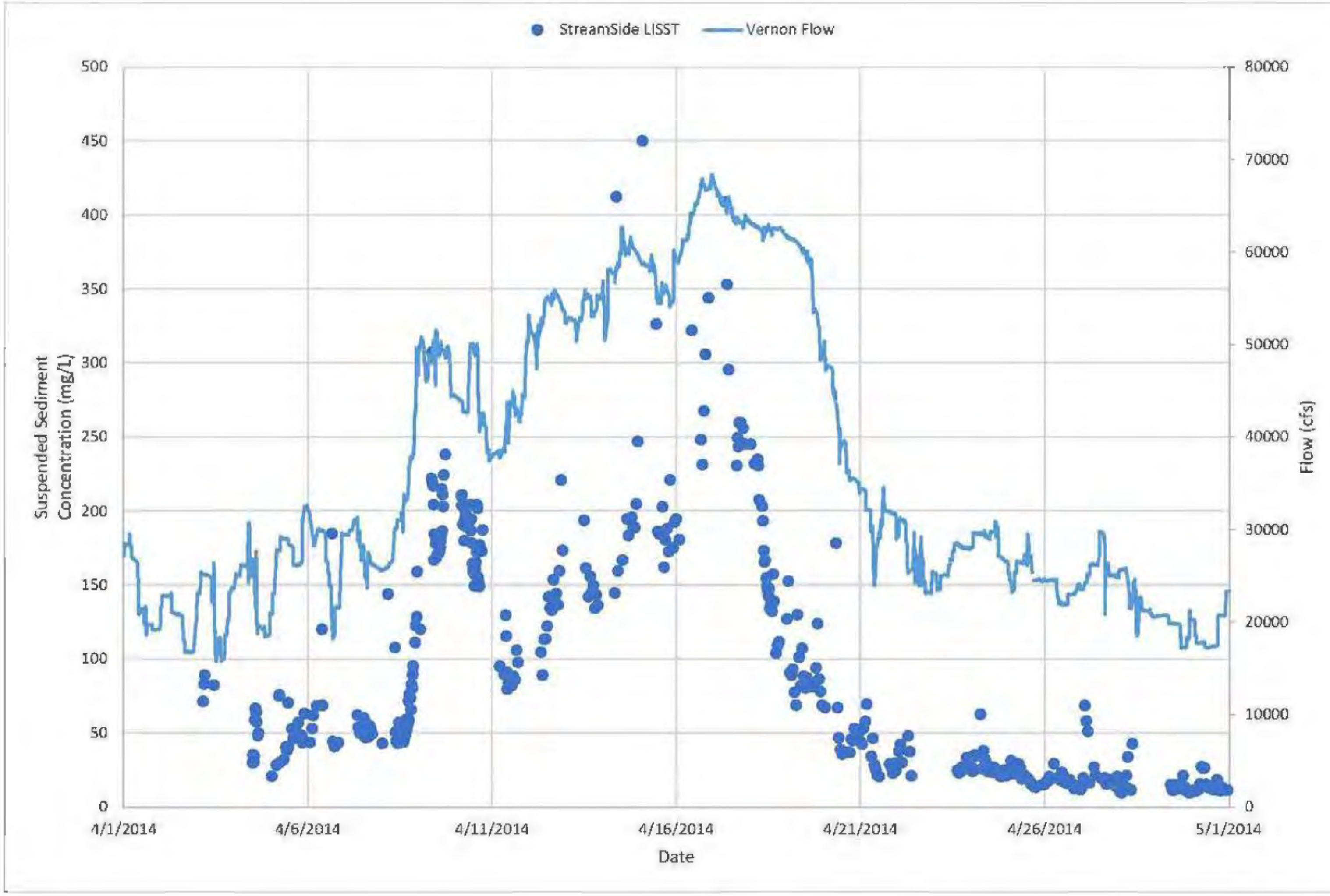

Figure 3.3.1.1.4-2: 2014 Spring Freshet – SSC vs. Flow[27]

[27] SSC values were measured in the vicinity of the Rt. 10 Bridge

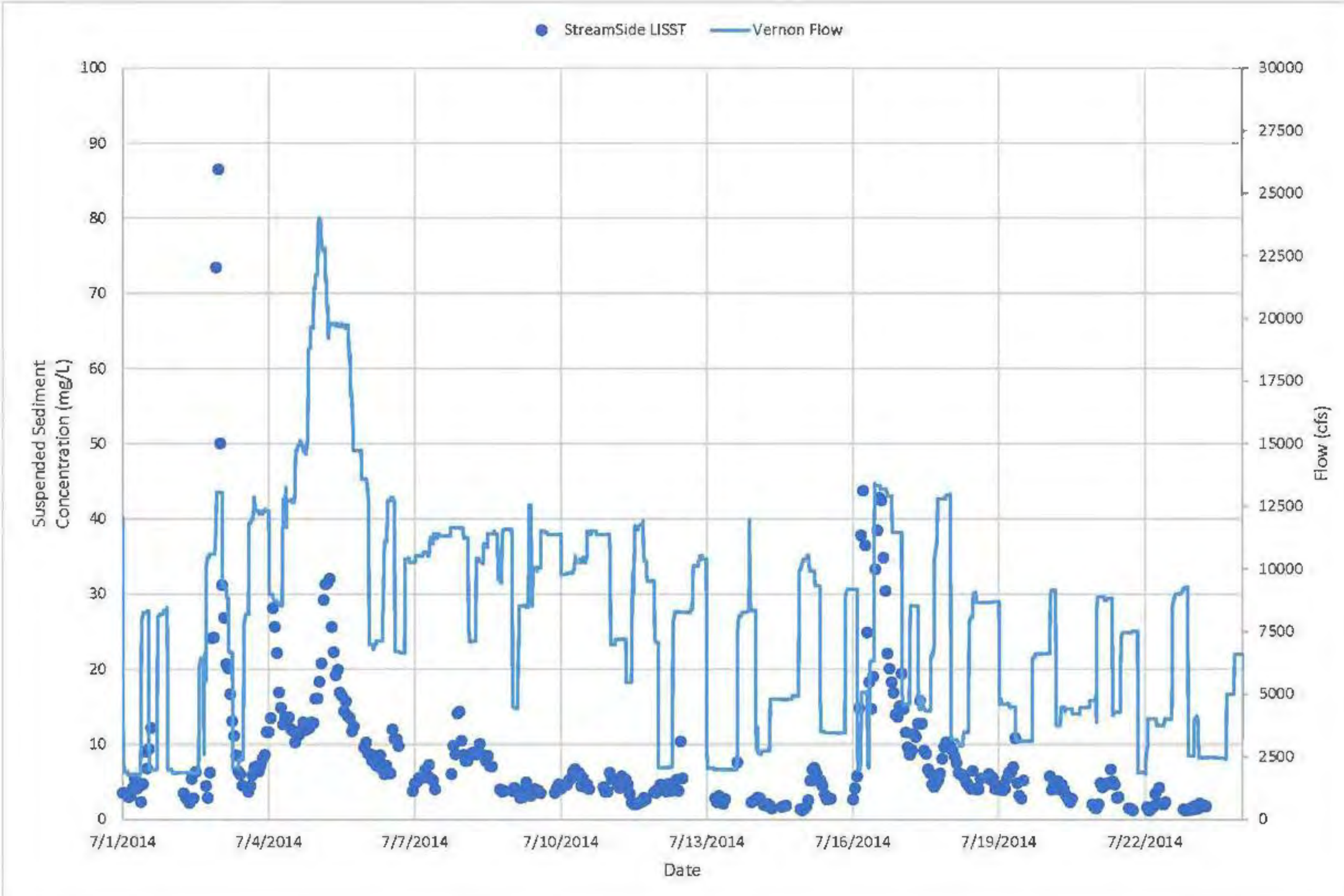

Figure 3.3.1.1.4-3: Typical Summer Period – SSC vs. Flow[28]

[28] SSC values were measured in the vicinity of the Rt. 10 Bridge

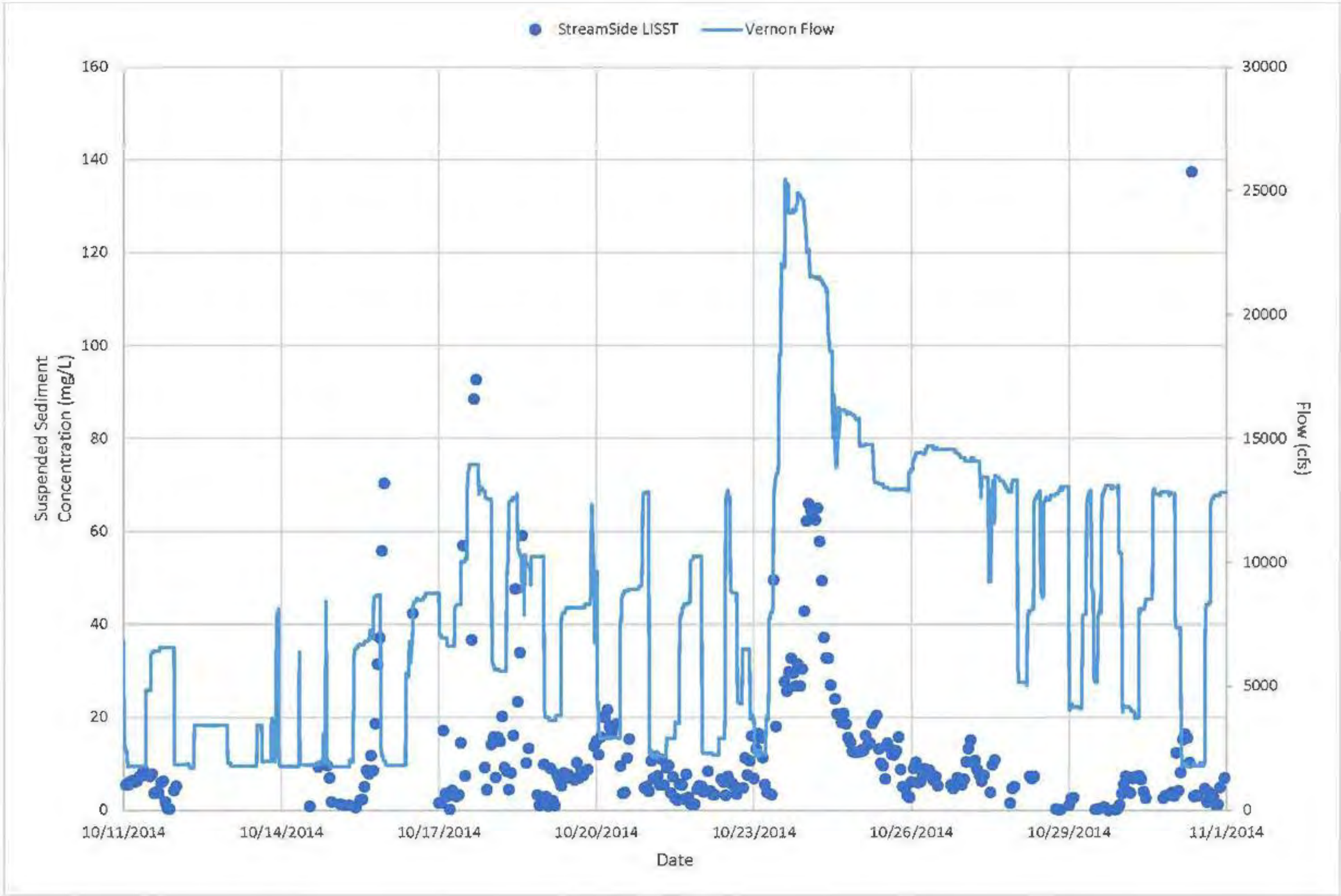

Figure 3.3.1.1.4-4: Typical Fall Period – SSC vs. Flow[29]

[29] SSC values were measured in the vicinity of the Rt. 10 Bridge

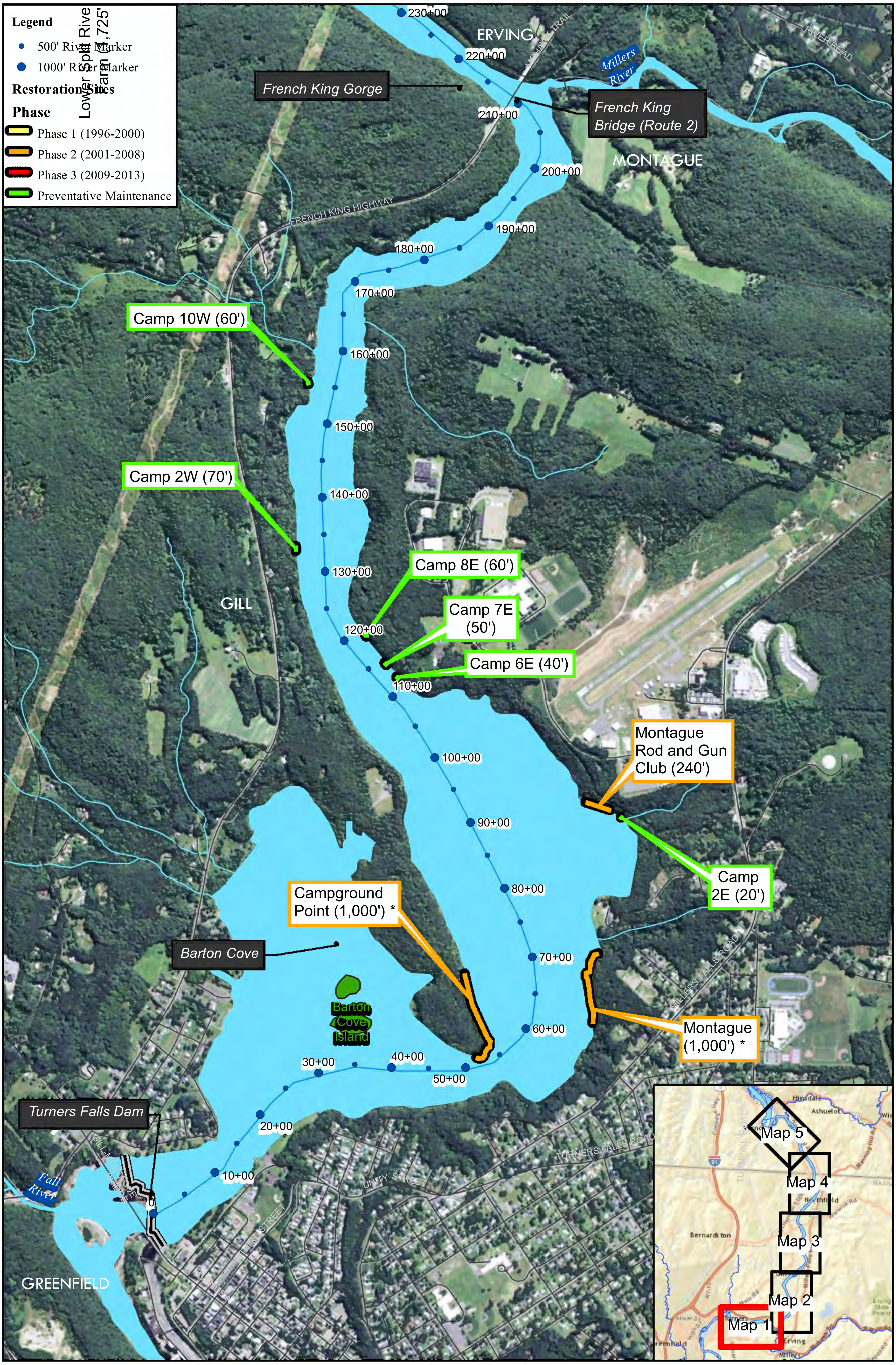

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Figure 3.3.1.2-1:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 1

0 625 1,250 2,500 Feet

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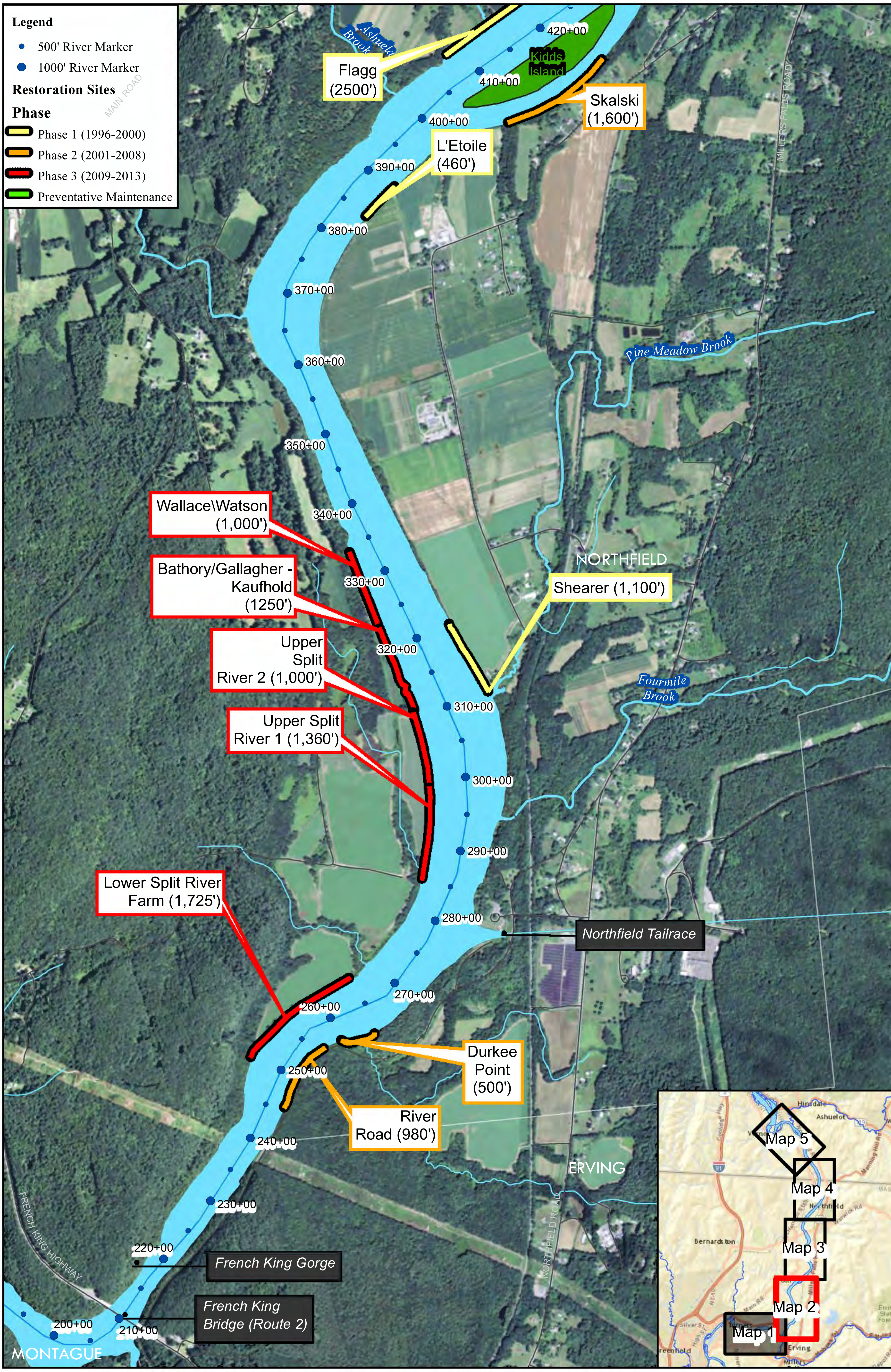

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0 625 1,250 2,500 Feet

Figure 3.3.1.2-2:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 2

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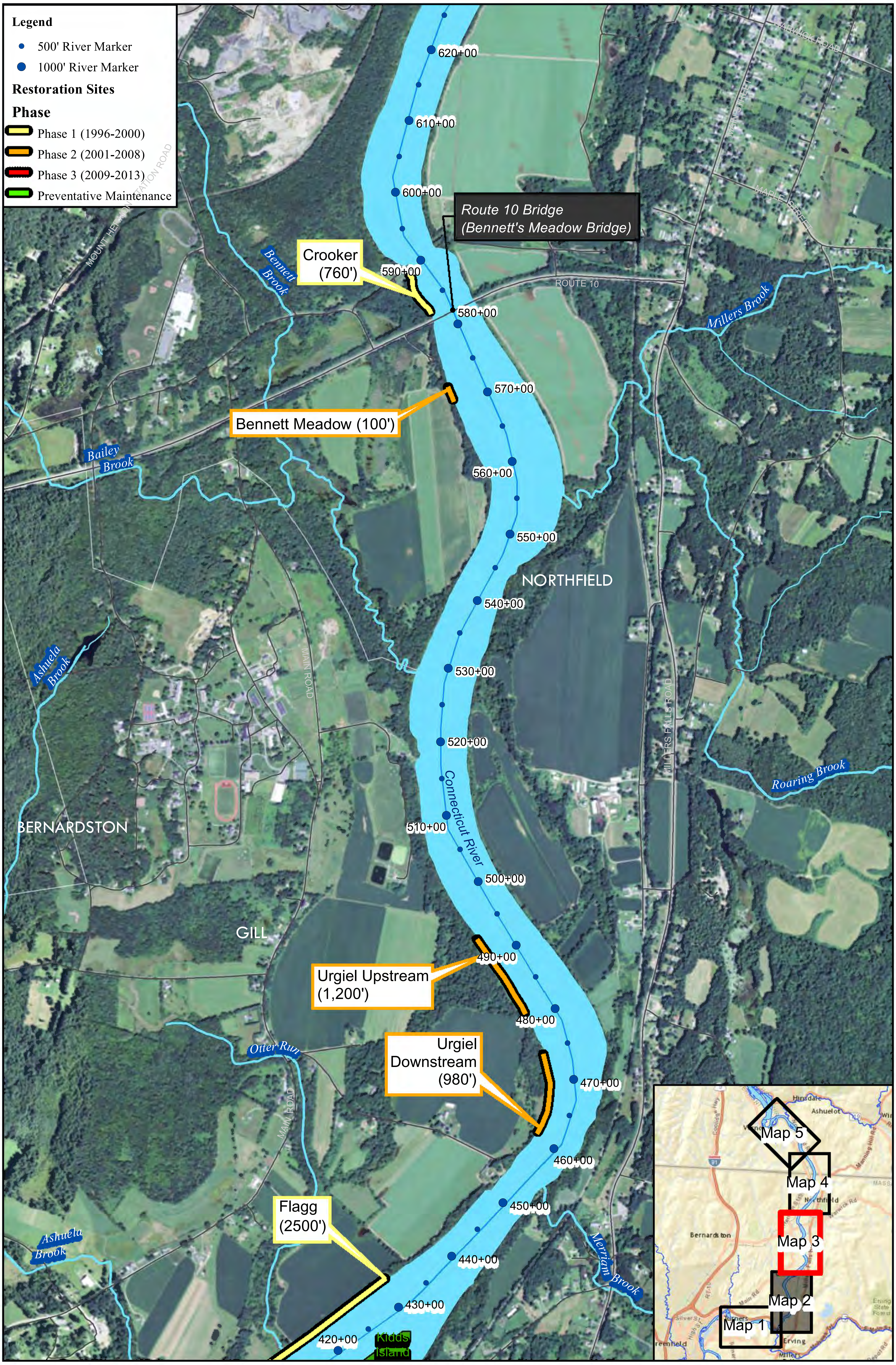

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0 625 1,250 2,500 Feet

Figure 3.3.1.2-3:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 3

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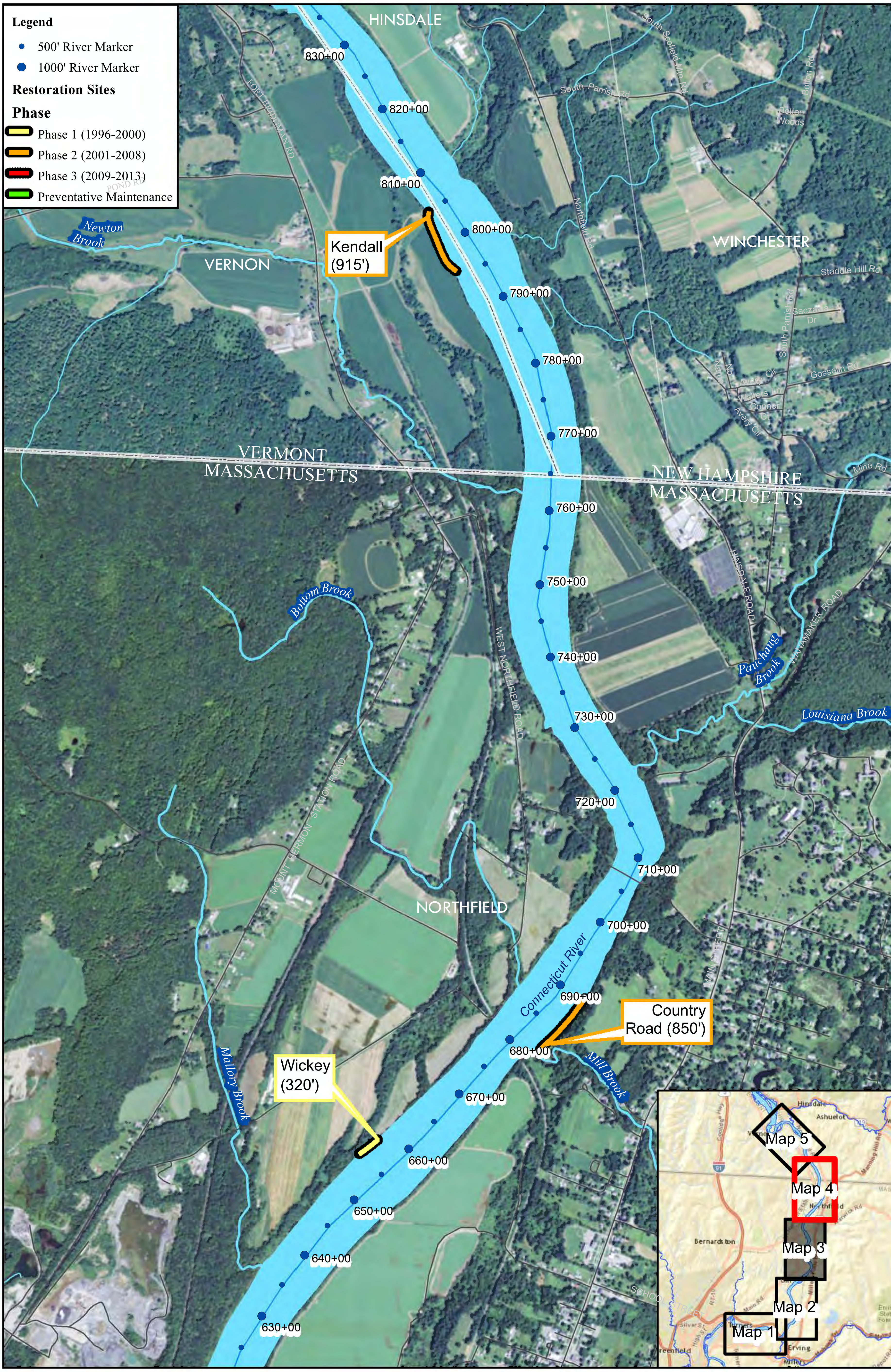

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

0 625 1,250 2,500 Feet

Figure 3.3.1.2-4:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan Map 4

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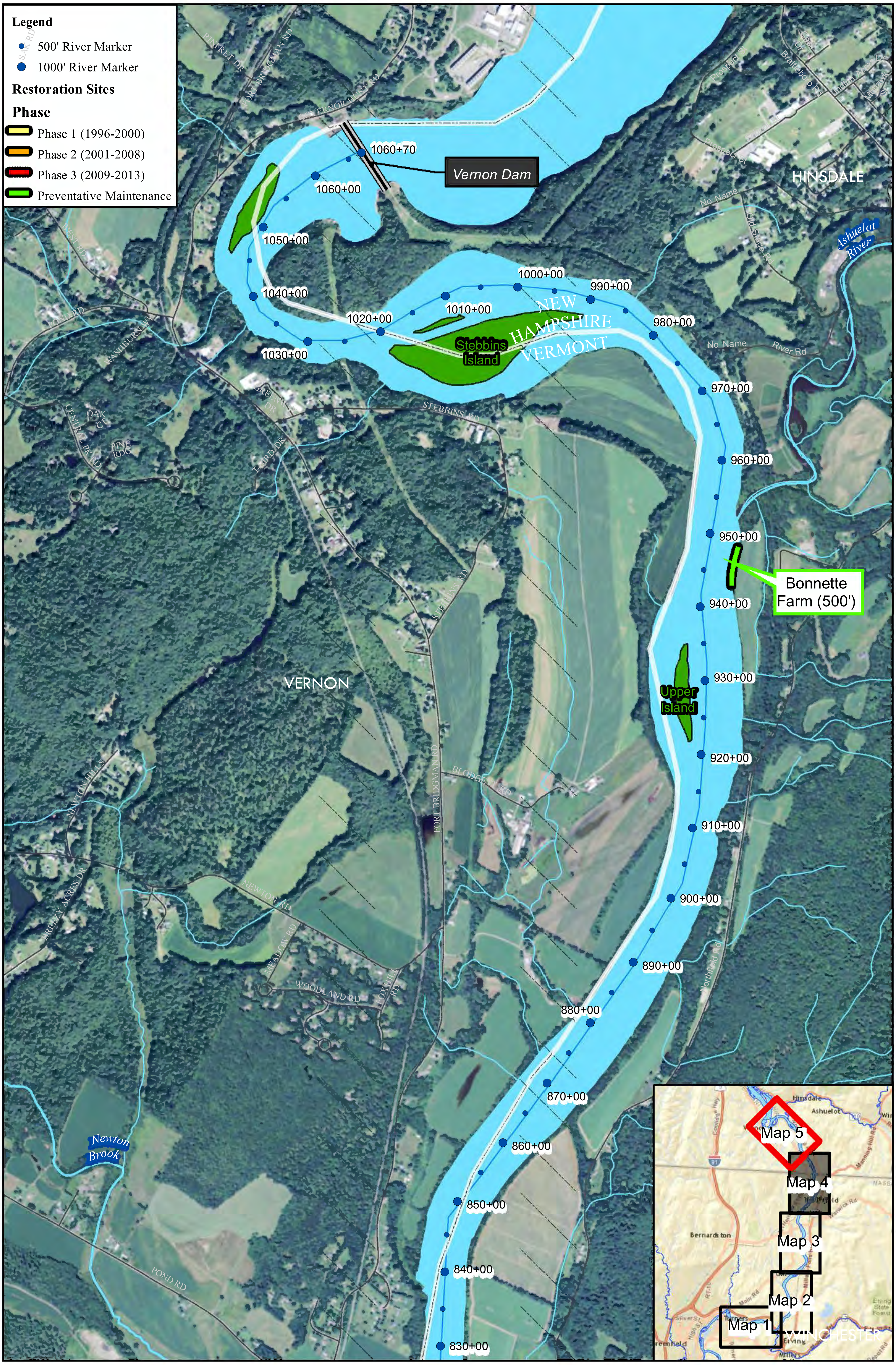
Path: W:\gis\maps\Exhibit_E\figure_3_3_1_2-4.mxd



FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

0 625 1,250 2,500 Feet

Figure 3.3.1.2-5:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 5

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Path: W:\gis\maps\Exhibit_E\figure_3_3_1_2-1.mxd

3.3.2 Water Resources

3.3.2.1 Affected Environment

3.3.2.1.1 Water Quantity

The Connecticut River drains an area of 11,250 mi^2. Within Massachusetts, the Connecticut River traverses approximately 67 river miles and drains approximately 2,726 mi^2. The total watershed area upstream of the Turners Falls Dam is 7,163 mi^2.

Upstream Dams

Inflows to the TFI are largely controlled by operations at several upstream dams on the Connecticut River. More specifically, five upstream dams on the Connecticut River operate as seasonal storage reservoirs, where water elevations are typically lowered in the fall and winter, and refilled with the spring freshet. The seasonal operation and re-regulation of discharges from these dams provides benefits to downstream hydropower facilities by curtailing high flows in the spring and increasing low flows in the summer for the benefit of hydropower production. These dams and storage volumes, in upstream to downstream order, include the following:

Second Connecticut Lake,	506 million ft^3
First Connecticut Lake,	3.33 billion ft^3
Lake Francis,	4.326 billion ft^3
Moore Reservoir, and	4.97 billion ft^3
Comerford Reservoir.	1.279 billion ft^3

Pursuant to a 1993 Headwater Benefit Agreement among predecessor companies and TransCanada, FirstLight pays an annual headwater benefit fee to TransCanada for the seasonal operation of its storage reservoirs (primarily driven by Moore Reservoir), which provides an incremental increase in generation at Cabot and Station No. 1. The Northfield Mountain Pumped Storage Development does not receive (or pay) any headwater benefit from these upstream projects. However, it is important that TransCanada's Vernon Project maintain flow into the TFI as the flow is needed for Northfield Mountain Pumped Storage Development operations.

In addition to the seasonal storage reservoirs, the next three projects (operated by TransCanada) above Turners Falls Dam - namely Vernon, Bellows Falls, and Wilder - operate as peaking hydropower facilities, whereby flows can fluctuate on an hourly basis. Like Turners Falls Dam, the minimum flow at Vernon Dam is equivalent to 0.2 cfs per square mile of drainage area or 1,250 cfs, which is provided from generation. The Vernon Hydroelectric Project has a station hydraulic capacity of 17,130 cfs[30] and when operating at full capacity, it exceeds the full hydraulic capacity of the Turners Falls Development of 15,938 cfs, not accounting for incremental inflow from the 897 mi^2 between the two dams. The magnitude and timing of discharges from the Vernon Hydroelectric Project are critical to the operation of the Turners Falls and Northfield Mountain Pumped Storage Developments.

Vernon Hydroelectric Project FERC license Article 304[31] requires TransCanada to coordinate project operations with FirstLight. A letter Agreement amending the original 1993 Headwater Benefit Agreement was filed with FERC on June 20, 2003. The Agreement requires TransCanada to provide FirstLight by 8:00 am each day, with its estimate of total discharge (cfs-hours) expected the next day at the Vernon Project.

[30] FERC Order Amending License and Revising Annual Charges, Project No. 1904-042, July 28, 2006.
[31] Article 304 was added to the license in 1992 (59 FERC ¶62,267) and generally requires the Licensee of Project No. 1904 (Vernon Hydroelectric Project) to develop and file with the Commission a coordination agreement with the licensee of certain downstream facilities in the event that the regional central dispatch system or NEPEX was ever discontinued. The dispatching of these hydropower projects under that system was discontinued several years ago in connection with the restructuring of the New England power markets.

When TransCanada receives the hourly dispatch schedule for the next day from the ISO-NE, it faxes or emails the schedule for Vernon discharges to FirstLight by 2:00 pm. There is no current requirement, however, for TransCanada to provide an hourly dispatch schedule the day ahead. If any subsequent dispatch schedules are received during the operating day showing changes in the projected hourly release schedules, the revised schedule for Vernon is faxed or emailed to FirstLight. Not having reliable and timely estimates of Vernon's hourly release schedule the day ahead prevents FirstLight from the most efficient management of the TFI for power production.

Hydrology and Streamflow

USGS streamflow monitoring gages located on the Connecticut River and its tributaries to the Connecticut River in the Project area are described below and shown in Figure 3.3.2.1.1-1.

Connecticut River at North Walpole, NH (No. 01154500, 5,493 mi^2).

This gage is located upstream of the Vernon Dam, in Vernon, VT. Between the North Walpole gage and the Turners Falls Dam are the Vernon Hydroelectric Project and the Northfield Mountain Pumped Storage Development[32]. The gage has a period of record from March 1942 to present. USGS notes that the flow measured at this gage is regulated by power plants and by reservoirs in the watershed, including First Connecticut and Second Connecticut Lakes, Lake Francis, and Moore and Comerford Reservoirs.

Using the gage's period of record, annual and monthly flow duration curves were developed as shown in Figure 3.3.2.1.1-2 through Figure 3.3.2.1.1-6. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-1.

Connecticut River at Vernon, VT (No. 01156500, 6,266 mi^2)

Over 87% of the drainage area at the Turners Falls Dam is from inflow received by the Vernon Hydroelectric Project. The remaining 13% of drainage area is from tributaries to the TFI, primarily the Ashuelot and Millers Rivers. A USGS gage was located directly below Vernon Dam, and was active from approximately Oct 1944 to Sep 1973, but was discontinued by the USGS when the Turners Falls Dam was raised causing the backwater, at times, to extend to the base of Vernon Dam, thus impacting the gage's rating curve. Using the gage's historic average daily flow data (Oct 1944-Sep 1973), an annual and monthly flow duration curves were developed as shown in Figure 3.3.2.1.1-7 through Figure 3.3.2.1.1-11. With the Vernon Hydroelectric Project having a hydraulic capacity of 17,130 cfs, on an annual basis, TransCanada can control discharges into the TFI approximately 84% of the time; 16% of the time Vernon's hydraulic capacity is exceeded. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-2.

Ashuelot River at Hinsdale, NH (No. 01161000, 420 mi^2)

The Ashuelot River enters the TFI approximately 3.5 miles upstream of the Massachusetts border from the east. Ashuelot River flows are regulated by the USCOE Surry Mountain Lake 33 miles upstream (since 1942), the USCOE's Otter Brook Lake, 29 miles upstream on Otter Brook (since 1958), and by small hydro plants upstream. The Ashuelot River gage became active in 1907.

[32] Prior to December 2014, the Vermont Yankee Nuclear Facility withdrew cooling water from the Vernon Impoundment.

Millers River at Erving, MA (No. 01166500, 372 mi²)

This gage is located 5.5 miles upstream of the mouth of the Millers River. The Millers River enters the TFI approximately 4.0 miles upstream of the Turners Falls Dam, immediately downstream of the French King Bridge. Millers River flows are regulated by power plants and by Lake Monomonac and other reservoirs; high flow is regulated by the USCOE's Birch Hill Reservoir, 22 miles upstream (since 1941) and Tully Lake (since 1948). The Millers River gage became active in 1915.

Deerfield River near West Deerfield, MA (No. 01170000, 557 mi²)

This gage is located 9.2 miles upstream of the mouth of the Deerfield River, which enters the Connecticut River mainstem approximately 3,500 feet below the Cabot Station tailrace. Deerfield River flows are regulated by Somerset Reservoir (since 1913), by Harriman Reservoir (since 1924), and by several power plants upstream. The period of record for this gage includes discharge records from March to November 1904, January 1905, March to December 1905, and October 1940 to current year.

Connecticut River at Montague City, MA (No. 01170500, 7,860 mi²)

This gage is located downstream of Cabot Station and approximately 1,000 feet downstream from the mouth of the Deerfield River (total drainage area of 663 mi^2). The gage has a period of record from April 1940 to present. USGS remarks for the gage indicate that flow is regulated by power plants and by upstream reservoirs in the watershed.

Using the gage's period of record, annual and monthly flow duration curves were developed as shown in Figures 3.3.2.1.1-12 through Figure 3.3.2.1.1-16. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-3.

Estimated Connecticut River Flow at Turners Falls Dam (7,163 mi²)

The Connecticut River flow at the Turners Falls Dam was estimated using the Montague and Deerfield River USGS gages for overlapping periods of record. The additional drainage area at the Montague gage compared to the Turners Falls Dam is 697 mi^2, of which the bulk of the increase is attributable to the Deerfield River (557 mi^2 as measured at the USGS gage and 665 mi^2 as measured at its the confluence with the Connecticut River). The Deerfield River gage flow data were prorated by a factor of 1.25 (697/557) to represent the additional inflow from the 697 mi^2 drainage area. This prorated flow was then subtracted from the corresponding flow measured at the Montague gage to estimate flows at Turners Falls Dam.

Annual and monthly flow duration curves for the period Jan 1941 through Dec 2014 were calculated for Turners Falls Dam, and are presented in Figure 3.3.2.1.1-17 through Figure 3.3.2.1.1-21. With the Turners Falls Development having a hydraulic capacity of 15,938 cfs, on an annual basis, FirstLight can control discharges from the Turners Falls Development approximately 76% of the time; 24% of the time the Turners Falls Development's hydraulic capacity is exceeded. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1-4.

Project-Related Data and Hydraulic Models

In addition to the streamflow gages described above, FirstLight maintains several water surface elevation (WSEL) gages as shown in Figure 3.3.2.1.1-22. Note that all FirstLight gages measuring the WSEL are based on the same msl datum (specifically NGVD 1929 datum). FirstLight also maintains hourly data (elevations, discharges, generation, and pumping) on daily log sheets. Hydraulic models were developed using the streamflow, WSEL and operations data and were used in support of the relicensing effort, as described below.

Turners Falls Impoundment

As part of the relicensing process, FERC approved Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach ad Below Cabot*[33]. This study report was filed with FERC on March 31, 2015 and an addendum to the report was filed with FERC on February 4, 2016. The hydraulic model of the TFI (TFI Model) determined the impact on WSEL fluctuations due to a) the Vernon Hydroelectric Project, b) the Northfield Mountain Pumped Storage Development, c) the Turners Falls Development d) naturally occurring high flows, and e) combinations of the above. Similarly, the hydraulic model of the Turners Falls to Holyoke Dam (Downstream Model) reach determined the impact on WSEL fluctuations due to a) the Turners Falls Development, b) the Deerfield River Project[34], c) naturally occurring high flows, d) operations at Holyoke Dam, and e) combinations of the above. The hydraulic modeling used the one-dimensional HEC-RAS (Hydrologic Engineering Center River Analysis System) developed by the U.S. Army Corps of Engineers (USACE) to produce WSEL, velocities, energy grade-line slopes, and other parameters at each transect. The hydraulic models developed for this study provided the ability to accurately model a variation of flows and downstream boundary conditions. Due to the high degree of calibration and validation to an array of water level loggers that were temporarily installed in the TFI and downstream of Cabot, as described in detail in the study report, the model was also used to simulate flows and WSELs based on observed historical data (pump-generation flows, Vernon discharges and TFI elevations at the Turners Falls Dam). The time period for the historical modeling of the TFI was January 1, 2000 to September 30, 2015 when hourly flow and downstream boundary conditions were available. The time period for the historical modeling of the reach below the Montague USGS gage was January 1, 2008 to September 30, 2015. As such, the two hydraulic models were extensively used in the relicensing process to provide hydraulic parameters used in many other studies.

Under the current license, the WSEL at the Turners Falls Dam is allowed to fluctuate between 176 and 185 feet. As described in Exhibit B, FirstLight is required by an agreement with the USACE to lower the WSEL at the Turners Falls Dam to the lower range during high flows and FirstLight does this to limit the effects of high water near Barton Cove. Based on hourly data, the median WSEL for the lower part of the TFI as measured from an existing long term monitor near the Turners Falls Dam is 181.3 feet. Under most flow conditions the approximately 20-mile long TFI acts as a somewhat riverine impoundment due to constrictions such as the French King Gorge, inflow from the Vernon Hydroelectric Project and major tributaries including the Ashuelot and Millers Rivers, and a steeper gradient river channel above Stebbins Island (located just below the Vernon Hydroelectric Project). As shown in Figure 3.3.2.1.1-23, the hourly WSEL at:

- Barton Cove near the dam;
- the Riverview Picnic area just upstream of the Northfield Mountain Pumped Storage Development tailrace; and
- the Pauchaug Boat Launch near the MA and NH/VT stateline,

are generally within one to two feet throughout most of the TFI except under high flow conditions when the WSEL gradient of the TFI increases. However, variations in the inflow from the Vernon Hydroelectric Project which operates as a peaking generation facility when inflows are below its maximum generation capacity of 17,130 cfs (current minimum flow is 1,250 cfs), operation of the Northfield Mountain Pumped Storage Development, and variations in the WSEL at the Turners Falls Dam result in daily WSEL fluctuations within the TFI. The WSEL fluctuations at the Turners Falls Dam are a result of the variation in the flow from upstream sources, gatehouse operations at the Turners Falls Dam, and Cabot Station also

[33] FirstLight had a variance on the geographic extent of the study. Rather than terminating the upstream extent of the hydraulic model at the Turners Falls Dam, it was terminated at the Montague USGS Gage.

[34] The Deerfield River enters the Connecticut River just below Cabot Station. The Deerfield River has several peaking hydroelectric projects and two seasonally operated storage reservoirs. The most downstream facility (Deerfield River Project Station No. 2) has a maximum generation of 1,450 cfs and a minimum flow requirement of 200 cfs.

operating as a peaking facility. Based on the TFI Model, the daily variation within the TFI is 1 to 4 feet about 90% of the time as shown in Figure 3.3.2.1.1-24. Based on the results of the modeling scenarios summarized in detail in Study No. 3.2.2, and a few examples shown in Figure 3.3.2.1.1-25 the following general conclusions were made based on steady state modeling:

- When the Northfield Mountain Pumped Storage Development is idle, the difference in the WSEL with Vernon at its maximum generation versus Vernon at its minimum flow ranges from slightly over 6 feet at the Vernon tailrace to slightly over 1 foot at the Northfield Mountain Pumped Storage Development tailrace;
- When Vernon is at its minimum flow, and the Northfield Mountain Pumped Storage Development is at its maximum generation, the TFI impoundment is relatively flat except when the WSEL at the Turners Falls Dam is near 176 feet which is an extremely rare occurrence;
- When Vernon is at its maximum discharge and Northfield Mountain Pumped Storage Development is idle, the difference in the WSEL at the Vernon tailrace, with Northfield Mountain Pumped Storage Development at maximum pumping is about -0.1 feet, and with Northfield at maximum generation is about 0.8 feet;
- When Vernon is at its maximum generation, the difference in the WSEL when the Northfield Mountain Pumped Storage Development is at maximum generation or pumping is about 0.9 feet at the Vernon tailrace and slightly over 4 feet at the Northfield Mountain Pumped Storage Development tailrace;
- Under low flow condition from Vernon and when the Northfield Mountain Pumped Storage Develement is idle or pumping, the WSEL at the Turner Falls Dam is the most controlling factor for the majority of the WSEL in the TFI. However at the Vernon tailrace, the WSEL generally does not fall to under 181 ft even under lower WSELs at the Turners Falls Dam;
- Under low flow conditions, the French King Gorge does not a have a substantial effect on the WSEL in the TFI; and
- At higher flow conditions, especially above 20,000 cfs, the French King Gorge becomes more of a hydraulic control affecting WSELs in the middle and upper TFI.

Below Cabot Station

Under the current license, the Turners Falls Development has a minimum flow requirement of 1,433 cfs or inflow, whichever is less, to be passed belwo the Project—it is commonly passed via Cabot Station. Holyoke Dam is located approximately 30 miles below Cabot Station and since about 2008, the Holyoke Dam has been operating in a modified run-of-river conditions with a WSEL as measured at the dam of between 99.47 and 100.67 feet. Similar to the TFI Model, the Downstream Model was used to determine the historical WSELs at numerous locations and to determine the effects of Project operations. However, due to the change in operations at Holyoke Dam, the time period for the Downstream Model was January 1, 2008 to September 30, 2015. The Downstream Model had a lower degree of calibration than the TFI Model due mostly to a larger separation between transects as described in Study Report 3.2.2 but was still suitable to estimate historical WSELs and impacts of Project operations. Shown in Figure 3.3.2.1.1-26 are the WSEL fluctuations at the Montague USGS Gage and at the Route 116 Bridge in Sunderland. This figure shows that modeled hourly WSELs at the Montague Gage commonly vary on a daily basis up to 5 feet, but generally less than 3 feet at the Route 116 Bridge which is about nine miles farther downstream. Based on the results of the modeling scenarios as summarized in detail in Study Report 3.2.2, and a few examples shown in Figure 3.3.2.1.1-27, the following general conclusions of the effects of Project operations on the downstream reach were made:

- The WSEL difference between maximum generation at both the Turners Falls Development and Deerfield River Project and maximum generation only the Turners Falls Development and minimum flow at the Deerfield River Project is about 0.5 feet at the Montague Gage and decreases to slightly more than 0.2 feet near Mitch's Marina;

- Under minimum flows from the Deerfield Project the WSEL difference between maximum generation and minimum flows from the Turners Falls Project is about 8.3 feet at the Montague Gage, 5.4 feet at the Route 116 Bridge and between about 2 and 2.7 feet at Mitch's Marina depending on the downstream WSEL at the Holyoke Dam;
- A constriction in the Connecticut River about 4 miles upstream of Holyoke Dam, limits the influence of the impact of the downstream boundary condition of the WSEL at Holyoke Dam when river flows are above approximately 11,000 cfs; and
- The influence of the WSEL at the Holyoke Dam, even under low flows is generally less than 0.2 feet at the Route 116 Bridge and falls to basically zero at the Montague USGS gage.

Water Withdrawals

This section summarizes additional surface water withdrawals in the TFI. The Massachusetts Water Management Act (MAWMA), which became effective in March 1986, authorizes the MADEP to regulate the quantity of water withdrawn from both surface and groundwater supplies. The MAWMA consists of a registration program (for withdrawals existing in 1988) and a permit program for withdrawals commencing after 1988. Since 1988, persons withdrawing water from ground or surface sources in excess of an annual average of 100,000 gallons per day (GPD) or 9 million gallons in any three month period must either file an annual registration (for existing withdrawals) or apply for a MAWMA Permit (new withdrawals). Non-consumptive uses, such as hydroelectric facilities, are not required to register or obtain MAWMA permits.

The TFI is not used as a source of domestic drinking water supply or for industrial purposes. Farms along the TFI use river water for irrigation.

A list of current MAWMA water registrations and permits was obtained from the MADEP. The water withdrawal registrations and permits within the Connecticut River basin, for the towns of Northfield and Montague (including the Village of Turners Falls) were reviewed. The MADEP shows that the only current surface water withdrawal permitted or registered under the MAWMA from Connecticut River waters is for agricultural purposes: Four Star Farms, in Northfield (MAWMA Permit No.: 9P2-1-06-217.03), is allowed an authorized daily withdrawal volume of 0.167 million gallons per day (MGD or 0.26 cfs) from the TFI. Compared to the Connecticut River flow at this location, this withdrawal volume is negligible. In addition to Four Star Farms, Sudbury Nurseries West, LLC at Great Meadow Road in Northfield is currently permitted a withdrawal from the TFI under the MAWMA.

In addition to the registered Four Star Farms withdrawal under the MAWMA, FirstLight is aware of four water withdrawals, in the Massachusetts reach of the TFI, where no MAWMA water registrations and permits were obtained from the MADEP. From north to south, they include:

- Nourse Farms, Inc. Caldwell Road, West Northfield, MA (two withdrawal locations);
- Smiarowski Brothers, LLC, Great Meadow Road, Northfield, MA;
- Northfield Mount Hermon School, off Main Street, Gill, MA;
- Spilt River Farm, River Road, Gill MA.

There are several entities withdrawing water from the Turners Falls power canal. For a description of water usage on the canal, refer to Exhibit A (Table 1.4-1) which lists the water users, approximate hydraulic capacity, and FERC project number (where applicable).

3.3.2.1.2 Water Quality

Water Quality Standards and Classifications

Massachusetts

The Massachusetts Surface Water Quality Standards (314 CMR 4.00) assign all inland, coastal, and marine waters to classes according to the intended beneficial uses of those waters. For example, Class A waters are designated as the source of public water supplies and, where compatible with this use, should also be suitable for supporting aquatic life, recreational uses such as swimming and boating, and fish consumption. Class B waters are not designated as a source of public water supplies, but are designated for all of the other Class A uses. Class C waters should be suitable for aquatic life and recreational uses where contact with the water is incidental, such as boating and fishing, but may not be suitable for swimming, diving, or water skiing. Inland waters are also subcategorized as to fishery type (e.g., "warm water fishery") based on the waterbody's natural capacity to support these resources.

The Commonwealth of Massachusetts classifies the entire Connecticut River as Class B, Warm Water Fishery. Applicable water quality standards for Massachusetts are listed in Table 3.3.2.1.2-1.

New Hampshire

New Hampshire water quality standards apply to the Connecticut River upstream of the Massachusetts border. The state of New Hampshire has designated the entire Connecticut River as Class B.

According to applicable water quality standards for New Hampshire, Class B waters shall: have *Escherichia coli* levels that do not exceed a geometric mean of 126 colonies/100 milliliter (ml, based on at least 3 samples obtained over a 60-day period) or more than 406 colonies/100 ml in any one sample; have no objectionable physical characteristics; and contain a dissolved oxygen content of at least 75% of saturation.

The New Hampshire Rivers Management and Protection Act (RSA 483) provides general guidance for future land use in the New Hampshire corridor of the Connecticut River. Under this act, the Connecticut River is designated as a rural river segment from the point 0.3 miles below the Vernon Dam to the Massachusetts line (RSA 483:15, VIII). The law defines these waters as "*adjacent to lands which are partially or predominantly used for agriculture, forest management and dispersed or clustered residential development. Management of rural river... segments shall maintain and enhance the natural, scenic, and recreational values of the river for agricultural, forest management, public water supply, and other purposes which are compatible with the instream public uses of the river and the management and protection of the resources for which the...segment is designated*" (RSA 483:7-a River Classification Criteria, I(b)).

Vermont

Although the Connecticut River is commonly thought to define the boundary between Vermont and New Hampshire, it is located in New Hampshire (i.e., the state border is on the Vermont shoreline[35]). However, Vermont considers most of the Connecticut River to be a Class B waterbody. Vermont's water numerical quality standards for Class B waters include: *Escherichia coli* are not to exceed 77 organisms/100 ml, and dissolved oxygen levels shall not be less than 5 milligram/liter (mg/l) and 60% saturation at all times (for warm water fish habitat waters). Vermont's water quality standards also include narrative protective criteria.

Historical Water Quality

The following sections describes water quality conditions in the Project area based on information from historical studies.

[35] The border between New Hampshire and New York (later to become Vermont) was set by King George II in 1764 as the western bank of the Connecticut River. The U.S. Supreme Court re-affirmed this boundary in 1934 as the ordinary low-water mark on the Vermont shore, and markers were set. In some places, the state line is now inundated by the impoundments of dams built after this time.

Water Quality Assessment and Impairments

Every two years, states must file a document called the "Integrated List" to comply with sections 303d and 305b of the Clean Water Act. The Integrated Lists for Massachusetts and New Hampshire divide the Connecticut River into distinct segments for the purpose of determining water quality uses and impairments. The 2014 Integrated Lists for Massachusetts and New Hampshire report that the entire Connecticut River is water quality impaired. Impaired waters are listed as "Category 5," which indicates that a total maximum daily load (TMDL) study is required for that particular water body.

From upstream to downstream, a description of each water body segment and associated water quality impairments is listed below.

Based on New Hampshire's Watershed Report Card (NHDES, 2012), the Connecticut River from the Vernon Dam downstream to the state line (Segment NHRIV802010501-05) is listed as impaired (Category 5 – TMDL Needed). This segment supports swimming and boating uses, but does not meet state standards for supporting aquatic life due to aluminum, copper, and low pH from unknown sources. New Hampshire's general statewide fish consumption advisory due to mercury applies to this segment of the Connecticut River.

Vermont's Integrated List (VTDEC, 2014) indicates that the Connecticut River from the Vernon Dam downstream to the state line (Segment VT13-05) is impacted by flow alteration (Part F - Waters Altered by Flow Regulation). The aquatic life support use is impacted by fluctuating flows due to hydropower production.

The entire mainstem Connecticut River in Massachusetts is listed as impaired due to PCBs in fish tissue based on results from the Connecticut River Fish Tissue Contaminant Study (Hellyer, 2006) as discussed further below.

Massachusetts' Integrated List (MADEP, 2015) indicates that from the New Hampshire/Vermont border to the Route 10 Bridge (Segment MA34-01, 3.5 miles) in Massachusetts, the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to "other flow regime alterations," and "alteration in stream-side or littoral vegetative covers."

The section of the river between the Route 10 Bridge crossing the TFI and the Turners Falls Dam (Segment MA34-02, 11.2 miles) is listed as impaired by MADEP (Category 5- Waters Requiring a TMDL) due to "alteration in stream-side or littoral vegetative covers." Additionally, Barton Cove is listed as impaired for non-native aquatic plants (Eurasian water milfoil).

From the Turners Falls Dam to the confluence with the Deerfield River (Segment MA34-03, 3.6 miles), the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to total suspended solids, "low flow alterations" and "other flow regime alterations."

From the confluence with the Deerfield River to Holyoke Dam (Segment MA4-04, 34.4 miles), the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to *E. coli* bacteria.

The Northfield Mountain Upper Reservoir (Segment MA34061) is listed as a Massachusetts Category 3 Waters, meaning "No Uses Assessed."

2003 Massachusetts Water Quality Assessment

Water quality sampling in the Connecticut River Watershed was conducted by MADEP in April - September 2003, as part of its five-year rotating watershed monitoring and management schedule (Carr & Kennedy, 2008). This effort includes two locations in the Connecticut River in the Project area: Station CT06 on the Connecticut River, at the Route 10 Bridge in Northfield; and Station 02A on the Connecticut River, downstream of the Fourmile Brook confluence in Northfield, and east of Pisgah Mountain Road in Gill (Figure 3.3.2.1.2-1). The parameters included in the sampling were: dissolved oxygen, pH, conductivity, water temperature, total dissolved solids, total suspended solids, ammonia, nitrate–nitrite, total phosphorus, chlorophyll-a, fecal coliform, and *E. coli* bacteria.

Water quality data collected at stations CT06 and 02A are summarized in Table 3.3.2.1.2-2 and Table 3.3.2.1.2-3. The data were used by the MADEP to assess the status of the designated uses as defined in the Massachusetts Surface Water Quality Standards.

Data collected from Station CT06 between April and October 2003 were used to assess water quality conditions as the river entered the state. All measurements were indicative of good water quality conditions (Carr & Kennedy, 2008).

Station 02A is located in the TFI, downstream of the Fourmile Brook confluence, approximately 5.5 river miles downstream of station CT06, in the vicinity of the Northfield Mountain Pumped Storage picnic area. Data were collected from this station between July and September 2003. All measurements were indicative of good water quality conditions (Carr & Kennedy, 2008).

NHDES Water Quality Data

The NHDES, assisted by the USEPA, assessed the entire Connecticut River mainstem in New Hampshire in 2004. The parameters included in the sampling were bacteria, dissolved oxygen, pH, specific conductance, temperature, and metals. Sampling locations included the Connecticut River at the Route 10 Bridge in Northfield, and the Ashuelot River at the Route 119 Bridge in Hinsdale.

Results from this effort were reported by the Connecticut River Joint Commissions (CRJC) and indicated that the river's quality fully supports swimming and other forms of recreation, although it was reported that elevated aluminum and copper levels may affect aquatic habitat in the river below Vernon Dam. The copper levels may be related to contributions from the Ashuelot River (CRJC, 2009).

CRWC Volunteer Monitoring

The CRWC conducted a volunteer water quality monitoring program in the Connecticut River in 2007 and 2008. Sampling was conducted at six locations, which included four sites in the Connecticut River. One of these sites was located in the TFI, at the Franklin County Boat Club docks at Barton Cove in Gill, MA (Figure 3.3.2.1.2-1). Parameters included water temperature, dissolved oxygen, conductivity and transparency.

In 2007, measurements were collected on: August 30, September 20, and October 23. In 2008, measurements were collected on: June 11, July 9, August 13, September 9 and 18, and October 7. The data for the Franklin County Boat Club docks are presented in Table 3.3.2.1.2-4. The results reported that all the water temperature and dissolved oxygen measurements met the Massachusetts Water Quality Standard for warm water fisheries. Dissolved oxygen at the Franklin County Boat Club docks ranged from 7.14 mg/l to 9.55 mg/l. Specific conductance readings at the site ranged from 80.7 microsiemens (μS) to 146.2 μS. Transparency was consistently measured as greater than 120 centimeters (cm), indicating very clear water.

In addition, the CRWC has monitored bacteria at the Barton Cove state boat launch on a weekly basis from the week after Memorial Day to the first week of October since 2010. Data from 2010 and 2011 were collected by the CRWC, in cooperation with Franklin Regional Council of Governments (FRCOG), the Pioneer Valley Planning Commission (PVPC) and the University of Massachusetts Water Resources Research Center. Barton Cove's state boat launch *E. coli* data from 2010 to 2015 are compared with corresponding daily average flows from the Montague USGS gage and the MA water quality standard in Figure 3.3.2.1.2-2. The same *E. coli* and flow data, in addition to instances samples were collected during a wet weather event, are displayed in Table 3.3.2.1.2-5.

All of the corresponding *E. coli* measurements from 2010 met the Massachusetts Water Quality Standard. Several measurements from this same location exceeded the Massachusetts Water Quality maximum standard of 235 colonies/100 ml for *E. coli* from 2011 to 2015.

River flows were appreciably higher in 2011 when compared to 2010. The low daily average flows observed during the 2012 sampling period were comparable to those of 2010 (USGS, 2016). Five out of the nineteen samples (26%) collected exceeded the MA water quality standard in 2012. The highest flows corresponding to sampling events from 2010 to 2015 were observed in 2013. Thirteen of the nineteen samples (68%) collected exceeded the MA water quality standard in 2013. 2014 had similar results to 2013 with 13 of the 20 samples (65%) collected exceeding the MA water quality standard. Counts were lower in 2015 with seven of the 20 sampling events (35%) resulting in exceedances (CRWC, n.d).

USGS Water Quality Monitoring

Water quality measurements were occasionally taken by the USGS at the Montague City gage site. Data includes physicochemical measurements and nutrients collected most recently in 2006-2007, as shown in Table 3.3.2.1.2-6. In addition to collecting data from this site, a study of total nitrogen concentrations and loads was conducted by the USGS from December 2002 to September 2005 at 13 river sites in the upper Connecticut River Basin. In this study, the mean annual load and yield of total nitrogen at the Connecticut River at North Walpole, NH, was estimated at 9.60 million pounds/year and 1,750 (pounds/mi^2)/year, respectively. The mean annual load and yield of total nitrogen leaving the upper Connecticut River Basin, as estimated at the Connecticut River at Thompsonville, CT, was 21.6 million pounds/year and 2,230 (pounds/mi^2)/year, respectively (Deacon *et al.*, 2006).

Long Island Sound Nitrogen TMDL study

The Connecticut River accounts for 70% of freshwater entering Long Island Sound (the Sound) every year. An overabundance of nitrogen has been identified as the primary cause of hypoxia (low dissolved oxygen) in the Sound. Hypoxia is a serious problem affecting the overall health and abundance of fish, shellfish and other organisms, and occurs during the late summer months.

The USEPA approved the Long Island Sound nitrogen TMDL on April 3, 2001 with the goal of ultimately reducing nitrogen load and in turn, increasing dissolved oxygen levels. Under this policy, the USEPA specified a 58.5% reduction in human generated nitrogen from point and nonpoint sources over 15 years following several phases of implementation. Primary sources enriching the Sound with nitrogen include sewage treatment plant discharge, runoff and atmospheric deposition. Limiting these sources will reduce nitrogen loading and help to improve water quality (NYSDEC, 2000).

USEPA Connecticut River Fish Tissue Contaminant Study

The Connecticut River Fish Tissue Contaminant Study (Hellyer, 2006) was a collaborative federal and state project designed to provide a baseline of tissue contaminant data from several fish species, to better understand the risk to human health from eating Connecticut River fish, and to learn what threat eating these fish poses to other mammals, birds, and fish. For this study the Connecticut River was divided into eight sampling reaches with Reach 4 being the TFI.

Smallmouth bass, yellow perch and white suckers were collected during 2000 from the mainstem of the Connecticut River and composite samples were analyzed for total mercury, PCBs, organochlorine pesticides, and dioxins. Levels of contaminants were compared to USEPA and other current human health subsistence and recreational (sport) fisher and ecological risk screening criteria, and also were statistically compared between reaches and species.

Based on the information from this study, it was reported that fish tissue in the Connecticut River contained contaminants exceeding various human health and ecological risk screening values, and that state health agencies will evaluate existing advisories and consider the need for others, to adequately protect human health (Hellyer, 2006).

Existing Water Quality

As part of the relicensing process, FERC approved Revised Study Plan No. 3.2.1 *Water Quality Study*. As noted earlier (Section 1.4.3.1), closure of the Vermont Yankee Nuclear Power Plant (VY), located upstream of the Northfield Project, would change certain environmental baseline conditions during the relicensing study period. Due to the impending closure of VY, the implementation of the water quality study was delayed for a year. Consequently, a final report detailing the 2015 study was filed with FERC on March 1, 2016.

The purpose of the water quality study was to document baseline water quality conditions including water temperature, dissolved oxygen (DO) and other water quality parameters upstream and downstream of the Project.

A total of 18 water quality sampling stations were located from below Vernon Dam to downstream of Cabot Station as summarized in Table 3.3.2.1.2-7. Sampling sites were located in the TFI (Sites 1-7), bypass reach (Sites 8-9), Turners Falls power canal (Site 10), below Cabot Station and above the Deerfield River confluence (Site 11) and below Cabot Station below the Deerfield River confluence (Sites 12-18). At each sampling site one of the following was measured a) continuous temperature and DO, b) vertical profiles of temperature and DO, or c) continuous temperature (see Table 3.3.2.1.2-7).

Continuous water temperature data were collected every 15 minutes from early April to mid-November 2015 at the locations as shown in Figures 3.3.2.1.2-3 and 3.3.2.1.2-4. DO and temperature profiles were collected bi-weekly from early April to mid-November at three (3)[36] relatively deep locations within the TFI as shown in Figure 3.3.2.1.2-5.

Weather and flow conditions during the 2015 water quality sampling study period generally reflected typical conditions for the study area. April and May 2015 experienced less precipitation in comparison to long-term averages. June was very wet and cool. The summer months of July and August had fairly typical conditions, as did October. September was warmer than usual and November was warmer and also drier than usual. August was the warmest month and November was the coolest month during the 2015 monitoring period. Overall, flow conditions during the 2015 field sampling effort followed the typical seasonal trend of high flows in the spring, low flows in the summer, and then increasing flows in the fall.

All applicable MA water quality standards were met throughout the duration of the 2015 Water Quality Study (Study No. 3.2.1) sampling period. Some changes were observed in water quality based on project operations but none causing any violation of applicable water quality standards. DO supersaturation was noted at several sites, but was most prevalent in the bypass reach, correlating with greater spillage at Turners Falls Dam. Sites downstream of Cabot Station had similar rates of change in temperature regardless of Cabot Station operation.

3.3.2.2 Environmental Effects

3.3.2.2.1 Water Quantity

The following subsections address the expected water quantity effects of FirstLight's proposed operation.

Hydrology and Streamflow

Under FirstLight's proposed action, the Northfield Mountain Pumped Storage Development would continue to withdraw and discharge water from/to TFI. These operations would continue to alter the TFI impoundment levels on an intra-daily timeframe.

[36] At one of these locations—Upstream of the Turners Falls Dam boat barrier--continuous DO and temperature data were collected as well.

Other than the evaporative losses due to the Upper Reservoir, which are small, the Northfield Mountain Pumped Storage Development does not result in any net water loss to the Connecticut River Basin.

Under FirstLight's proposed action, the Turners Falls Development would continue to operate to alter TFI levels and downstream flow on an intra-daily timeframe.

3.3.2.2.2 Water Quality

All applicable water quality standards were met throughout the duration of the 2015 Water Quality Study (Study No. 3.2.1) sampling period.

DO results from within the TFI, the bypass reach, the power canal, and below Cabot Station (i.e., Site 1 through Site 11) remained above the MA water quality standard of 5.0 mg/L minimum for Class B warm water fisheries. The minimum observed DO concentration was 5.8 mg/L (and 71.1% saturation) at Site 11 below Cabot Station.

The water temperatures observed at each location remained below the MA water quality standard of 28.3°C for Class B warm water fisheries. The maximum instantaneous temperatures observed across all sites ranged from 26.4°C to 28.1°C. Monthly average water temperatures were very similar among all locations. August was the warmest month for all locations with an average water temperature of approximately 25°C.

DO and temperature profiles collected at the three sites in the TFI showed no evidence of thermal stratification and only a slightly negative DO gradient at times. The water column at all three profile locations was generally well-mixed throughout the sampling period.

Minor, short-term changes in water temperatures and DO at the Northfield Mountain Pumped Storage Development tailrace were observed during periods of generation at the Northfield Mountain Pumped Storage Development. The highest concentrations of DO were also most commonly observed in the bypass reach downstream of Turners Falls Dam where DO supersaturation (over 100%) was observed at times; generally found to increase in relation to spillage from Turners Falls Dam.

Water temperature and DO levels in the power canal tracked similarly to conditions at the boat barrier in the TFI. Similarly, water quality conditions just downstream of Cabot Station (Site 11) tracked closely to conditions in the power canal while Cabot Station was generating. When Cabot Station was off-line, downstream conditions were dictated by flow and water quality conditions in the bypass reach.

Water temperature patterns were similar from site to site in the Connecticut River downstream of Cabot Station (Site 11-18) regardless of Cabot Station operations during periods of low flow. Monthly average water temperatures from Sites 11-18 were within a range of +/- 1.0°C. Daily water temperature fluctuations and hourly temperature rates of change were greater at locations further downstream of Cabot Station (Sites 12-18) in comparison to just downstream of Cabot Station (Site 11). The maximum rate of change for temperature was 1.5°C/hr. Average rates of change below Cabot Station were typically up to 0.2°C/hr. The study results show that the Project had no adverse effects on water quality, specifically, DO and water temperature parameters.

3.3.2.3 <u>Cumulative Effects</u>

The Council of Environmental Quality (CEQ) regulations define "cumulative effects" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR §1508.7).

For this analysis, the action is the relicensing and continued operation of the Turners Falls Development and Northfield Mountain Pumped Storage Development. FERC has identified the geographical extent of cumulative effects on water quantity and water quality to include the Connecticut River from the base of Moore dam to the mouth of the Connecticut River at Long Island Sound. This geographic area was chosen to recognize the cumulative operational influences of the upstream water storage, and the operations of the five Connecticut River projects on water quantity throughout this area and subsequently on water quality that could occur downstream to mouth of the Connecticut River at Long Island Sound. The temporal scope of this analysis includes a discussion of the past, present, and reasonably foreseeable future actions, and their effects on the resource 50 years into the future.

The potential impact of the Project is associated with whether the continued operation of the Turners Falls Development and Northfield Mountain Pumped Storage Development affects water quantity and quality of the Lower Connecticut River, which had already been altered by construction of numerous dams.

Water Quantity

The cumulative impact of the Project on the affected resource occurs within the context of the presence of a series of hydroelectric facilities have the potential to collectively affect the water quantity of the Connecticut River. The Project contributes to the alternation of the Connecticut River's hydrology, particularly in terms of water levels and flow regime. The Project directly influences TFI water levels and streamflow in the reach between the Turners Falls Dam and Holyoke Dam. However, other than evaporative losses, the Project does not result in any net water loss to the Connecticut River Basin. It is difficult to quantify specific Project impacts, because TFI inflows are highly regulated by upstream hydroelectric projects and seasonally storage reservoirs. While the FERC license permits water levels to fluctuate between 176 and 185 feet at the Turners Falls Dam, in practice FirstLight maintains water levels high enough to maintain sufficient head to push flow through the gatehouse while still being accommodate pump-storage operations.

The Project does not directly alter the water quantity of the Connecticut River on a long-term basis and, therefore, does not impact water quantities in Long Island Sound. The Proposed Actions of the Project, in combination with other activities within the watershed, will not alter this condition for the reasonably foreseeable future.

Water Quality

The cumulative impact of the Project on the affected resource occurs within the context of the presence of a series of hydroelectric facilities have the potential to collectively affect the water quality of the Connecticut River. Dissolved oxygen and water temperature measured throughout the Project area met applicable state water quality standards. The Project does not result in local impacts to the water quality of the Connecticut River and, therefore, does not impact the area downstream of the Project. The Proposed Actions of the Project, in combination with other activities within the watershed, will not alter this condition for the reasonably foreseeable future.

3.3.2.4 Proposed Environmental Measures

No environmental measures are proposed at this time.

3.3.2.5 Unavoidable Adverse Impacts

Cabot Station peaking operations, under FirstLight's proposed action, would continue to alter flow on an intra-daily time step in the Connecticut River below Cabot Station.

With regard to sediment dynamics in the Upper Reservoir, as discussed in the Geology and Soils section, Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan* is still ongoing with the final report due on October 14, 2016. The results of Study No. 3.1.3 will be used to inform management measures to minimize the entrainment of sediment into the Northfield Mountain Pumped Storage Development works and discharge to the Connecticut River during drawdown or dewatering activities. The Project has no other known unavoidable adverse effects on water quality resources.

Table 3.3.2.1.1-1: Connecticut River at North Walpole, NH (USGS Gage No. 01154500), Drainage Area= 5,493 mi^2, Period of Record: Mar 1942-Sep Dec 2014 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	7,677	7,095	13,563	27,134	16,386	8,517	5,201	4,393	3,978	6,976	9,127	9,209	9,941
Mean/mi^2	1.40	1.29	2.47	4.94	2.98	1.55	0.95	0.80	0.72	1.27	1.66	1.68	1.81
Median	6,000	5,860	9,910	23,000	14,000	7,025	3,820	3,150	3,050	6,911	7,550	7,280	6,490
Median/mi^2	1.09	1.07	1.80	4.19	2.55	1.28	0.70	0.57	0.56	1.26	1.37	1.33	1.18

Data Source: USGS, mean daily flows

Table 3.3.2.1.1-2: Connecticut River below Vernon Dam (USGS Gage No. 01156500), Drainage Area= 6,266 mi^2, Period of Record: Oct 1944-Sep 1973 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	7,422	7,300	14,558	32,110	18,991	8,750	4,833	3,636	3,704	5,270	8,550	8,809	10,319
Mean/mi^2	1.18	1.17	2.32	5.12	3.03	1.4	0.77	0.58	0.59	0.84	1.36	1.41	1.65
Median	6,400	6,400	9,400	27,050	15,800	7,030	3,800	3,080	2,970	3,880	7,105	7,170	6,535
Median/mi^2	1.02	1.02	1.50	4.32	2.52	1.12	0.61	0.49	0.47	0.62	1.13	1.14	1.04

Data Source: USGS, mean daily flows

Table 3.3.2.1.1-3: Connecticut River at Montague City, MA (USGS Gage No. 01170500), Drainage Area= 7,860 mi², Period of Record: Apr 1940-Dec 2014 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	12,094	11,558	21,128	37,195	21,767	13,365	9,311	8,495	7,112	13,090	15,498	16,657	15,840
Mean/mi²	1.54	1.47	2.69	4.73	2.77	1.70	1.18	1.08	0.90	1.67	1.97	2.12	2.02
Median	9,600	9,345	15,500	33,700	19,100	9,910	5,650	4,680	4,700	6,850	11,100	11,100	9,790
Median/mi²	1.22	1.19	1.97	4.29	2.43	1.26	0.72	0.60	0.60	0.87	1.41	1.41	1.25

Data Source: USGS, mean daily flows

Table 3.3.2.1.1-4: Estimated Connecticut River at Turners Falls Dam Drainage Area= 7,163 mi², Period of Record Jan 1941-Dec 2014 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	10,242	9,682	18,514	34,713	19,680	11,887	8,432	7,549	6,267	11,710	13,810	14,793	14,079
Mean/mi²	1.43	1.35	2.58	4.71	2.75	1.66	1.18	1.05	0.87	1.63	1.93	2.07	1.97
Median	7,963	7,711	13,200	30,238	17,316	8,900	4,965	4,147	4,059	6,058	9,845	9,613	8,489
Median/mi²	1.11	1.08	1.84	4.22	2.42	1.24	0.69	0.58	0.57	0.85	1.37	1.34	1.19

Data Source: Estimated from manipulation of USGS gages

Table 3.3.2.1.2-1: Massachusetts Water Quality Standards for Class B Waters – Warm Water Fisheries

Parameter	Standard
Dissolved Oxygen (DO)	Shall not be less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
Temperature	Temperature shall not exceed 83 °F (28.3 °C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 3 °F (1.7 °C) in rivers and streams designated as cold water fisheries nor 5 °F (2.8 °C) in rivers and streams designated as warm water fisheries (based on the minimum expected flow for the month).
pH	Shall be in the range of 6.5 through 8.3 standard units and not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.
Bacteria – beaches	E. coli: the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml. Enterococci: the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml.
Bacteria – other waters	E. coli: the geometric mean of all samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml. Enterococci: geometric mean of all samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml.
Solids	These waters shall be free from floating, suspended and settleable solids in concentrations and combinations that would impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.
Color and Turbidity	These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this Class.
Oil and Grease	These waters shall be free from oil, grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course, or are deleterious or become toxic to aquatic life.
Taste and Odor	None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to this Class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.

Note: MA Standards also include narrative criteria applicable to all surface waters related to aesthetics, bottom pollutants or alteration, nutrients, radioactivity, and toxic substances.

Table 3.3.2.1.2-2: MADEP 2003 Water Quality Data Results – Physical Parameters

Date	Temp (°C)	pH	Conductivity (µS/cm)	TDS (mg/L)	DO (mg/L)	DO (% sat)
Station CT06 – Connecticut River at Route 10 Bridge						
04/29/03	8.9	7.1 c	92.5	59.2	12.1	106
06/02/03	16.6	7.2	122	77.9	9.4	99
08/05/03	23.9	7.2 c	121	77.2	7.7 u	92 u
08/06/03	23.9	7.0 c	120	76.8	7.0	84
09/09/03	21.5	7.3 uc	153	98.0	8.5	97
10/01/03	15.8	7.2	112 u	71.9 u	9.4 u	95 u
Station 02A – Connecticut River downstream of Fourmile Brook confluence						
07/08/03	27.7	7.6	139	90.0	8.3 i	105 i
07/09/03	27.2	7.5	138	89.0	7.8 i	99 i
08/05/03	23.7	7.2 uc	119	78.0	7.6	90
08/06/03	23.7	7.3 c	108	70.0	7.5	88
09/09/03	21.7	7.5 uc	152	99.0	9.3	106

Notes:
i = potentially inaccurate reading
u = unstable reading
c = meter not calibrated or calibration result outside accepted range of calibration standard

Table 3.3.2.1.2-3: MADEP 2003 Water Quality Data Results – Biological and Chemical Parameters

Date	Time (24 hr)	QA/QC	Fecal coliform (CFU/ 100mL)	E. coli (CFU/ 100mL)	Turbidity (NTU)	Alkalinity (mg/L)	Hardness (mg/L)	Chl-a (mg/m^3)	NH3-N (mg/L)	NO3-NO2-N (mg/L)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
Station CT06 – Connecticut River at Route 10 Bridge													
04/30/03	08:00	-	2	1	1.4	-	-	-	<0.06	-	-	0.021	5.2
06/04/03	08:05	-	20	5	0.40	26	37	-	<0.02	-	-	0.016	2
07/09/03	08:15	-	30	16	0.46	28	44	<1.0	<0.02	-	-	0.011	<2
08/06/03	07:45	-	250	30	1.0	25	33	1.0	0.11	-	-	0.019	4
09/10/03	08:00	-	4	2	-	-	-	<1.0	<0.02	0.17	R	0.010	<2
10/01/03	08:20	-	500	120	-	-	-	-	<0.02	0.14 f	R	R	6
Station 02A – Connecticut River downstream of Fourmile Brook confluence													
07/09/03	09:09	Left	24	20	-	-	-	<1.0	-	-	-	-	-
		Right	40	12	-	-	-	1.1	-	-	-	-	-
		Center	30	10	0.50	30	44	-	<0.06	-	-	0.011	<2
08/06/03	07:55	Left	500	160	-	-	-	-	-	-	-	-	-
		Right	600	70	-	-	-	-	-	-	-	-	-
		Center	1900	130	1.3	23 d	29	1.3	<0.02	-	-	0.020	2
09/10/03	08:12	Left	10	8	-	-	-	-	-	-	-	-	-
		Right	12	10	-	-	-	-	-	-	-	-	-
		Center	<2	<2	-	-	-	1.6	<0.02	0.16	R	0.008	<2

Note: R = data removed due to quality assurance flag in report.

Table 3.3.2.1.2-4: CRWC 2007-2008 Water Quality Data Results at Franklin County Boat Club Docks

Date	Time (24 hr)	Air Temp (°C)	Water Temp (°C)	Transparency (cm)	Specific Conductance (µS)	DO (mg/L)	DO (% sat)
8/30/2007	8:33	22.9	25.2	>120	146.2	7.22	86.1
9/20/2007	8:32	16.7	20.0	>120	138.7	7.33	99.3
10/23/2007	8:33	17.5	17.0	>120	134.8	7.81	82.0
6/11/2008	8:57	21.8	23.7	>120	126.7	9.55	113.1
7/9/2008	8:50	25.8	26.5	>120	104.5	8.52	105.1
8/13/2008	8:33	19.1	20.3	>120	80.7	8.52	93.5
9/9/2008	8:49	19.3	23.1	>120	117.4	7.14	83.3
9/18/2008	10:12	19.3	20.7	—	120.3	8.41	93.3
10/7/2008	8:43	10.8	14.9	>120	126.4	8.06	79.7

Sources: Donlon, 2008 and Donlon, 2009

Table 3.3.2.1.2-5: Yearly CRWC Bacteria Sampling Results for Barton Cove, 2010-2015

Year	Max Exceedance Concentration[a] (colonies/100ml)	Flow at Max Exceedance (cfs)	Total No. Exceedances	Exceedances During Wet Weather Events[b]	Number of Sampling Events (May - October)
2010	NA	NA	0	0	17
2011	1,553	25,200 **& 10,600**	6	1	11
2012	2,419.6	4,680	5	0	19
2013	>2,419.6	12,700	13	4	19
2014	>2,419.6	29,200 & 10,400	13	10	20
2015	1,120	34,600	7	5	20
TOTAL	**---**	**---**	**44**	**20**	**106**

[a] Result indicates exceedance of Massachusetts Criteria for single *E. coli sample* of 235 colonies/100ml.
[b] "Wet" signifies wet weather event defined as >0.1 inches of rain in 24 hours.

Note: Bacteria counts were generally determined on a biweekly basis between Memorial Day to the first week in October.

Sources:
2010-2011 *E. coli* and weather data: http://www.umass.edu/tei/mwwp/ctrivermonitoring.html,
2012 – 2015 *E. coli* and weather data: http://www.connecticutriver.us/site/content/sites-list
USGS gage 01170500 at Montague, MA: http://waterdata.usgs.gov/ma/nwis/current/?type=flow

Table 3.3.2.1.2-6: Select Water Quality Data from USGS Montague City Gage

Date/Time	Discharge (cfs)	pH	Nitrogen, total (mg/L)	Ammonia, as N (mg/L)	Nitrate + Nitrite (mg/L)	Orthophosphate (mg/L)	Phosphorus, total (mg/L)
10/26/2006 9:15	21,600	7.0	0.47	0.011 e	0.190	< 0.018	0.075
12/15/2006 7:30	16,000	7.3	0.46	0.023	0.285	0.013 e	0.040
2/8/2007 11:30	7,790	6.9	0.63	0.034	0.458	0.020	0.033
3/29/2007 11:00	53,800	7.0	0.75	0.030	0.339	0.012 e	0.142
4/20/2007 11:00	78,800	7.0	0.63	0.010 e	0.254	0.011 e	0.160
5/3/2007 11:15	35,200	7.0	0.49	0.011 e	0.268	0.012 e	0.034
5/17/2007 11:45	24,200	7.3	0.52	0.014 e	0.287	0.009 e	0.033
6/28/2007 12:00	2,430	7.3	0.51	0.020 e	0.310	0.013 e	0.016
8/2/2007 12:30	1,790	7.5	0.46	< 0.020	0.257	0.017 e	0.015
9/6/2007 8:00	1,750	7.4	0.39	0.014 e	0.238	0.013 e	0.008
Nutrient Criteria Reference Conditions for Ecoregion VIII Streams - Subecoregion 58 (Northeastern Highlands)							
Minimum			0.34		0.010		0.002
Maximum	-	-	0.84	-	2.850	-	0.450
25th percentile			0.42		0.160		0.005

Notes: Water quality data collected at this gage location ends on 9/6/2007. “e” = estimated. Nutrient criteria from USEPA, 2001

Table 3.3.2.1.2-7: Water Quality Monitoring Sampling Locations

Station No.	Type	Location	Comments
Connecticut River- Turners Falls Impoundment (Temperature and DO)			
1	Continuous	Below the Vernon Dam and Ashuelot River Confluence	Near thalweg at 25% depth
2	Profile	Deep area upstream of Northfield Mountain	Collect profile at one meter depth increments
3	Continuous	Above the Northfield Mountain Tailrace	Near thalweg at 25% depth
4	Continuous	Northfield Mountain Tailrace	Within the Northfield Mountain Tailrace at 25% depth
5	Continuous	Below the Northfield Mountain Tailrace	Near thalweg at 25% depth
6	Profile	Deepest area of Turners Falls Impoundment	Collect profile at one meter depth increments
7	Profile and Continuous	Upstream of the Turners Falls Dam at Boat Barrier	Collect profile at one meter depth increments and install continuous meter at 25% depth
Connecticut River- Bypass Reach (Temperature and DO)			
8	Continuous	Upstream of Station No. 1	Anchored near bottom, near shore
9	Continuous	Upstream of Rock Dam; west channel at Rawson Island	Anchored near bottom, near shore
Turners Falls Power Canal (Temperature and DO)			
10	Continuous	At the Railroad Bridge	Mid-channel, mid-depth
Connecticut River- Below Cabot Station (Temperature and DO)			
11	Continuous	Below the Cabot Station tailrace, upstream of Deerfield River confluence	Thalweg, mid-depth.
Connecticut River- Cabot Station to Holyoke Dam (Temperature)			
12	Continuous	Downstream of the Deerfield River confluence	Anchored near bottom, near shore
13	Continuous	Third Island	Anchored near bottom, near shore of island
14	Continuous	Second Island, near shore of island.	Anchored near bottom, near shore of island
15	Continuous	Submerged shallow bar	Anchored near bottom, at sandbar
16	Continuous	Submerged shallow bar	Anchored near bottom, at sandbar
17	Continuous	River right channel at Elwell Island	Anchored near bottom, near shore
18	Continuous	Mitch’s Island	Anchored near bottom, near shore

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0 1 2 4 Miles

Figure 3.3.2.1.1-1:
USGS Stream Gage Locations

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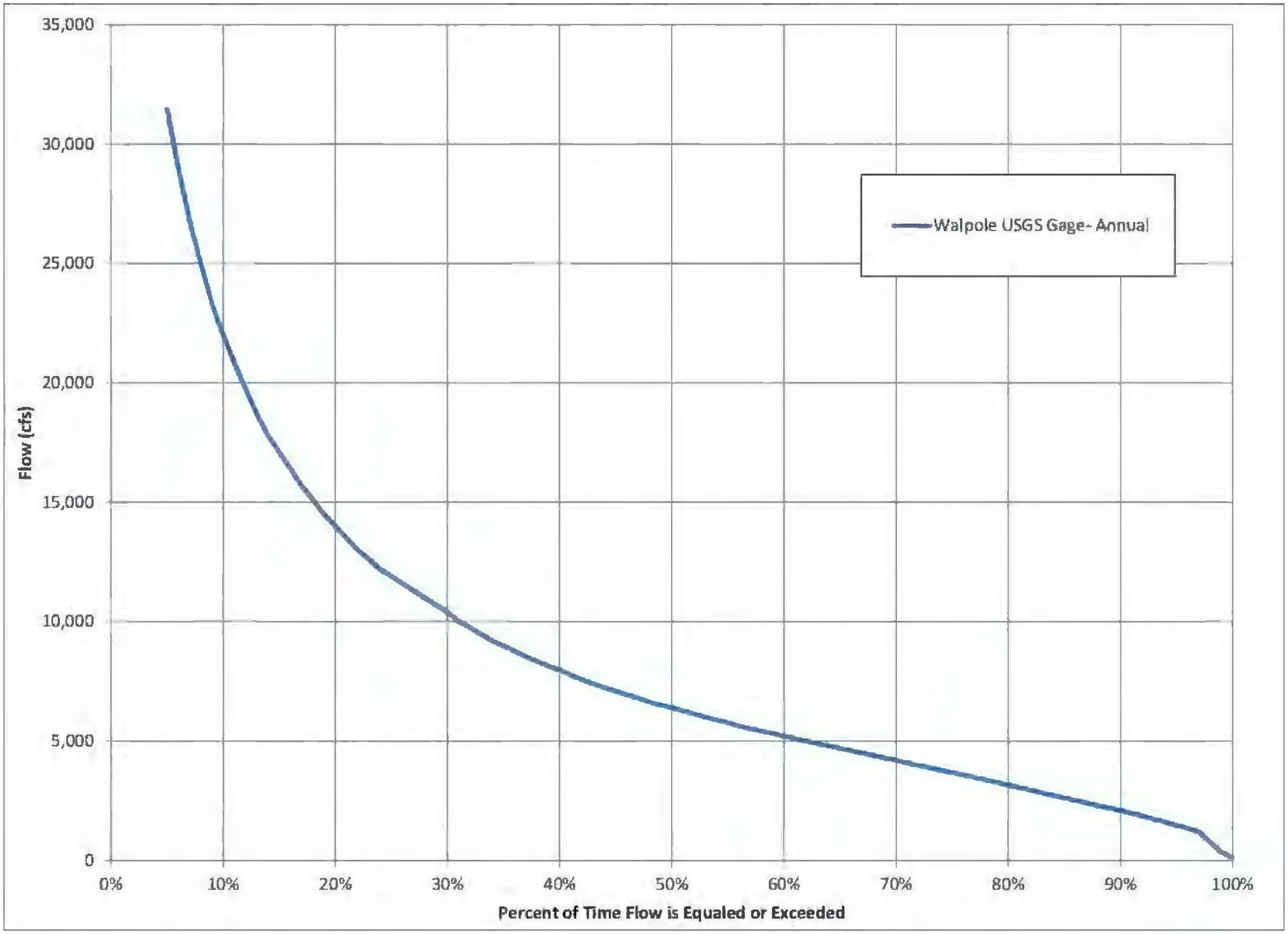

Figure 3.3.2.1.1-2: Connecticut River at Walpole, NH, Annual Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

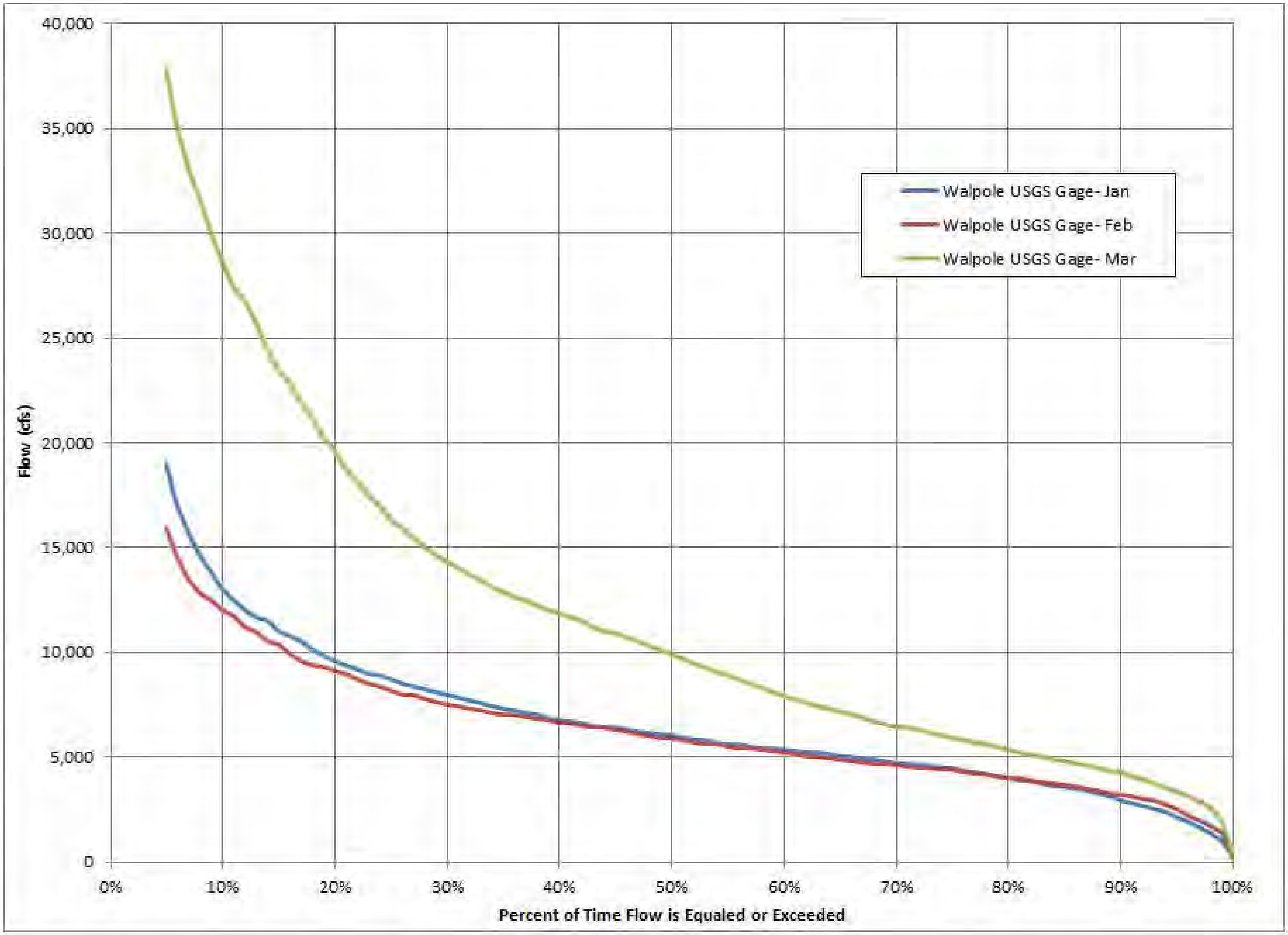

Figure 3.3.2.1.1-3: Connecticut River at Walpole, NH, Jan, Feb and Mar Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

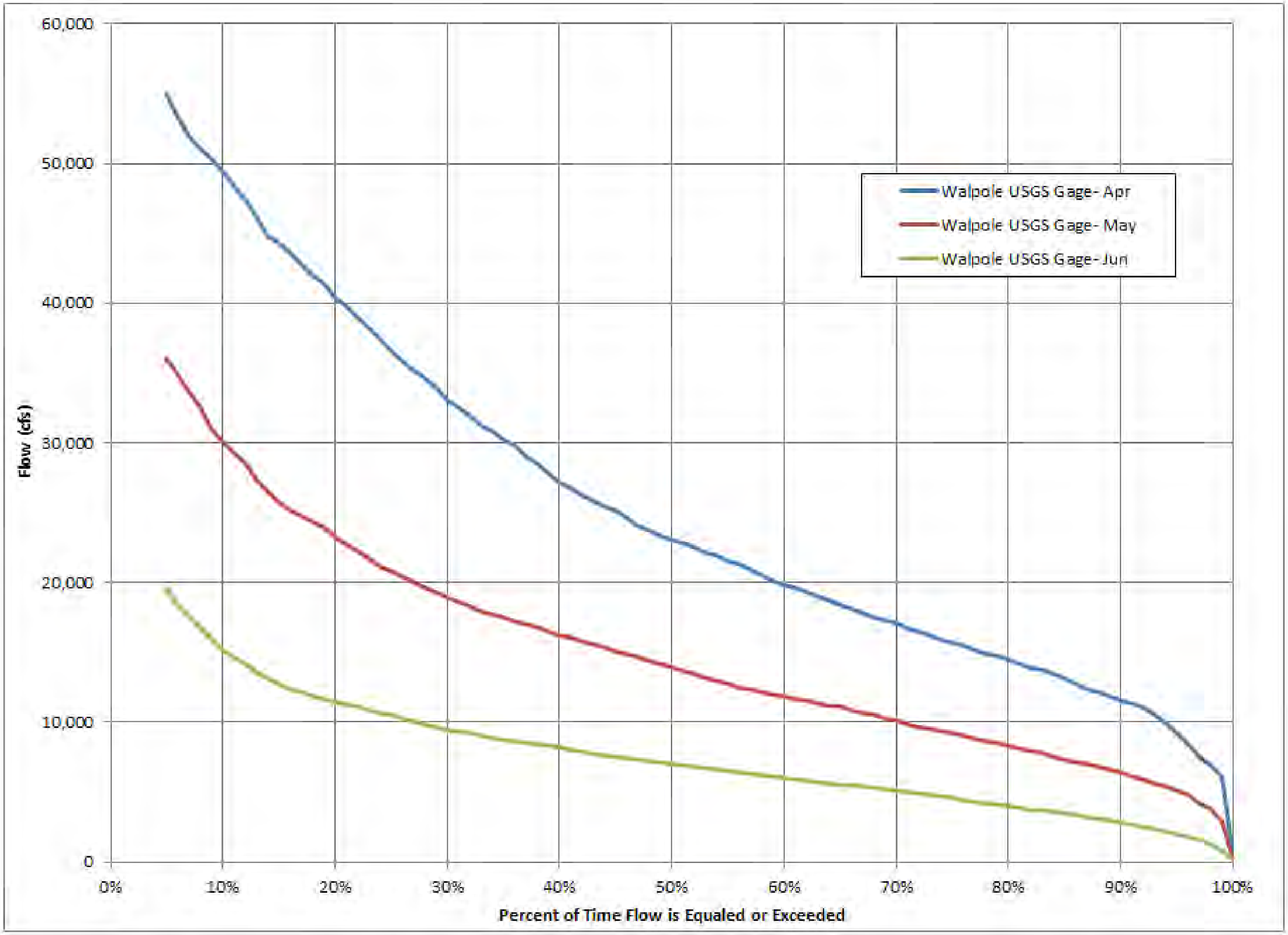

Figure 3.3.2.1.1-4: Connecticut River at Walpole, NH, Apr, May and Jun Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

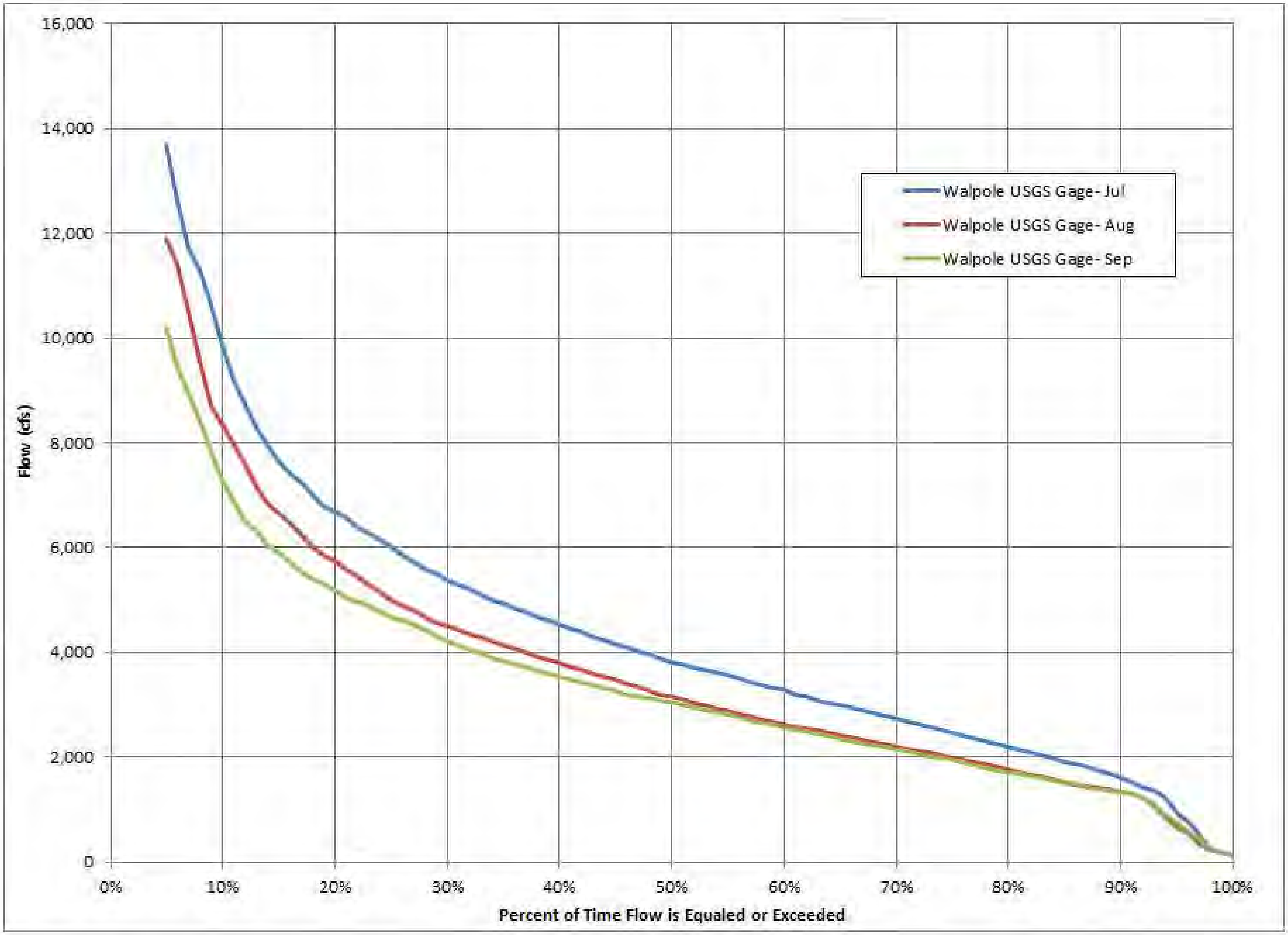

Figure 3.3.2.1.1-5: Connecticut River at Walpole, NH, Jul, Aug and Sep Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi^2

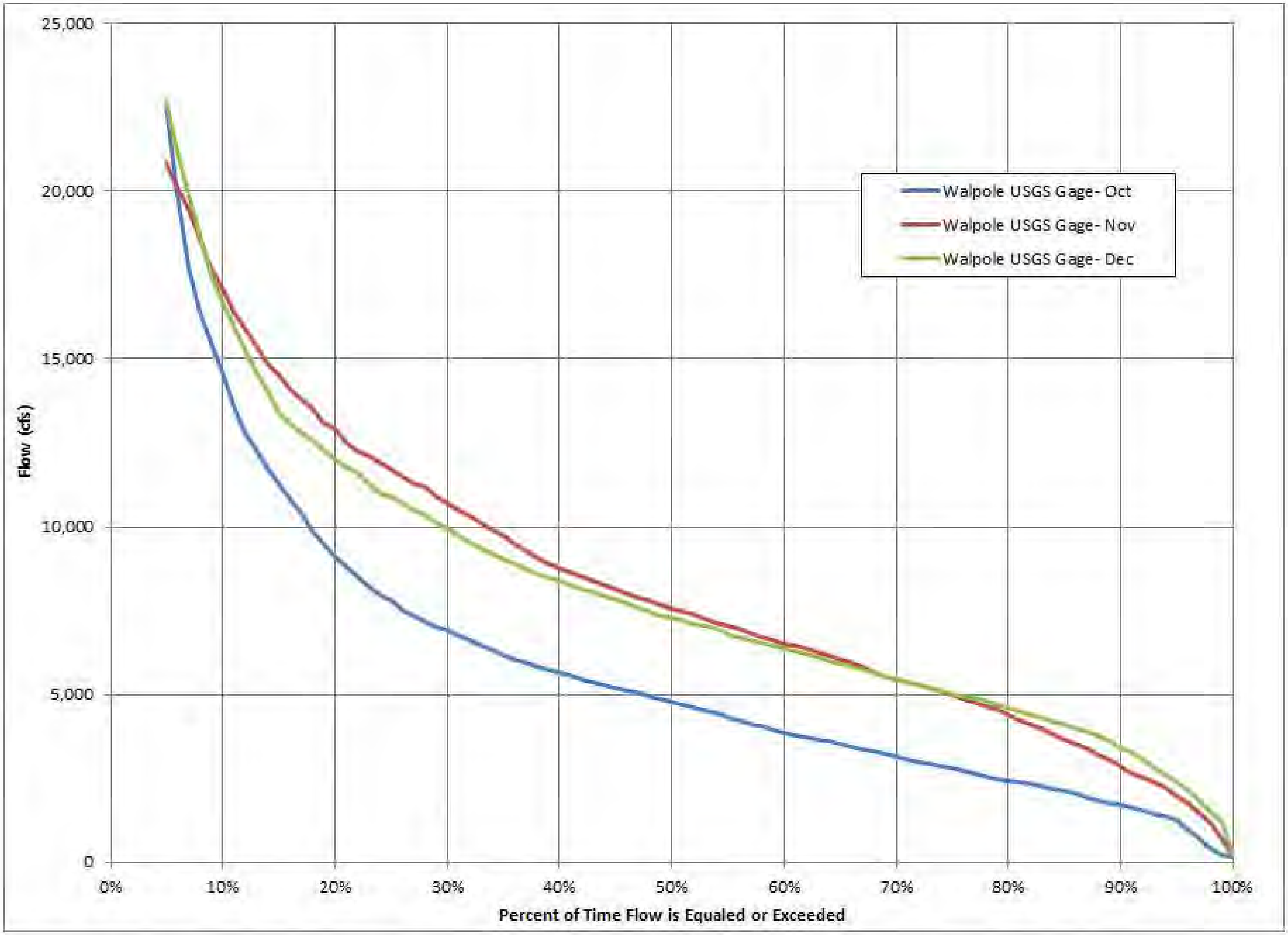

Figure 3.3.2.1.1-6: Connecticut River at Walpole, NH, Oct, Nov, and Dec Flow Duration Curve, Mar 1942-Dec 2014, Drainage Area= 5,493 mi²

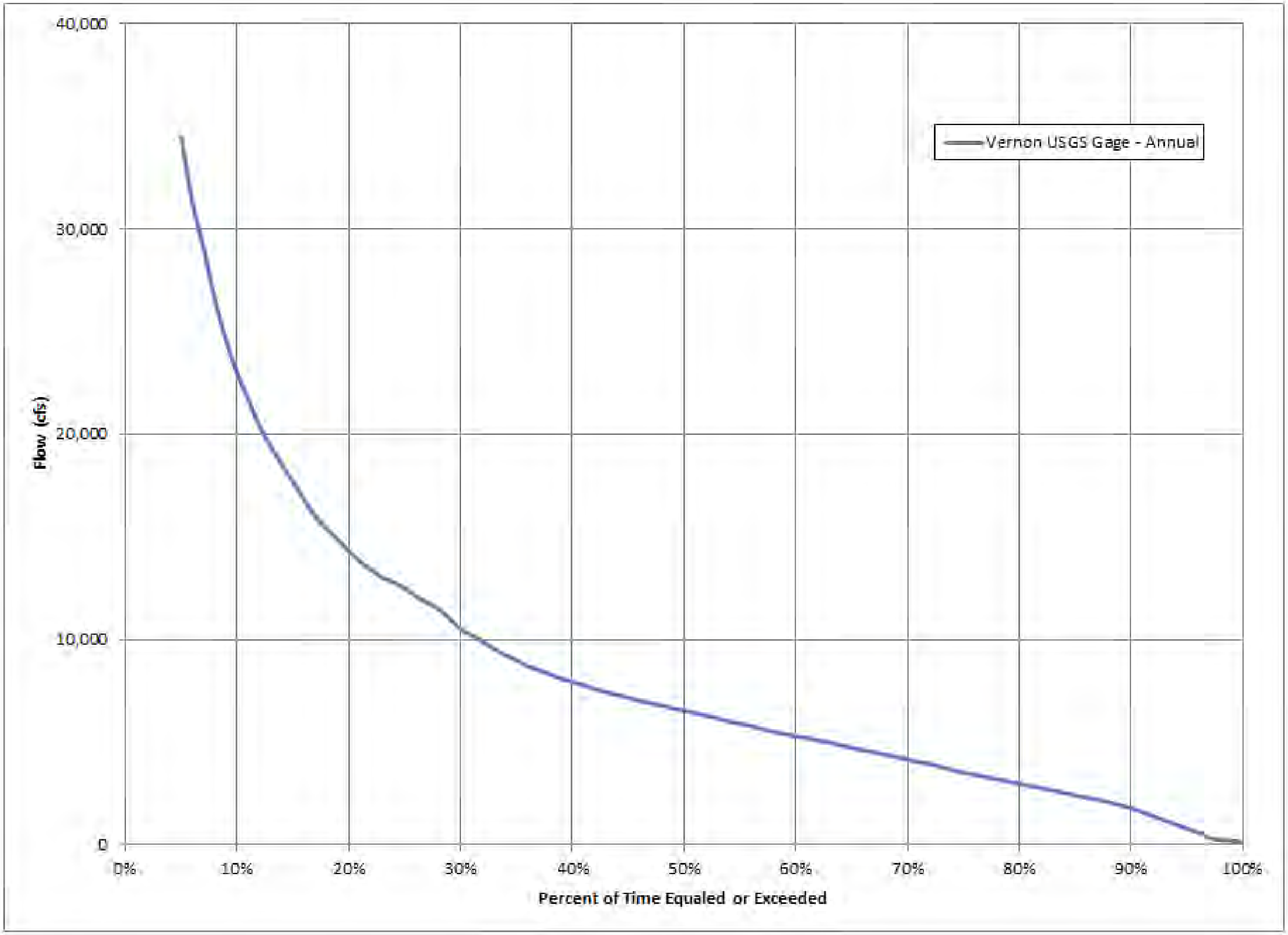

Figure 3.3.2.1.1-7: Connecticut River below Vernon Dam, VT, Annual Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

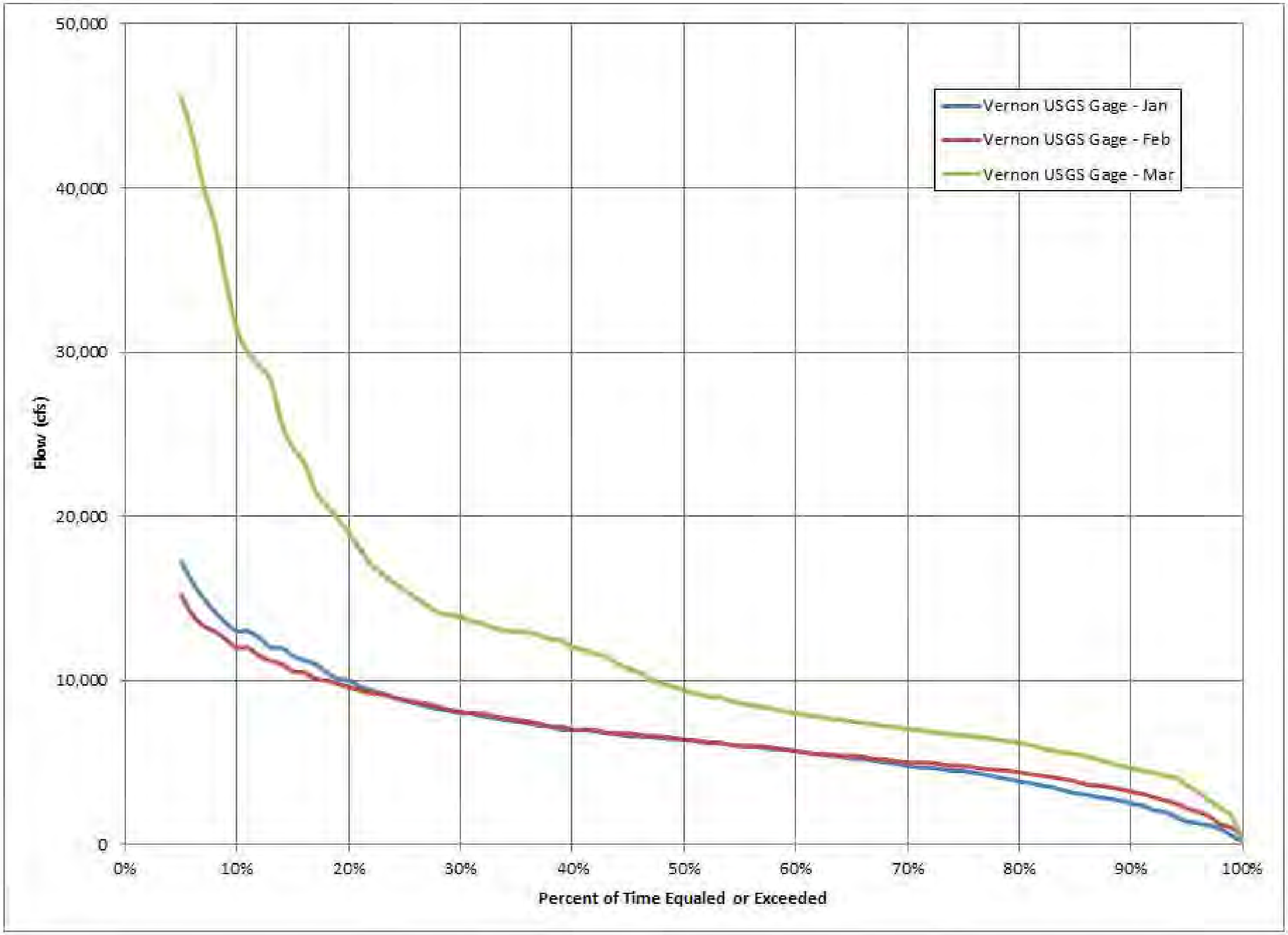

Figure 3.3.2.1.1-8: Connecticut River below Vernon Dam, VT, Jan, Feb and Mar Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

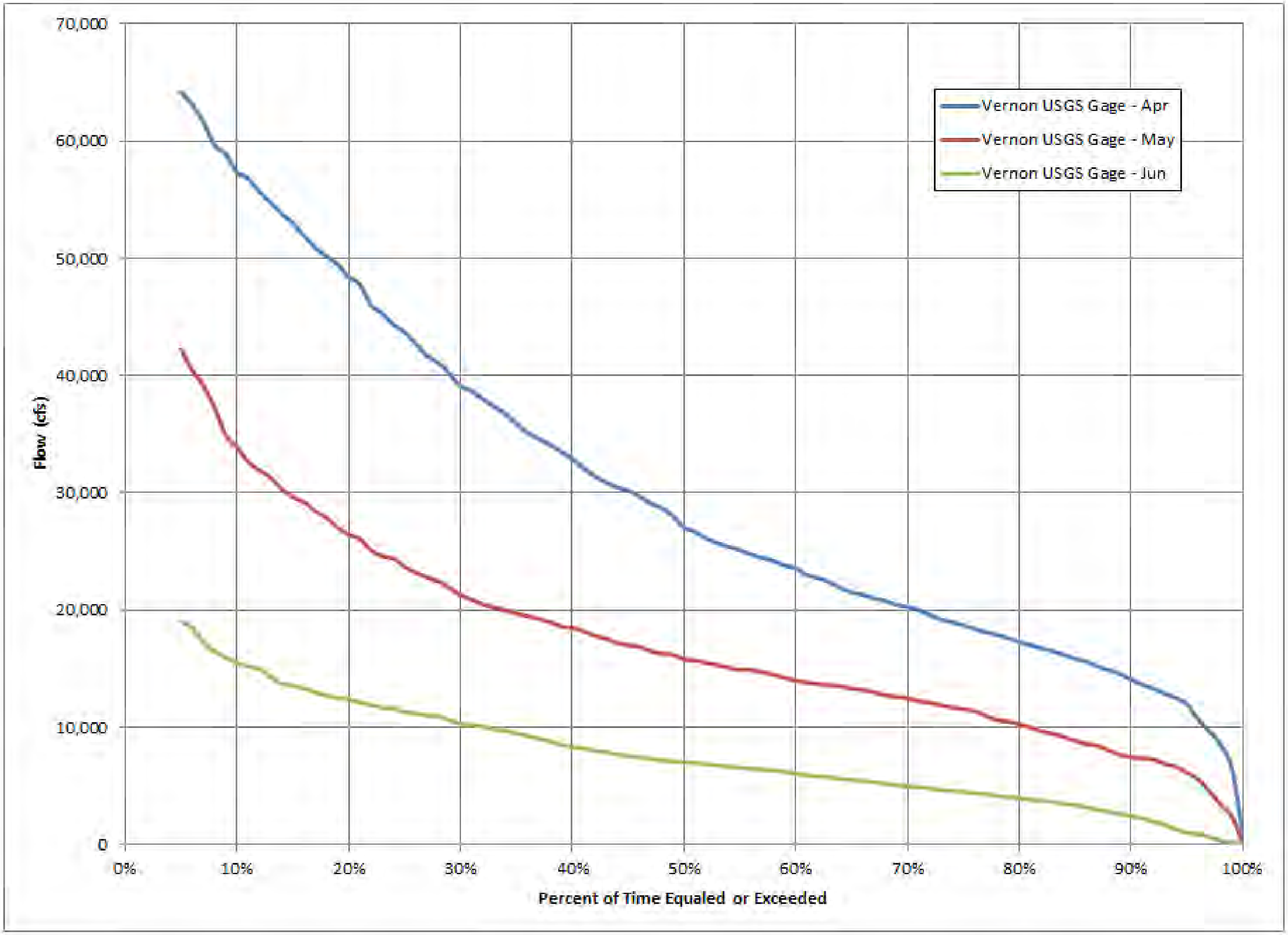

Figure 3.3.2.1.1-9: Connecticut River below Vernon Dam, VT, Apr, May and Jun Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

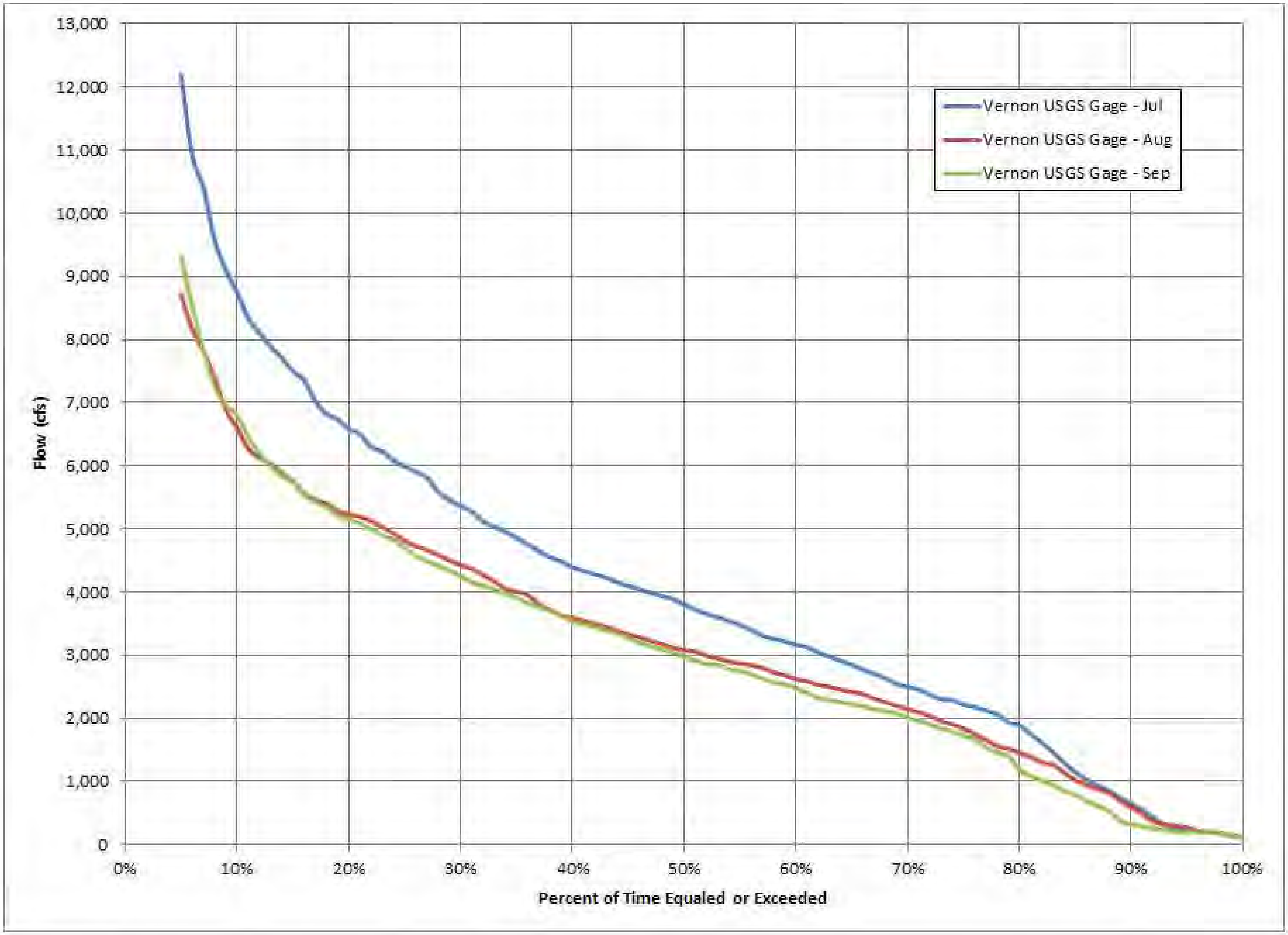

Figure 3.3.2.1.1-10: Connecticut River below Vernon Dam, VT, Jul, Aug and Sep Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

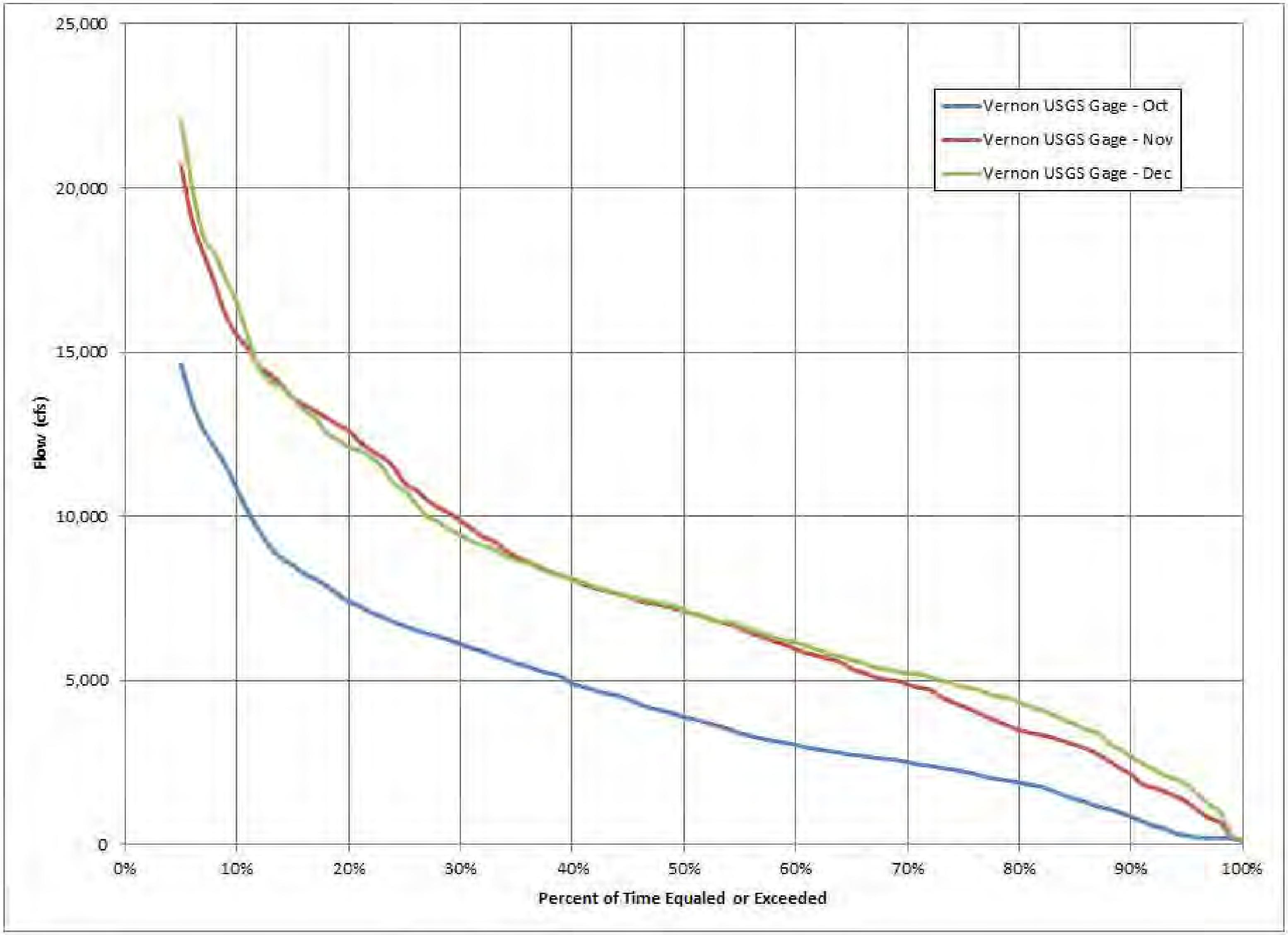

Figure 3.3.2.1.1-11: Connecticut River below Vernon Dam, VT, Oct, Nov and Dec Flow Duration Curve, Oct 1944-Sep 1973, Drainage Area= 6,266 mi^2

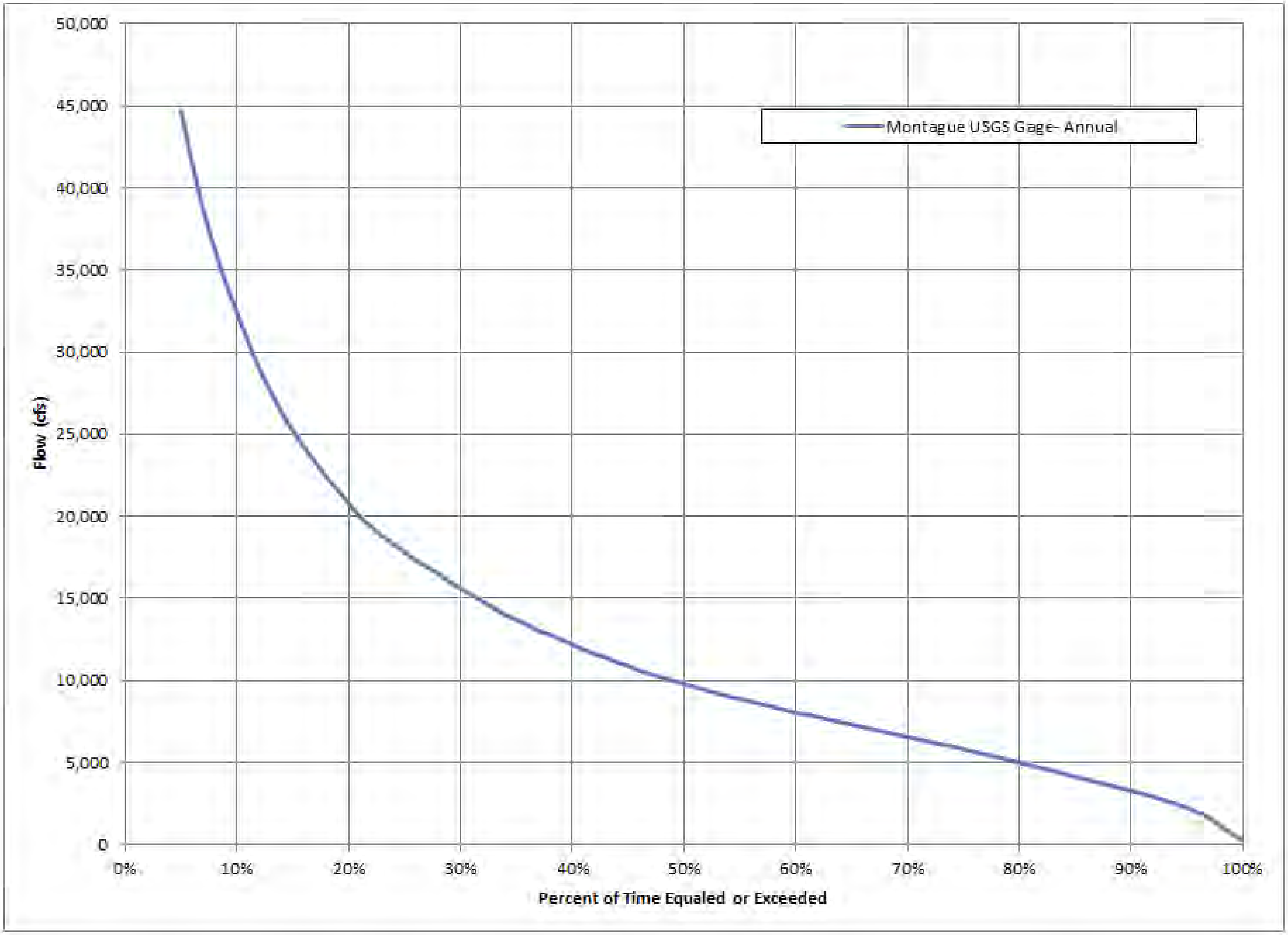

Figure 3.3.2.1.1-12: Connecticut River at Montague, MA, Annual Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi^2

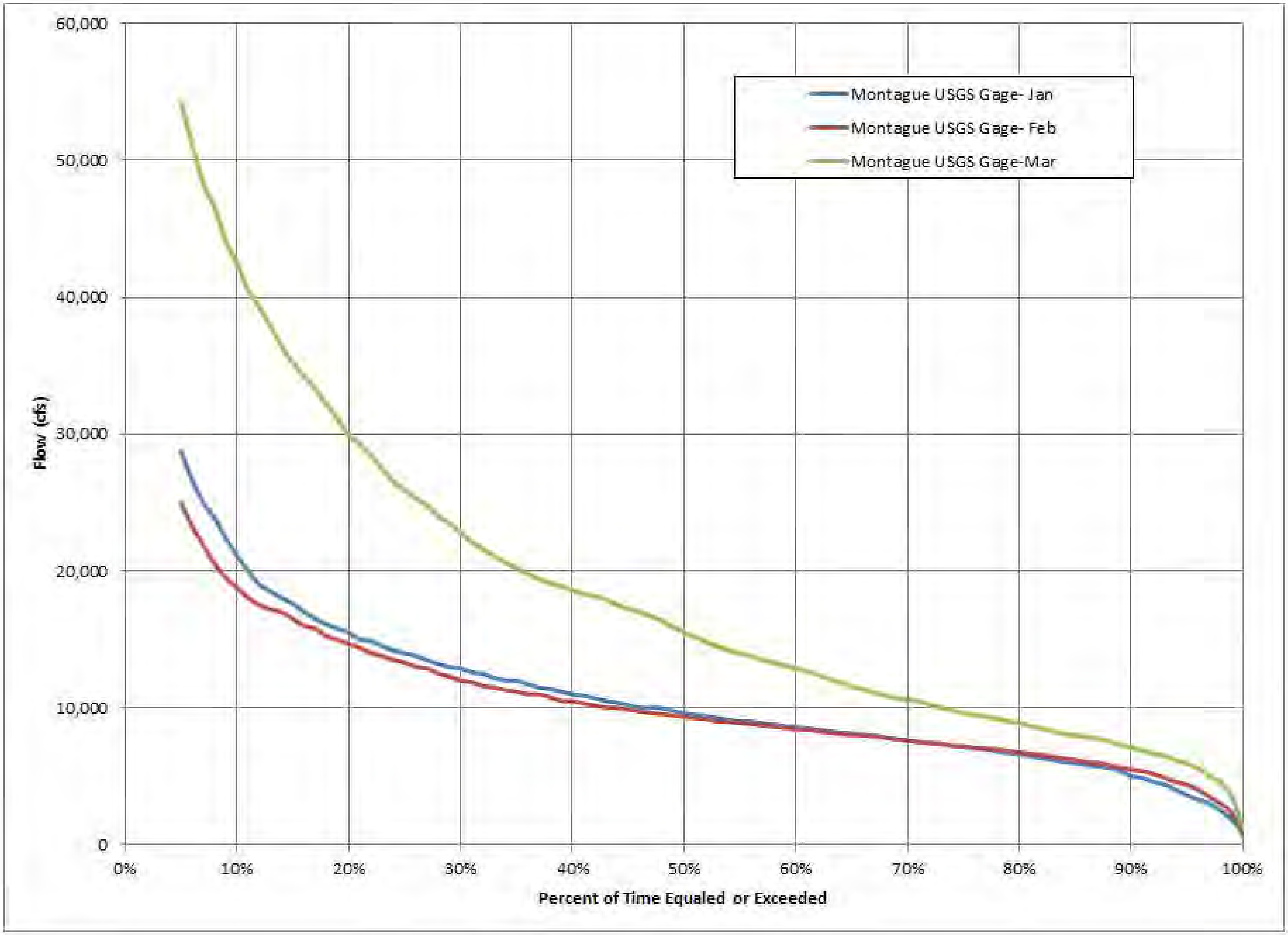

Figure 3.3.2.1.1-13: Connecticut River at Montague, MA, Jan, Feb and Mar Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi^2

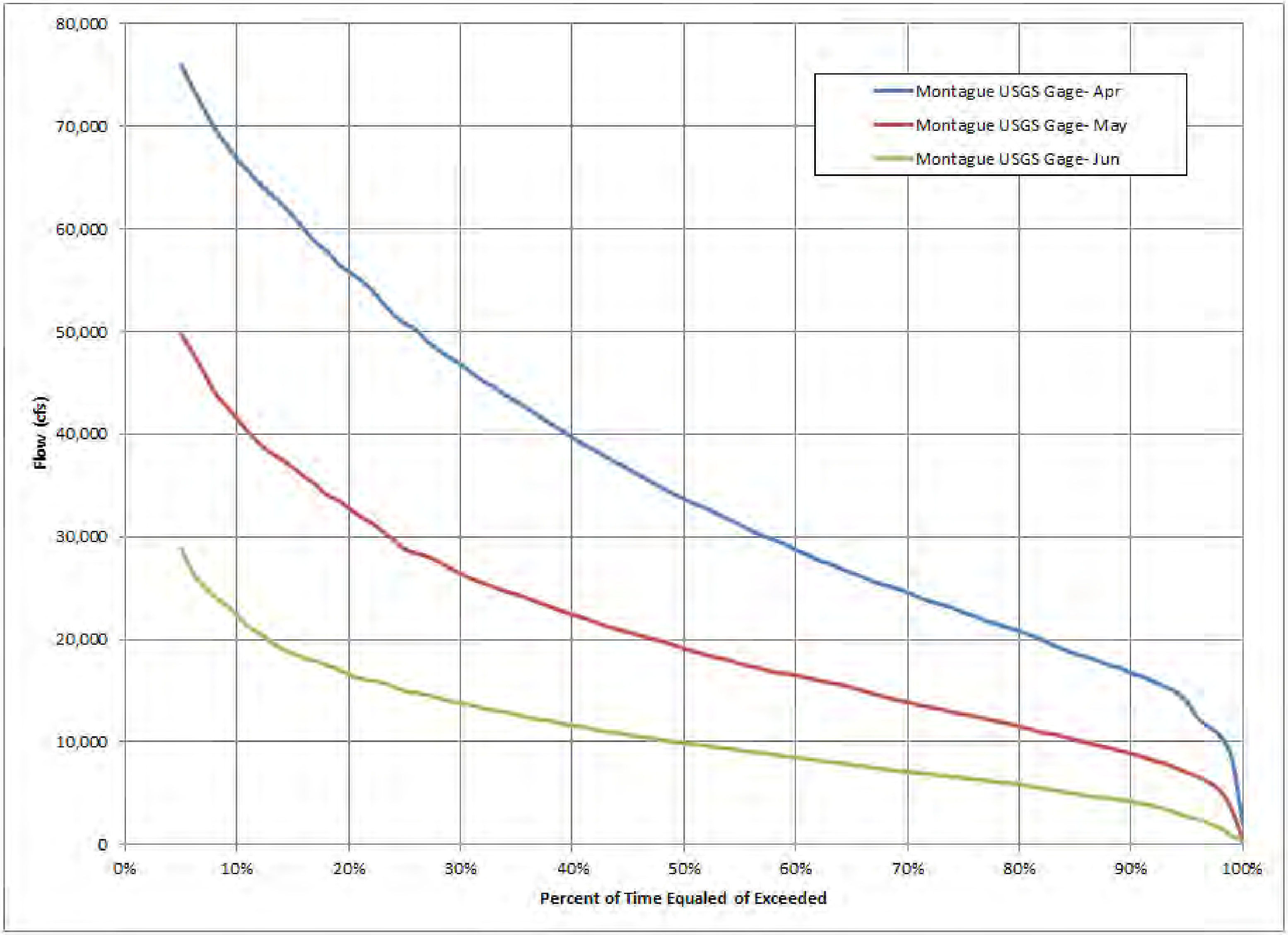

Figure 3.3.2.1.1-14: Connecticut River at Montague, MA, Apr, May and Jun Annual Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi²

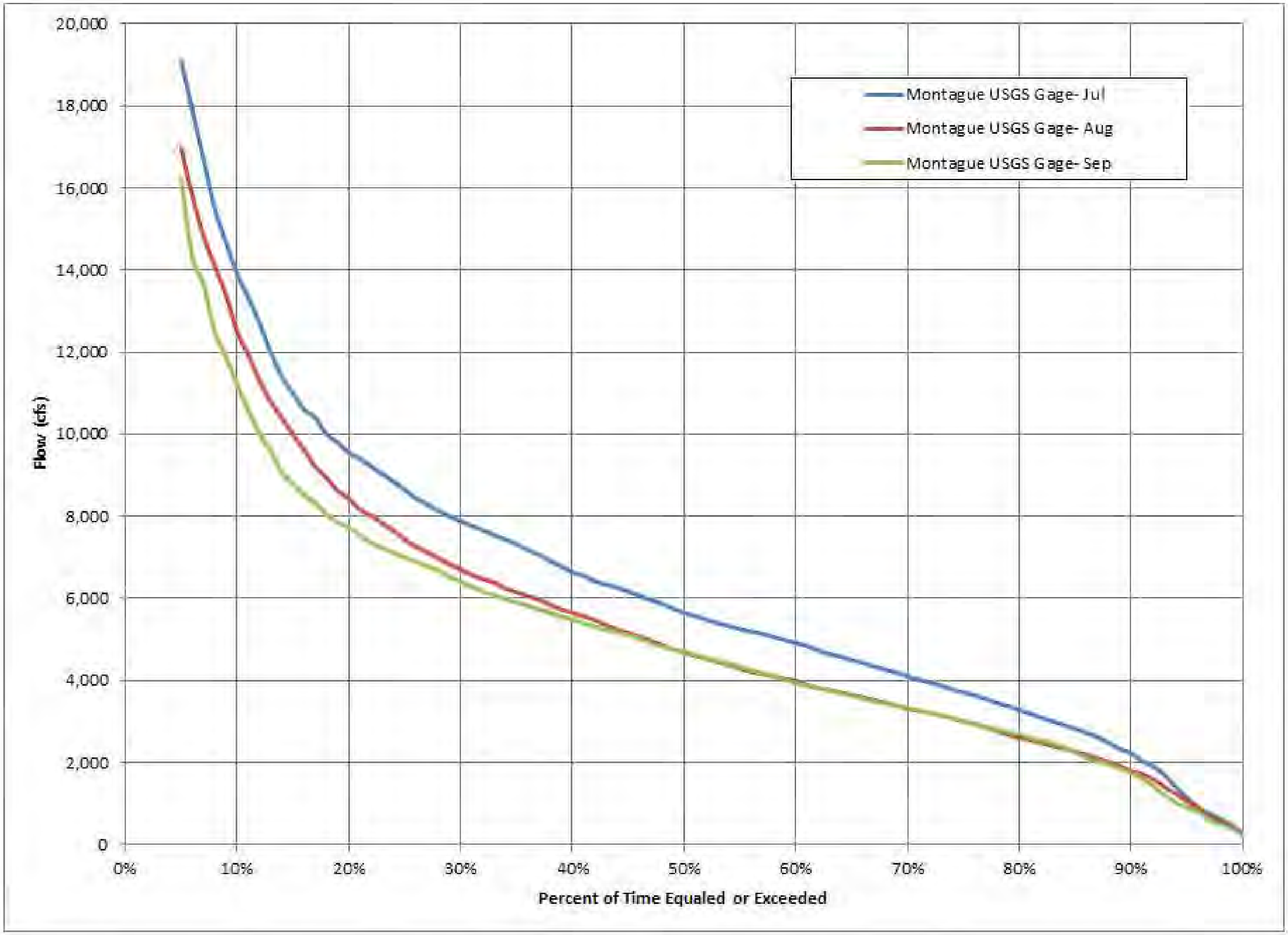

Figure 3.3.2.1.1-15: Connecticut River at Montague, MA, Jul, Aug and Sep Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi^2

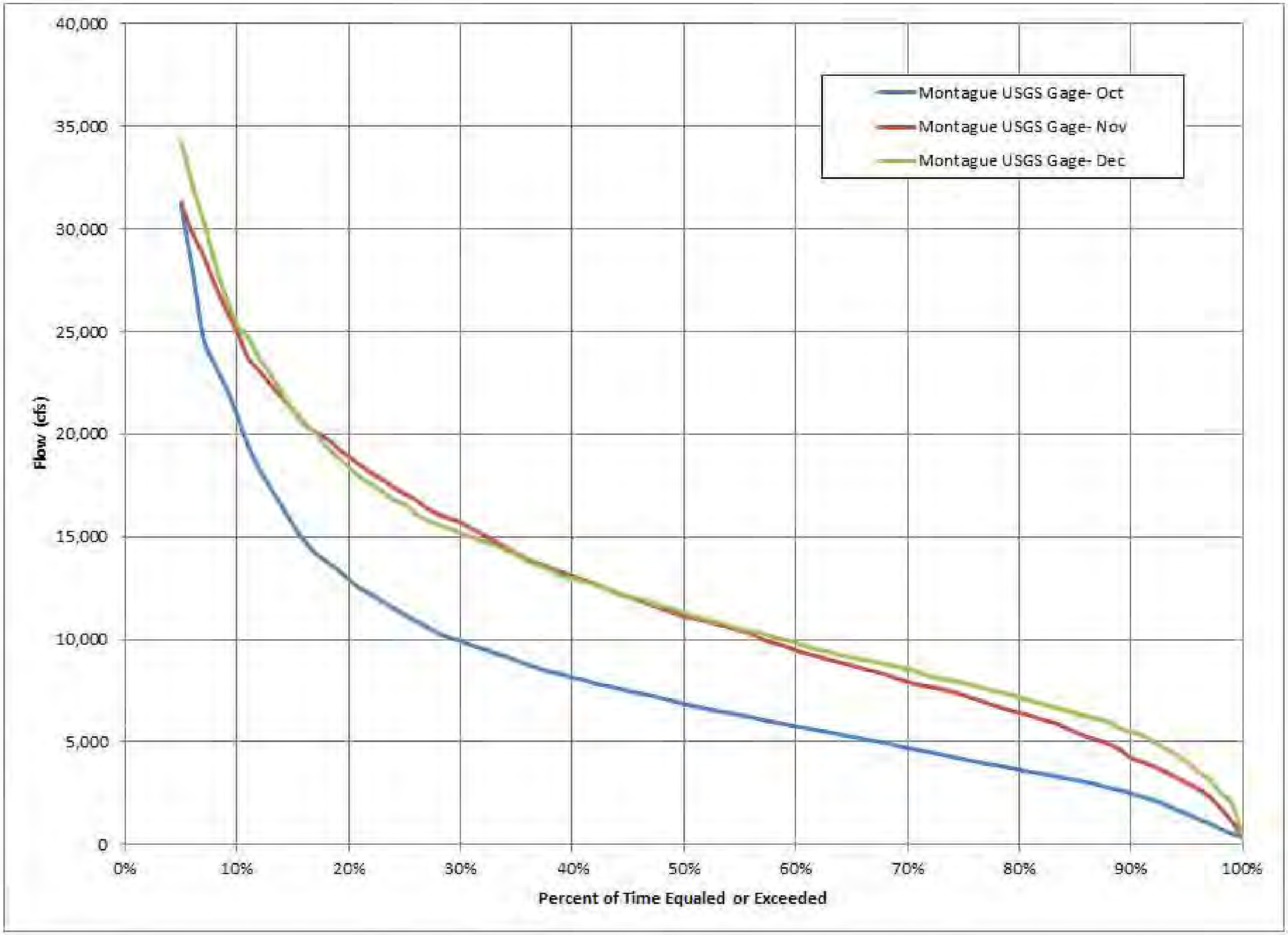

Figure 3.3.2.1.1-16: Connecticut River at Montague, MA, Oct, Nov and Dec Flow Duration Curve, Apr 1940-Dec 2014, Drainage Area= 7,860 mi^2

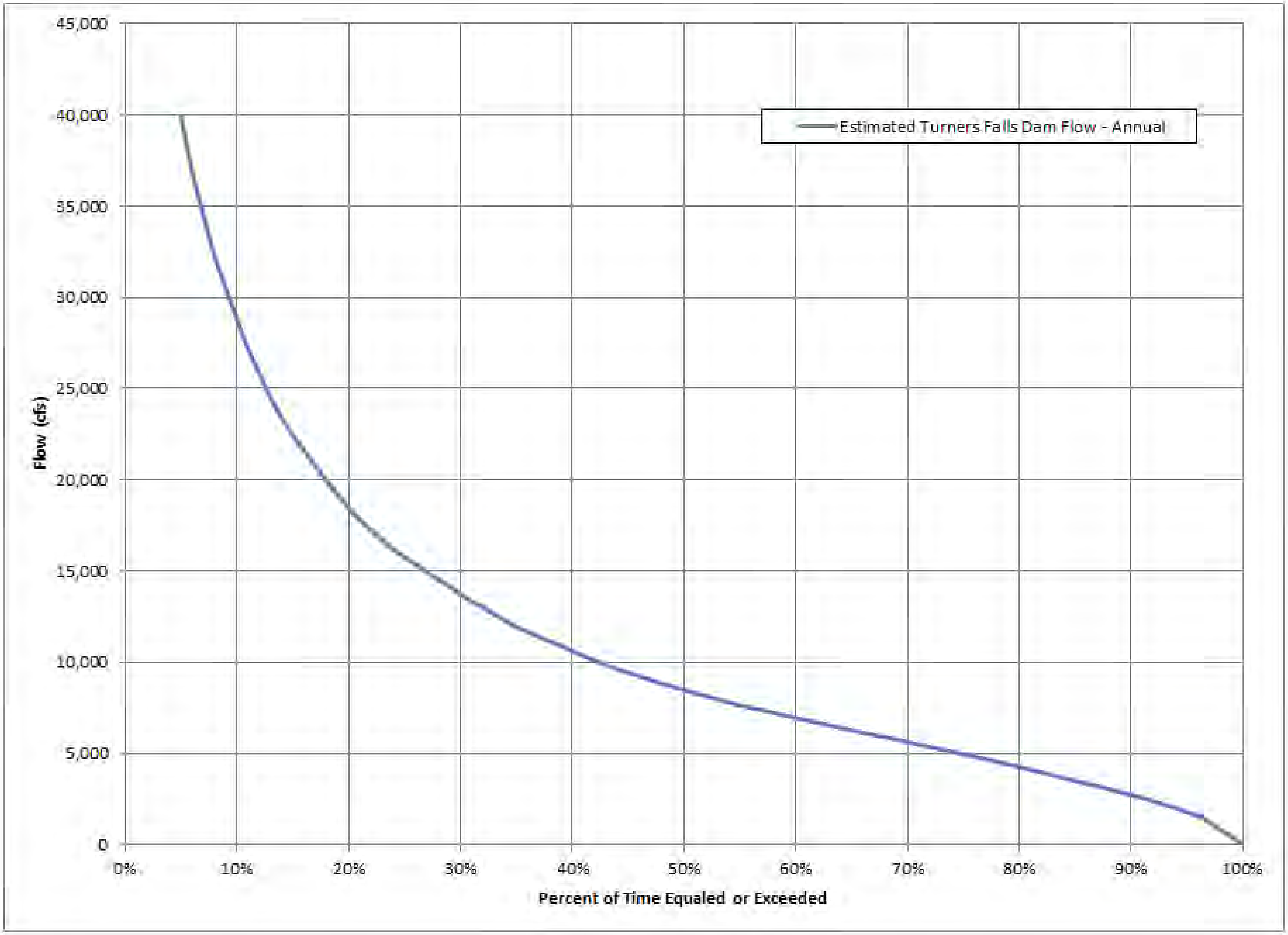

Figure 3.3.2.1.1-17: Connecticut River at Turners Falls Dam, Annual Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

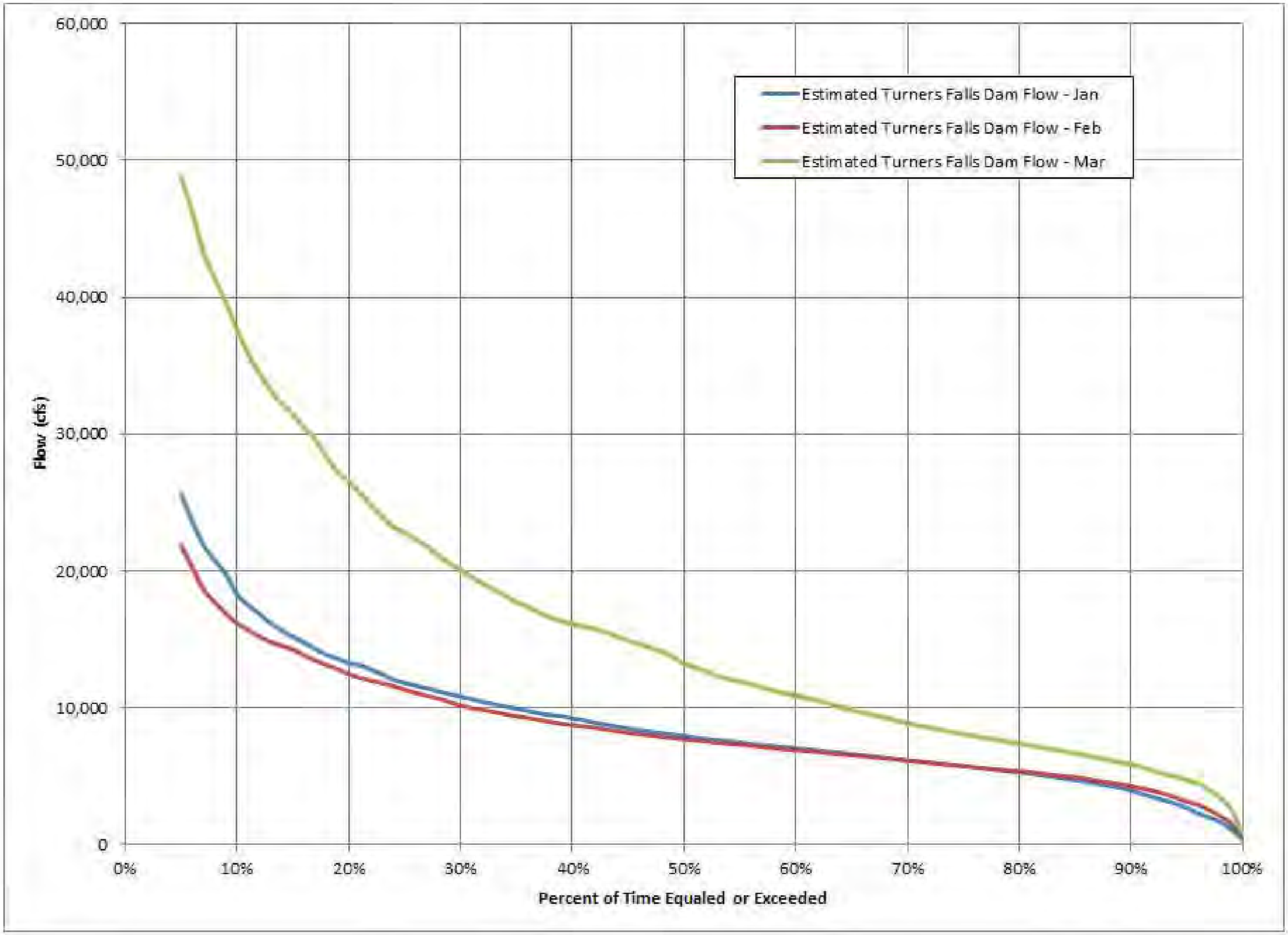

Figure 3.3.2.1.1-18: Connecticut River at Turners Falls Dam, Jan, Feb and Mar Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

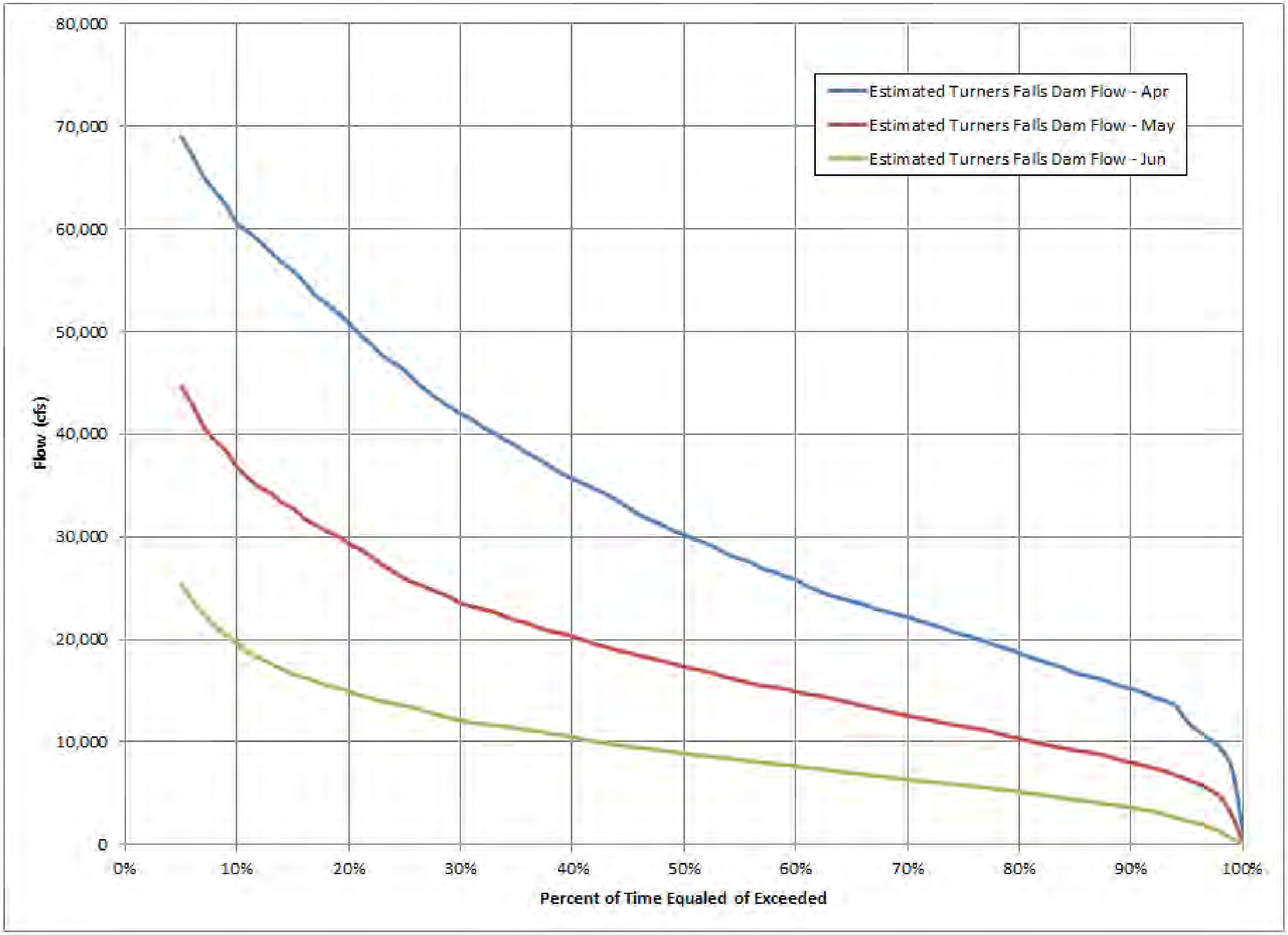

Figure 3.3.2.1.1-19: Connecticut River at Turners Falls Dam, Apr, May and Jun Annual Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

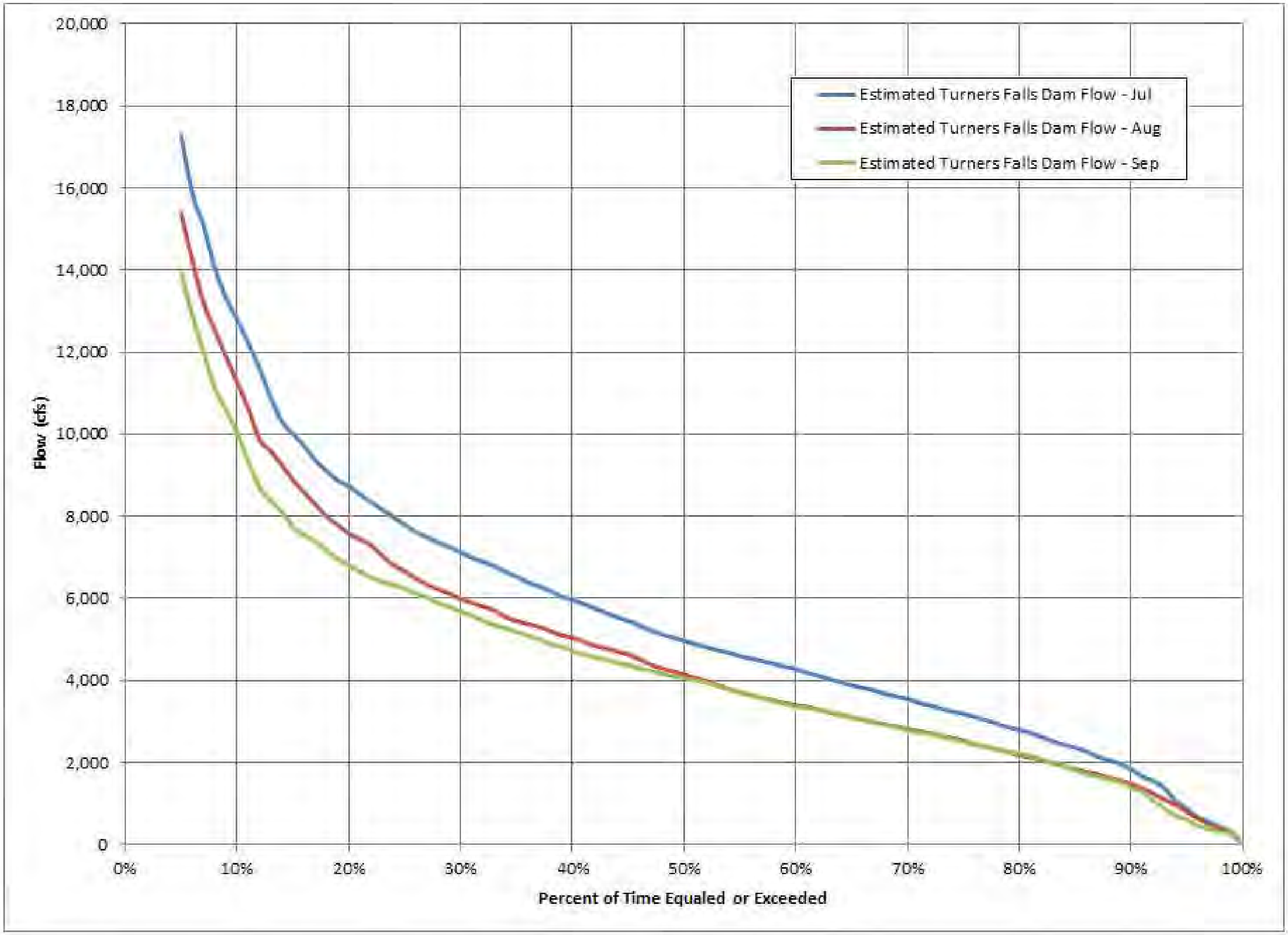

Figure 3.3.2.1.1-20: Connecticut River at Turners Falls Dam, Jul, Aug and Sep Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi^2

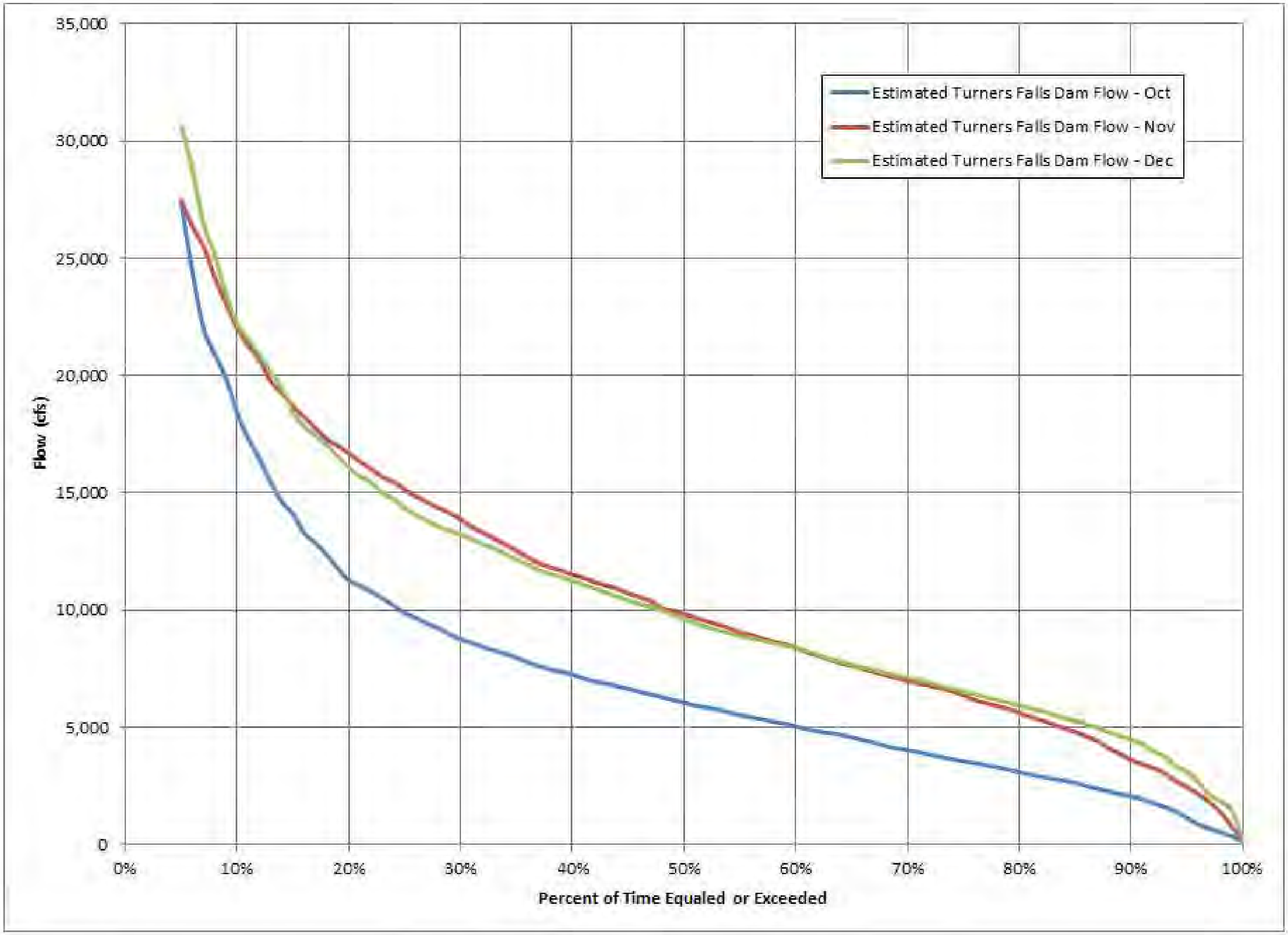

Figure 3.3.2.1.1-21: Connecticut River at Turners Falls Dam, Oct, Nov and Dec Flow Duration Curve, Jan 1941-Dec 2014, Drainage Area= 7,860 mi²

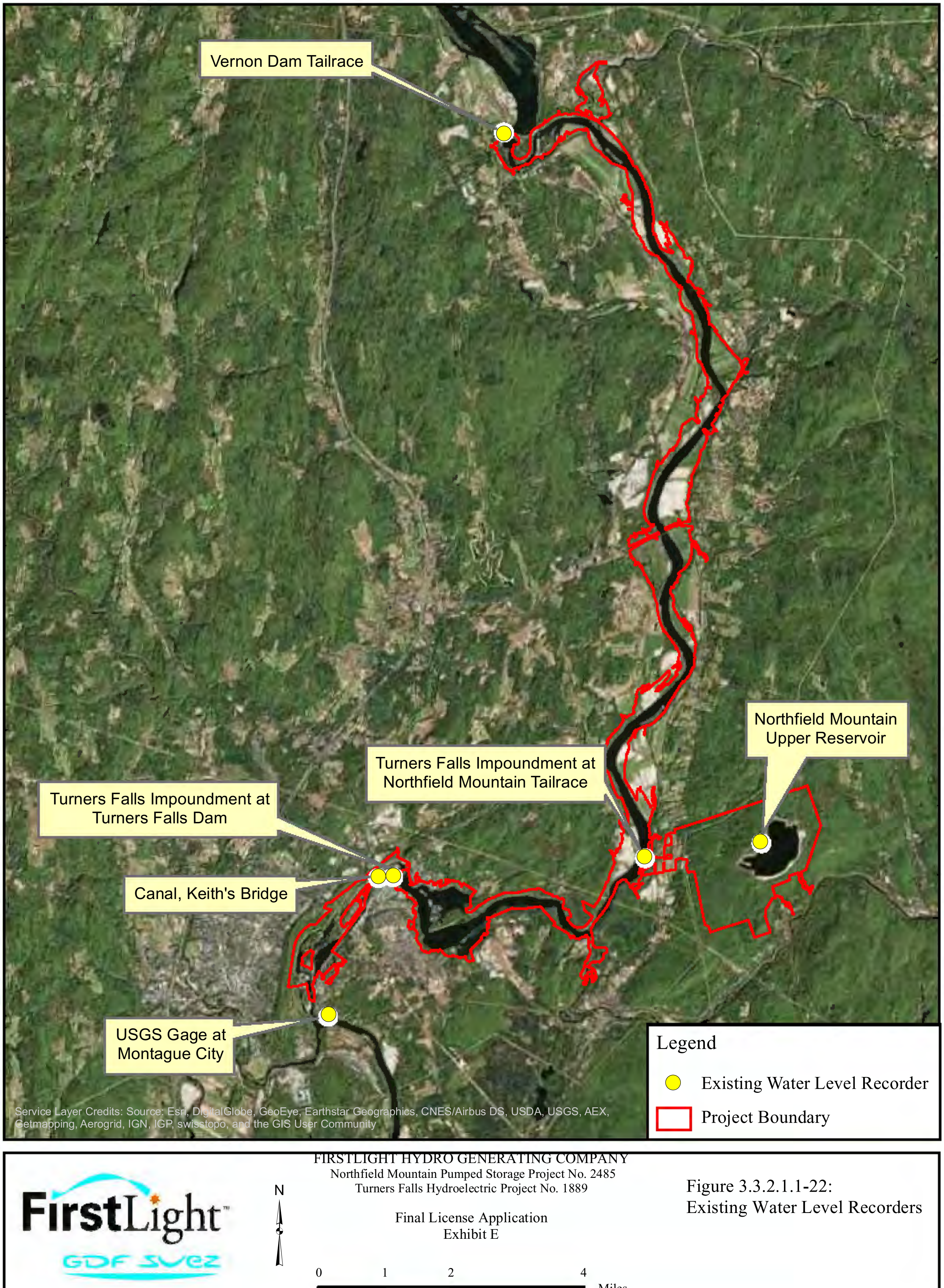

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Figure 3.3.2.1.1-22:
Existing Water Level Recorders

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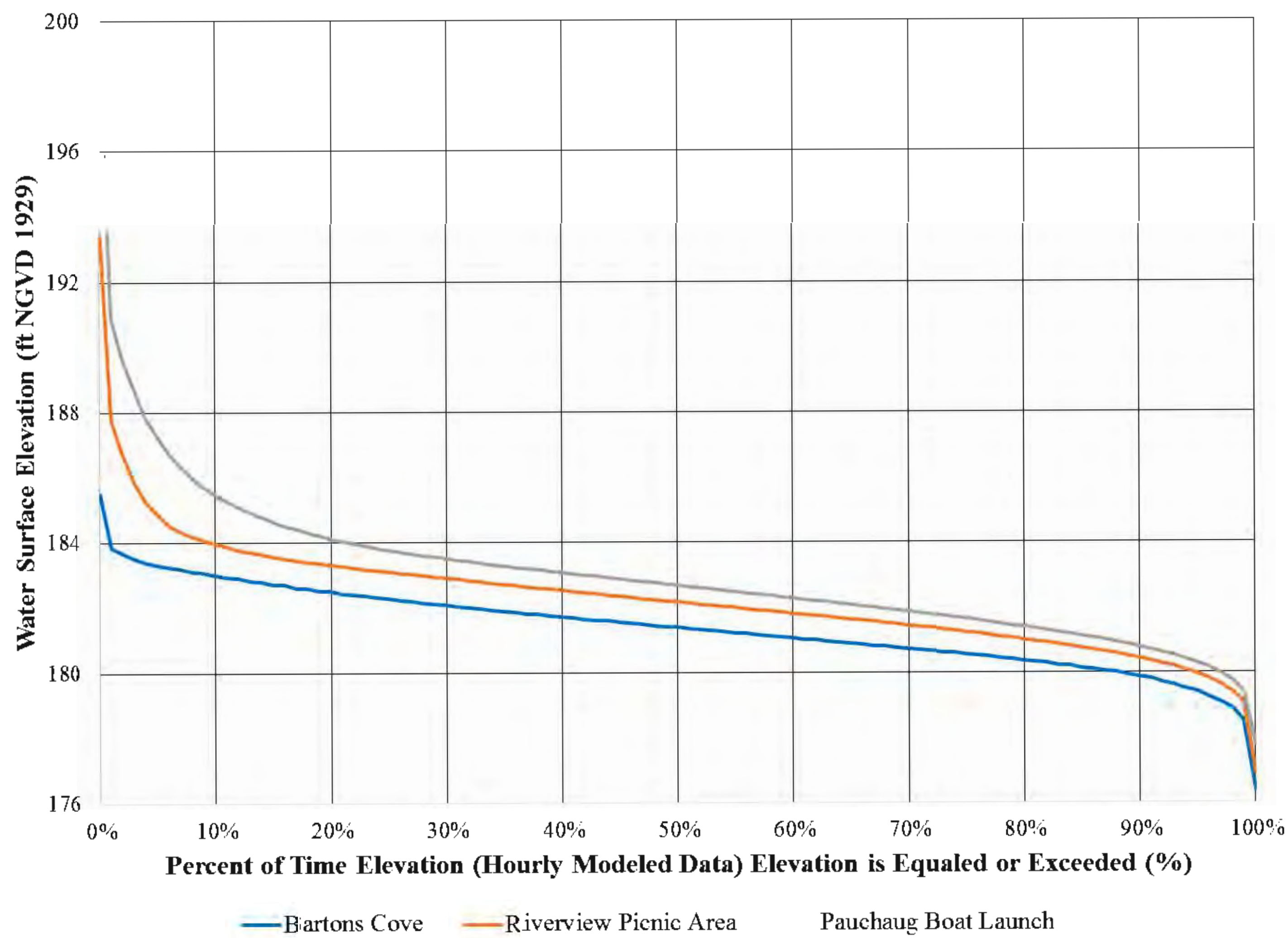


Figure 3.3.2.1.1-23: Water Surface Elevations within the TFI based on Modeled Data for January 1, 2000 to September 30, 2015

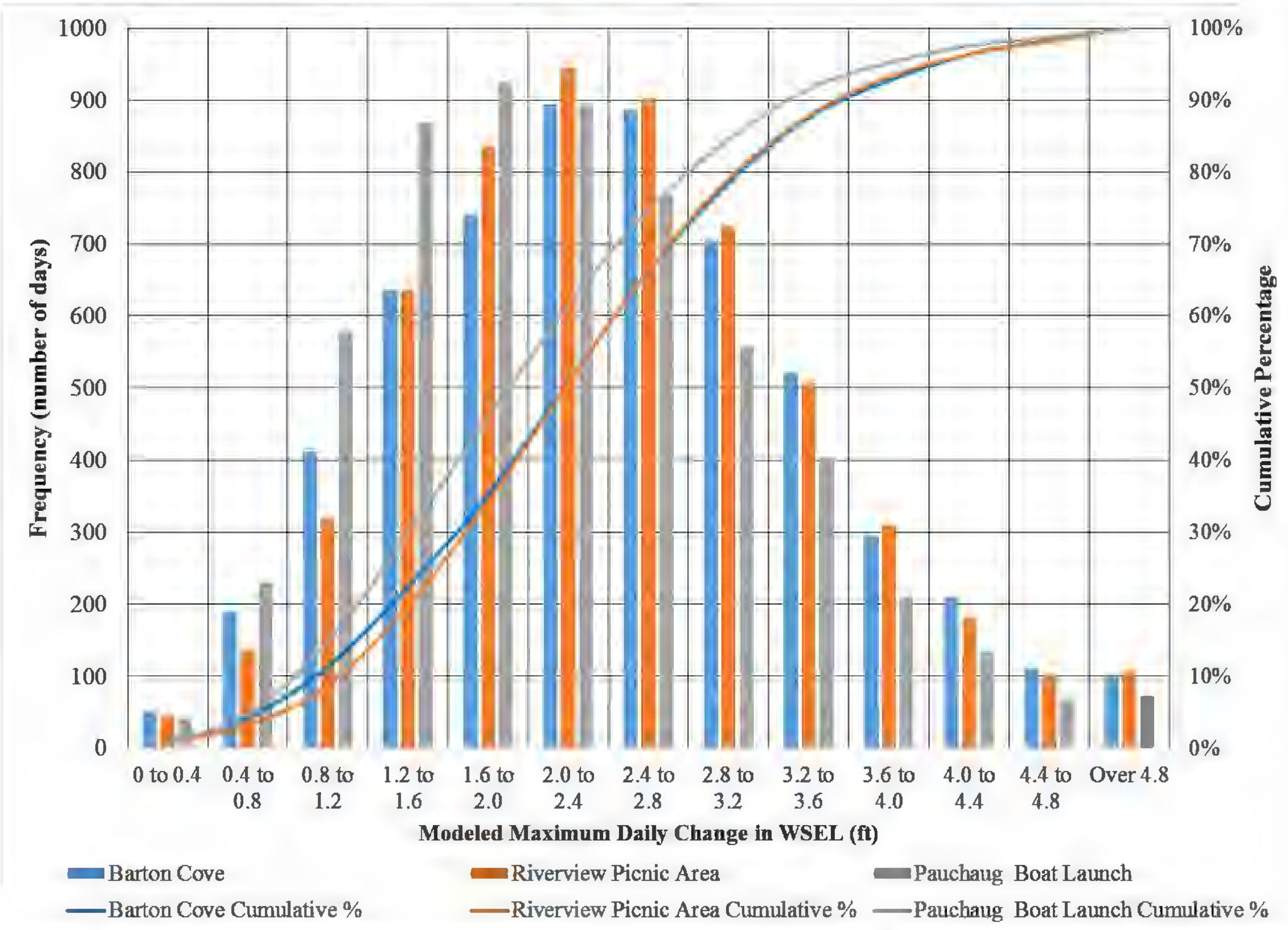


Figure 3.3.2.1.1-24: Daily Change in Water Surface Elevations within the TFI based on Modeled Data for January 1, 2000 to September 30, 2015

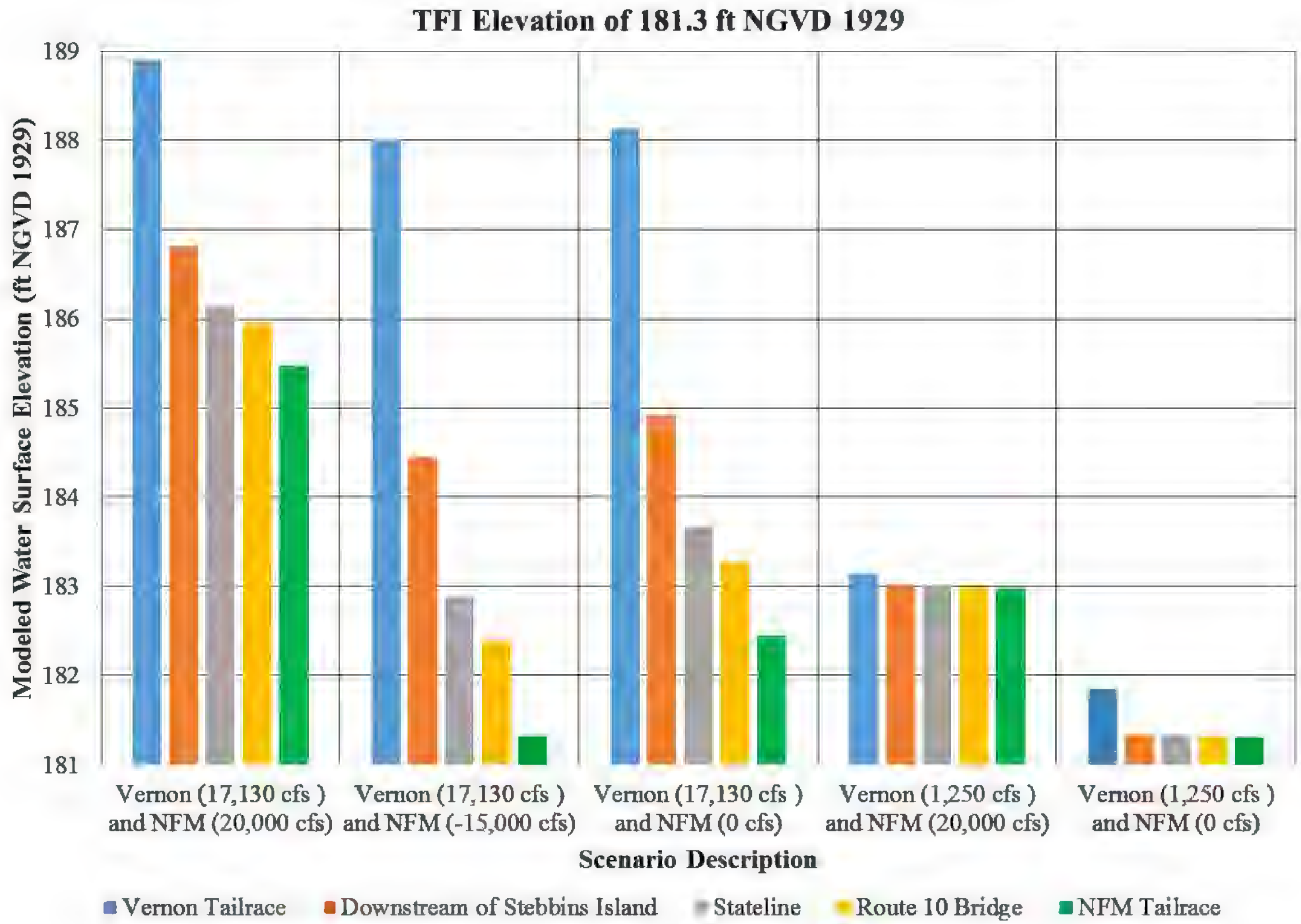


Figure 3.3.2.1.1-25: TFI – WSELs at 5 Locations under Steady-State Conditions and a WSEL at the Turners Falls Dam of 181.3 ft

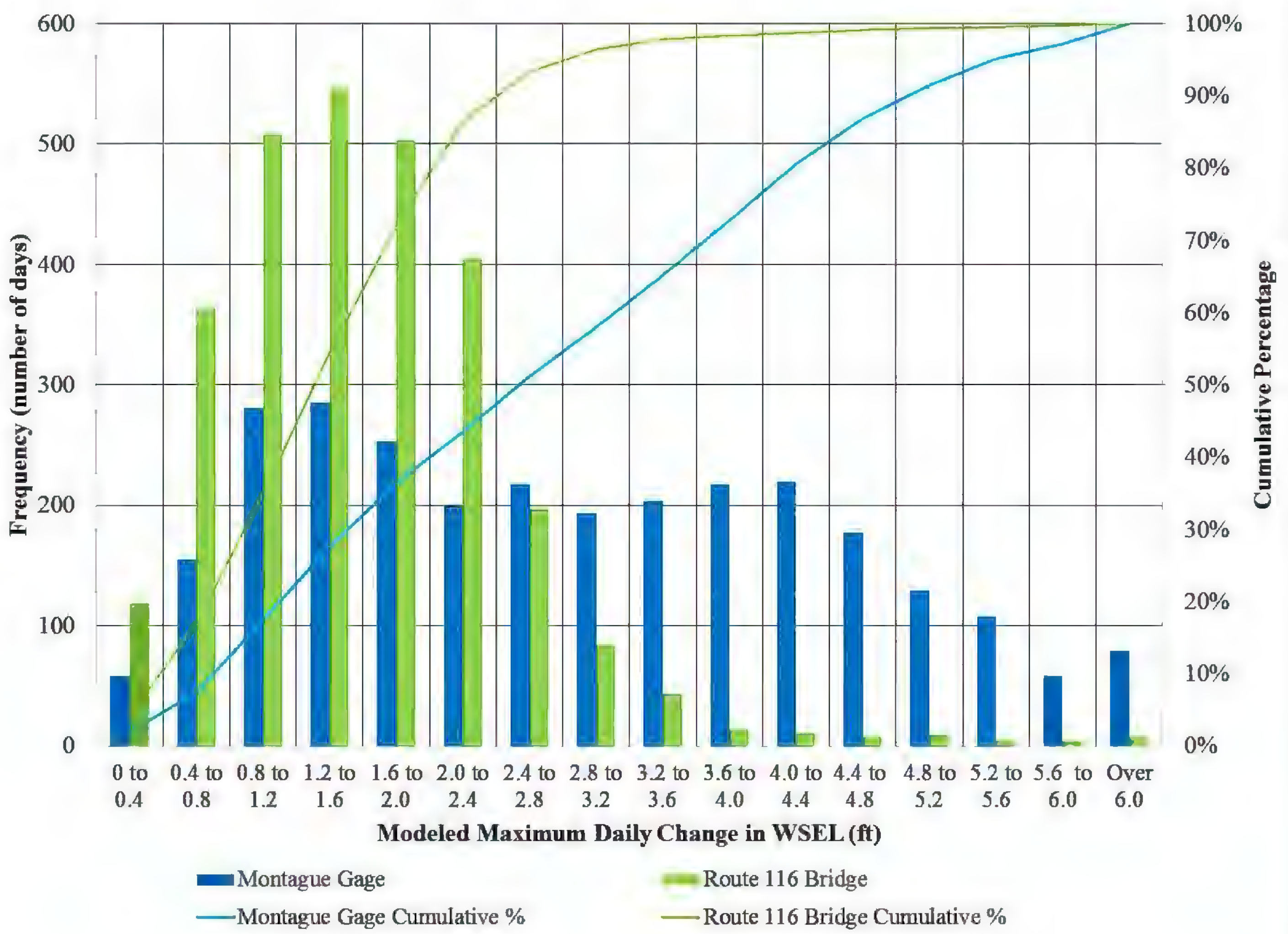


Figure 3.3.2.1.1-26: Daily Change in Water Surface Elevations Downstream of the Turners Falls Project based on Modeled Data for January 1, 2008 to September 30, 2015

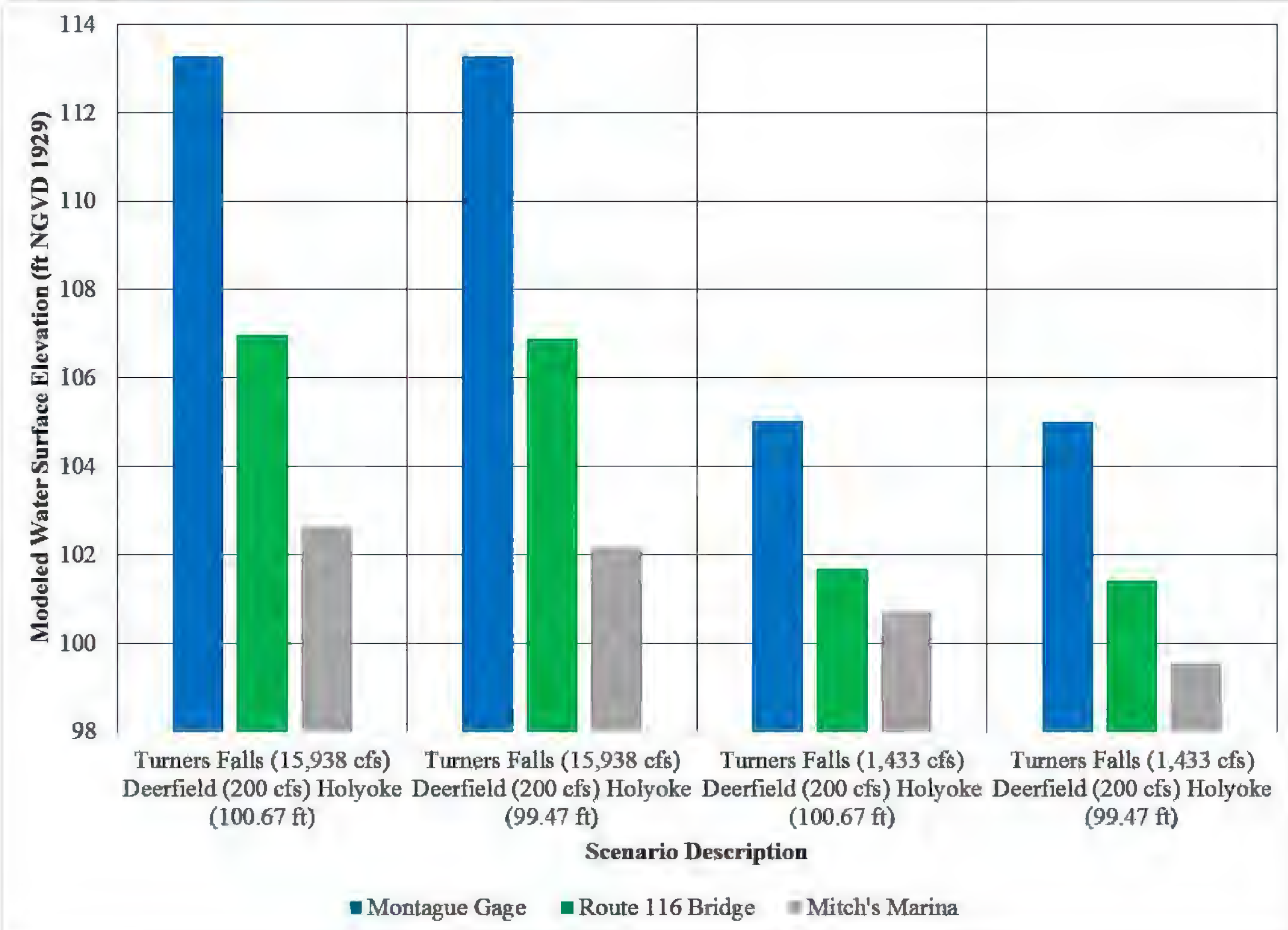
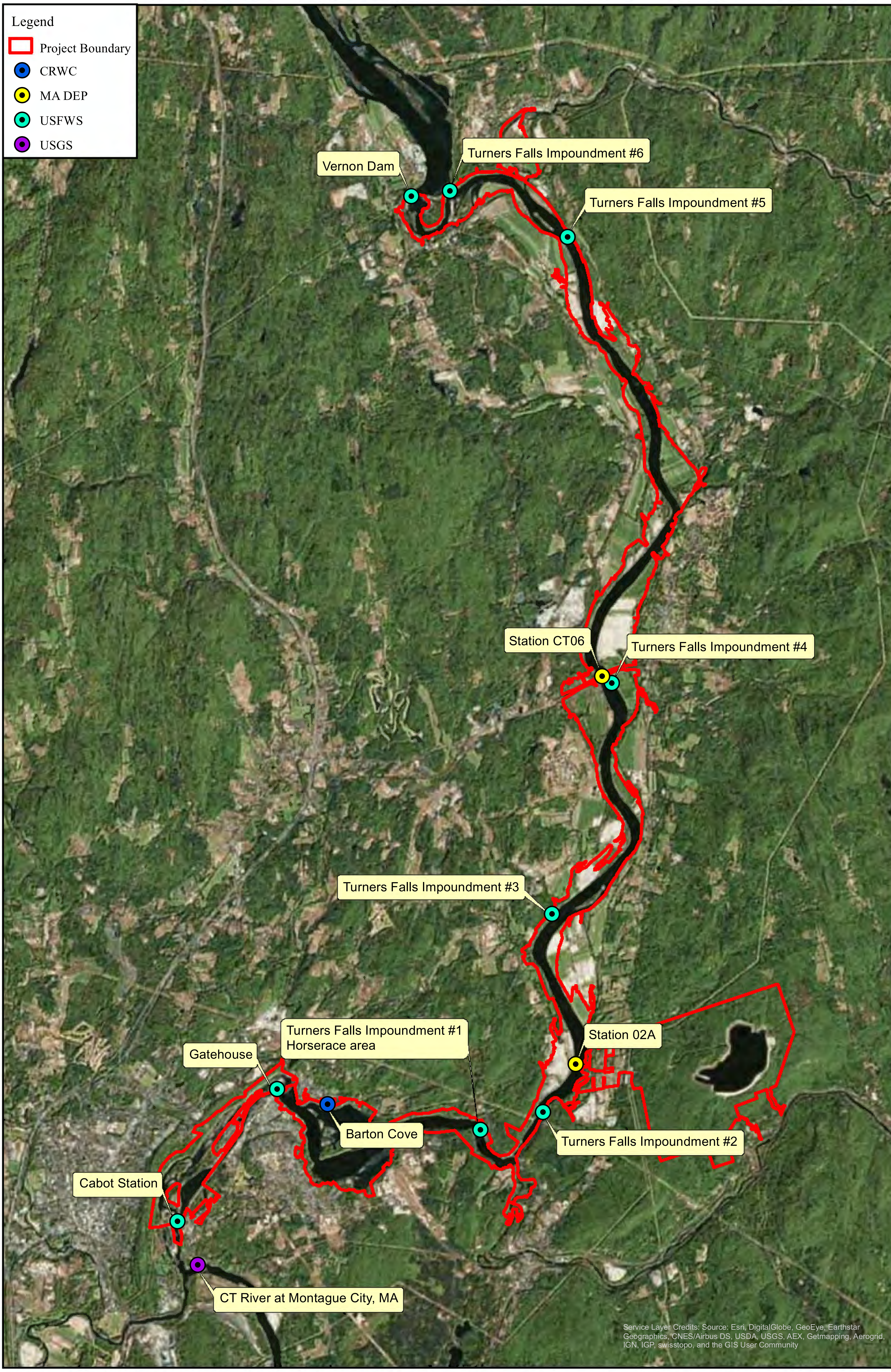


Figure 3.3.2.1.1-27: Downstream of the Turners Falls Project – WSELs at 3 Location under Steady-State Conditions



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0 0.5 1 2 Miles

Figure 3.3.2.1.2-1:
Water Quality Sampling Locations
(Agency and Volunteer Groups)
in the Vicinity of the Project

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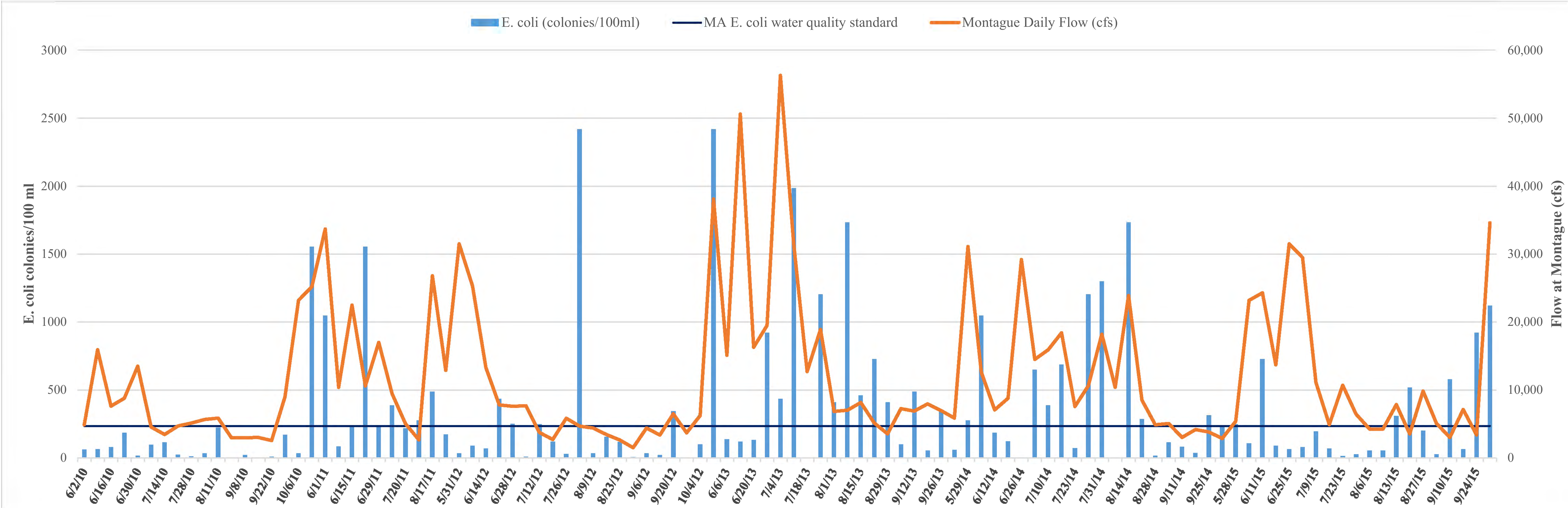
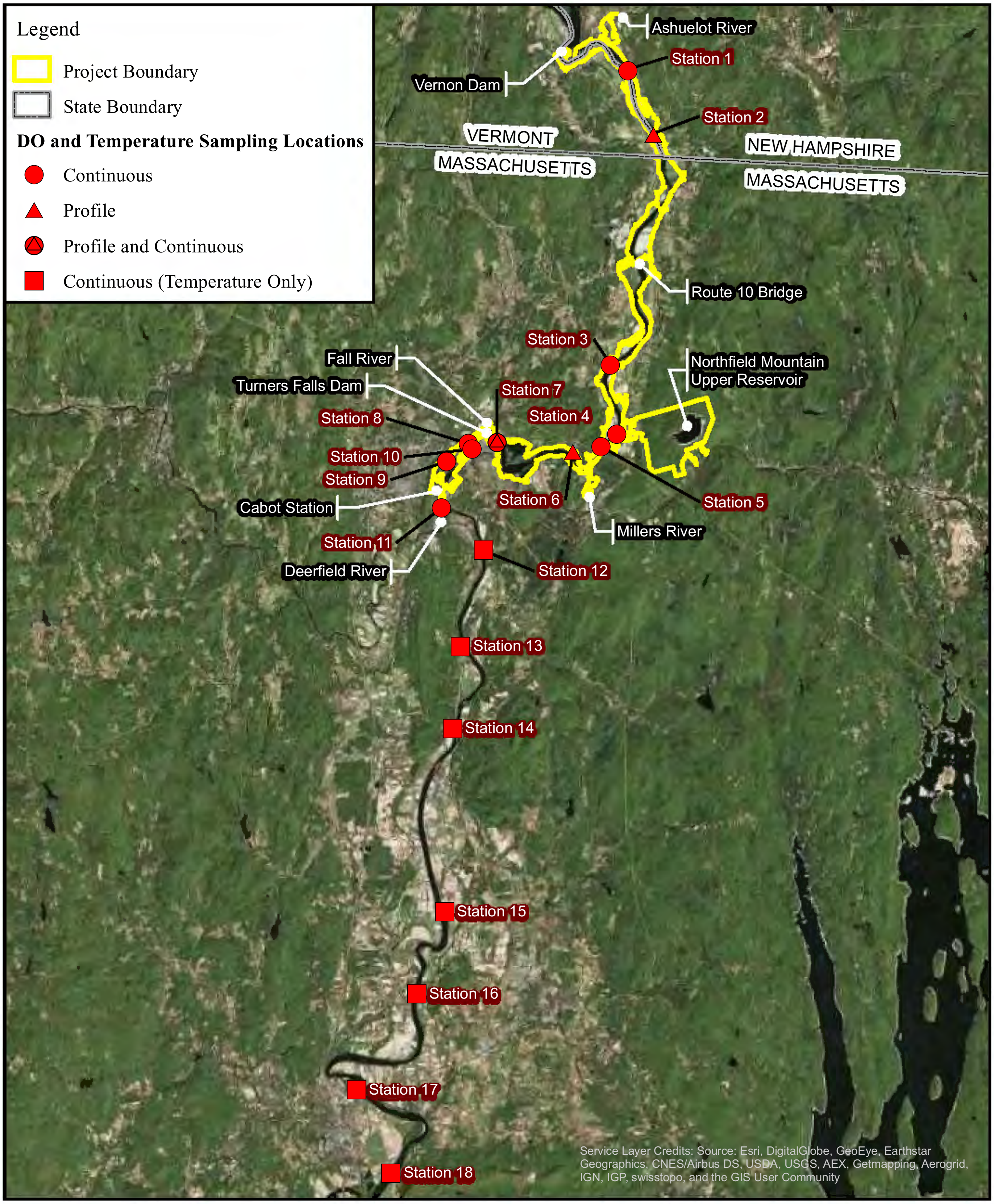
Figure 3.3.2.1.2-2: *E. coli* Colony Bacteria Counts at Barton Cove in Comparison to the Connecticut River Flow at Montague (2010 – 2015)



Sources:
2010-2011 *E. coli* data: http://www.umass.edu/tei/mwwp/ctrivermonitoring.html,
2012 – 2015 *E. coli* data: http://www.connecticutriver.us/site/content/sites-list
USGS gage 01170500 at Montague, MA (http://waterdata.usgs.gov/ma/nwis/current/?type=flow)



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0 2 4 8 Miles

Figure 3.3.2.1.2-3: Overview of DO and Water Temperature Sampling Locations

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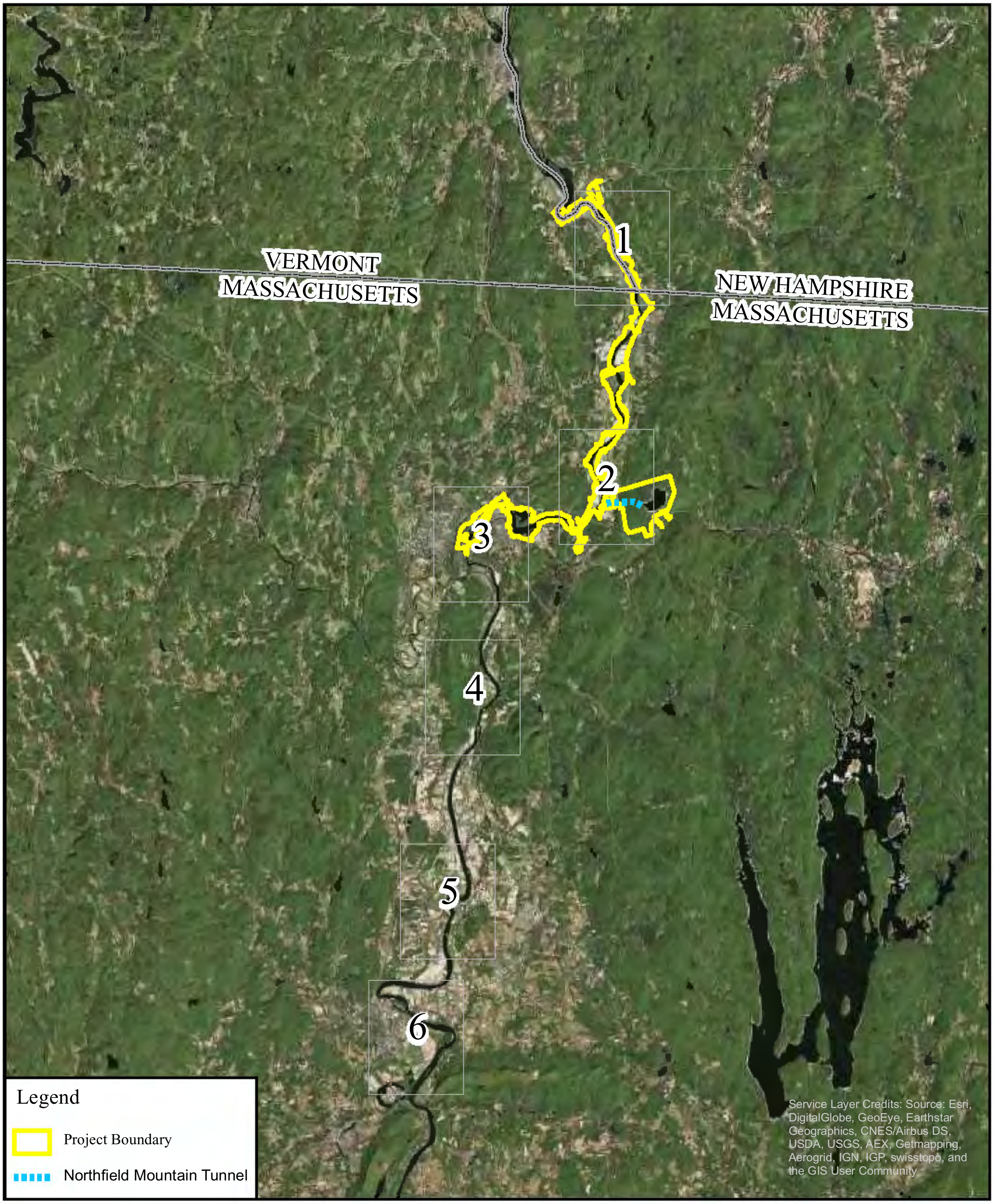

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N

0 2.5 5 10 Miles

Figure 3.3.2.1.2-4:
Water Quality Sampling Locations

Map Index

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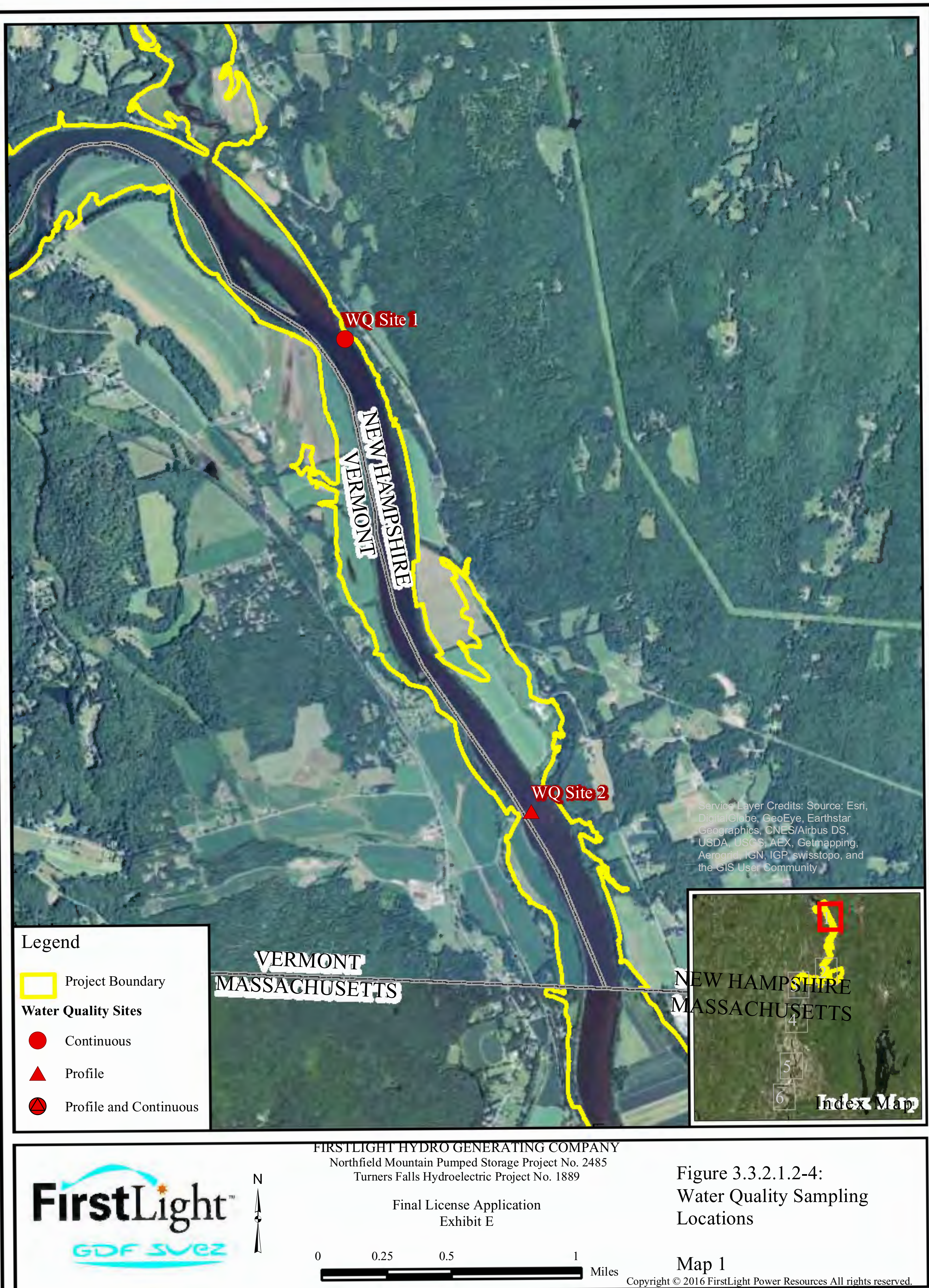

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Figure 3.3.2.1.2-4:
Water Quality Sampling Locations

Map 1

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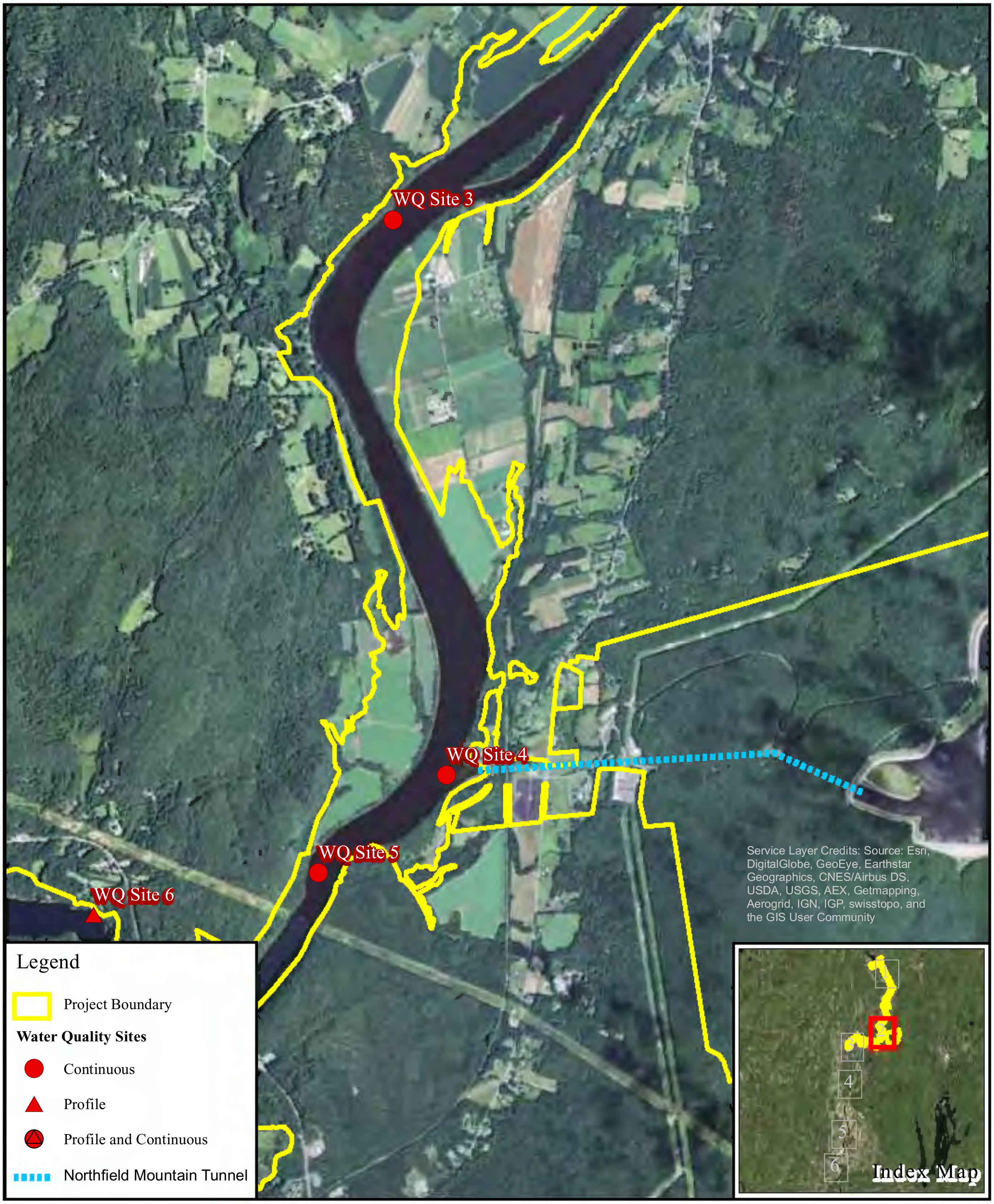

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Figure 3.3.2.1.2-4:
Water Quality Sampling Locations

Map 2

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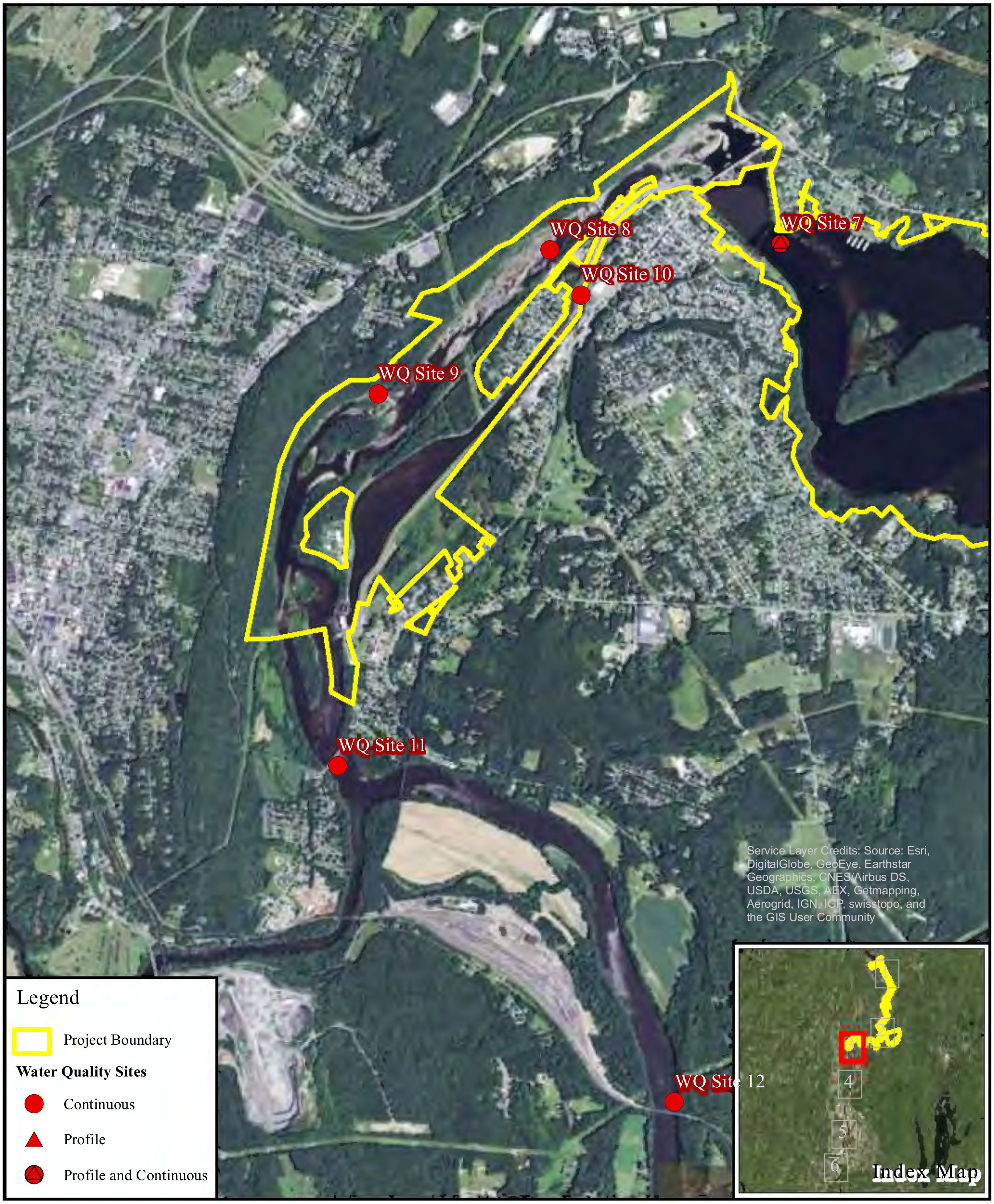

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N

0 0.25 0.5 1 Miles

Figure 3.3.2.1.2-4:
Water Quality Sampling Locations

Map 3

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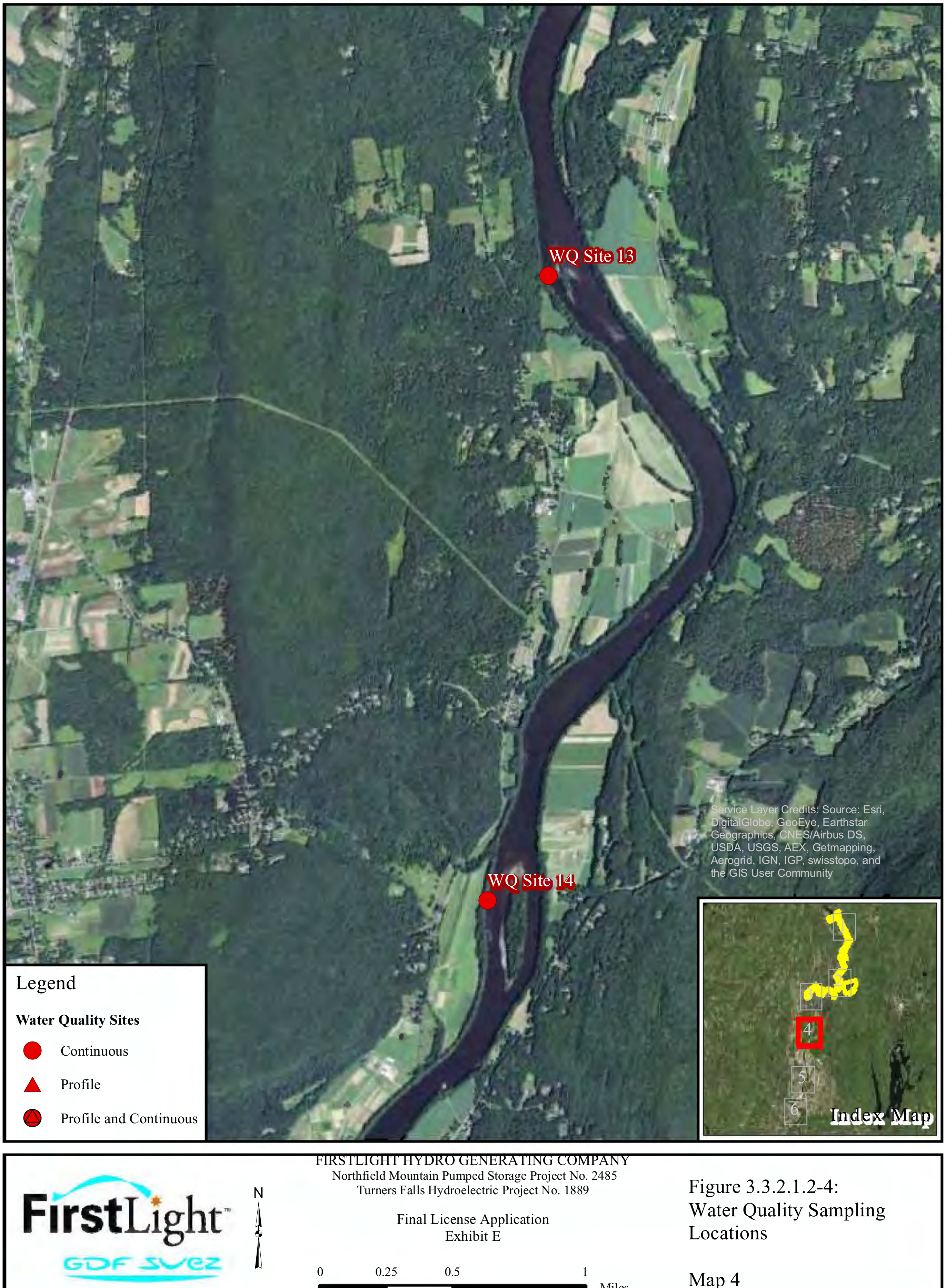

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Figure 3.3.2.1.2-4:
Water Quality Sampling Locations

Map 4

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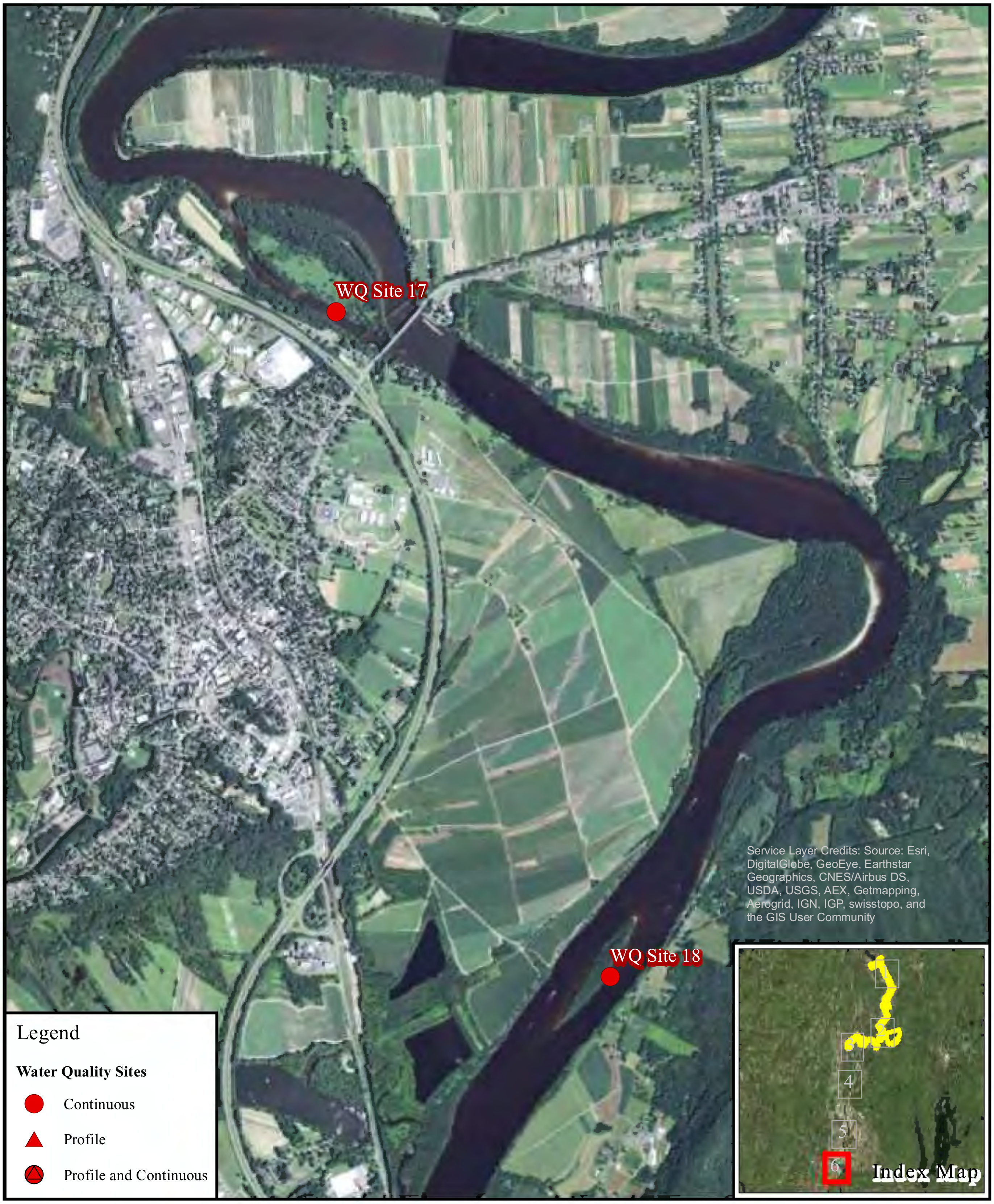
N

0 0.25 0.5 1 Miles

Figure 3.3.2.1.2-4:
Water Quality Sampling Locations

Map 5

Path: W:\gis\maps\Exhibit_E\Figure 3.3.2.1.2-4.mxd



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N

0 0.25 0.5 1 Miles

Figure 3.3.2.1.2-4:
Water Quality Sampling Locations

Map 6

Path: W:\gis\maps\Exhibit_E\Figure 3.3.2.1.2-4.mxd

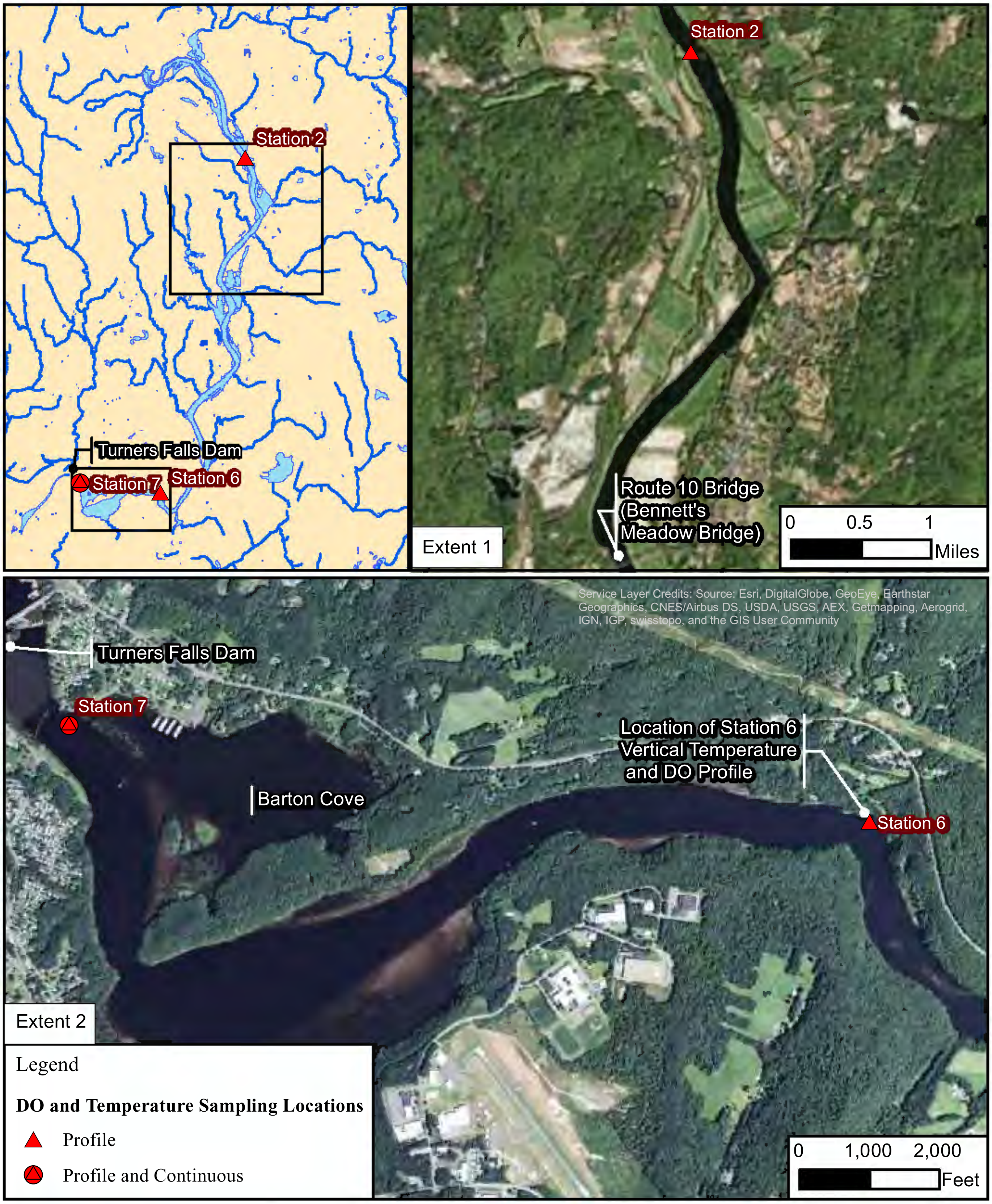

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Figure 3.3.2.1.2-5:
Turners Falls Impoundment
Vertical Profile Locations

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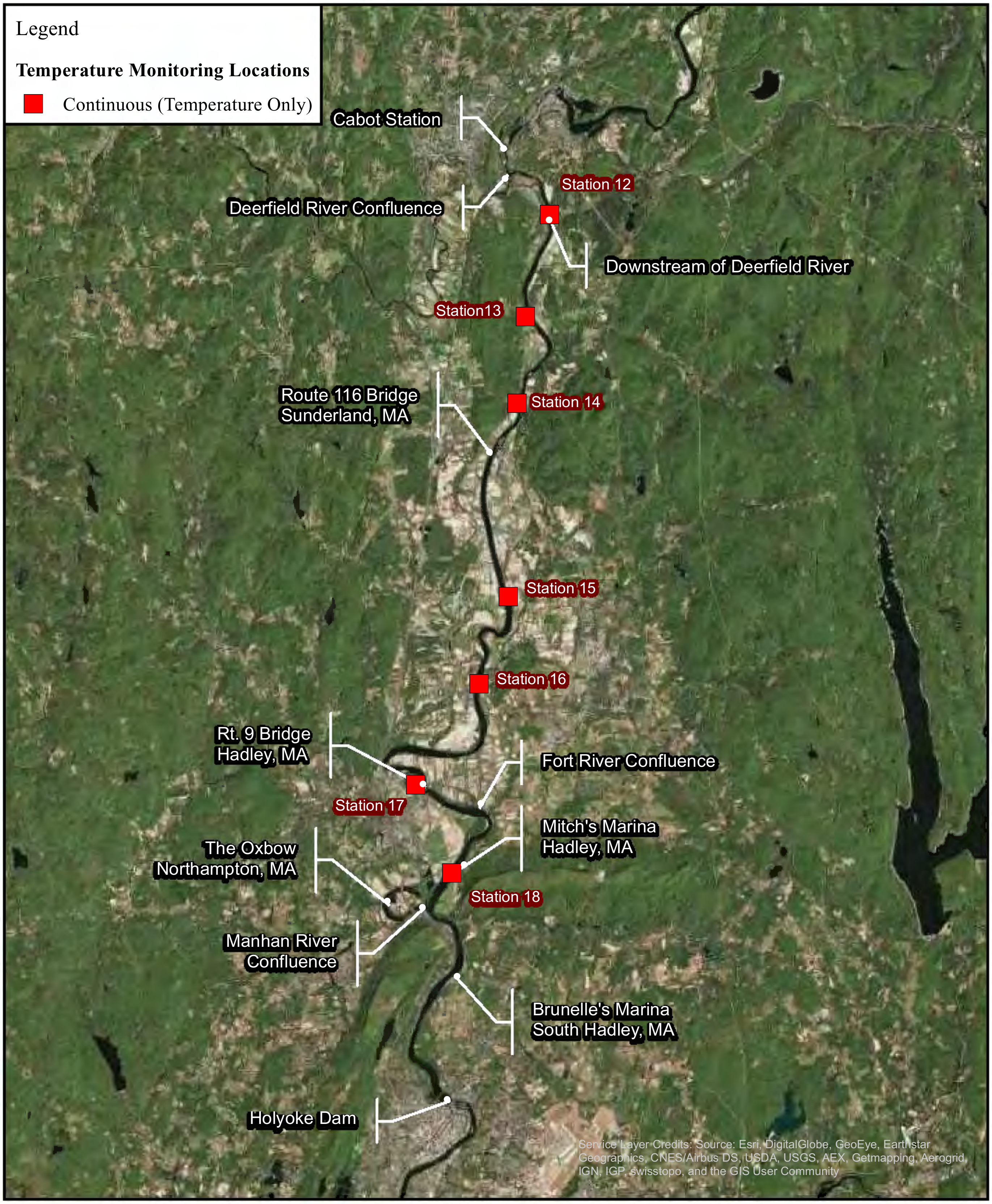
Document Accession #: 20160429-5414 Filed Date: 04/29/2016



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N

0 1.25 2.5 5 Miles

Figure 3.3.2.1.2-6: Continuous Water Temperature Monitoring Locations Cabot Station to Holyoke Dam

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3.3.3 Aquatic Resources

The Turners Falls Development and Northfield Mountain Pumped Storage Development provide aquatic habitat for a variety of plants and animals. Studies conducted in the Project area provide information on the presence and distribution of the aquatic biota and on potential effects of Project operation on these resources.

FERC Relicensing Studies

As noted earlier (Section 1.4.3.1), closure of the Vermont Yankee Nuclear Power Plant (VY), located upstream of the Northfield Project, would change certain environmental baseline conditions during the relicensing study period. Due to the impending closure of VY, the implementation of 18 proposed or requested studies pertaining to aquatic resources were delayed for a year. Of the remaining aquatic reports, seven (7) will be filed with FERC on October 14, 2016 and two (2) will be filed with FERC on March 1, 2017 or as directed by FERC in its process plan and schedule. For those reports completed, the results are summarized in this application. The remaining studies will be summarized in an amended FLA to be filed with FERC on April 30, 2017.

3.3.3.1 Affected Environment

The Connecticut River in the vicinity of the Northfield Project area is generally narrow, with areas of floodplain and terraces of silt, sand and gravel. The basin is steep and makes for quick drainage to the river during rain events, snow melts and storms. The Northfield Project area from upstream to downstream consist of aquatic habitats associated with the TFI, bypass reach, and downstream riverine area. In addition, there is a 2.1-mile long power canal that is an important part of the passage route for migratory fish.

Turners Falls Impoundment

The TFI extends approximately 20 miles upstream from the Turners Falls Dam to the Vernon Dam (FERC No. 1904) tailrace and includes two major tributaries (Ashuelot and Miller Rivers) as well as several smaller tributaries (Figure 3.3.3.1-1). Both lentic and lotic conditions are present in the TFI. Study No. 3.3.14 *Aquatic Habitat Mapping of the Turners Falls Impoundment* was conducted to determine the distribution and abundance of aquatic habitat within the TFI. The distribution and abundance of aquatic habitats, including biological and geomorphological characteristics, were documented during field surveys in 2014 and 2015. Survey results were used to develop maps depicting the distribution of mesohabitat. Habitat maps of the TFI, bypass reach and below Cabot Station are shown in Figure 3.3.3.1-2.

The upstream reach of the TFI, extending approximately 15 miles from Vernon Dam tailrace to the Northfield Mountain Pumped Storage Development tailwater, is located within a broad flood plain and is relatively uniform and generally shallow, with gentle bends. A river channel exists with rock shorelines and lotic conditions. The substrate in this reach is variable ranging from sand to boulders.

There are a few narrow islands comprised of alluvial materials such as gravel, cobble and fines. Scour holes and shoals generally are confined to locations downstream of features such as bridge piers and there are few deep pools. Scour holes provide the most extensive cover; object cover in the littoral zone is sparse, and limited to isolated patches of submerged aquatic vegetation (SAV) and clusters of woody debris.

The downstream reach of the TFI extends from the Northfield Mountain Pumped Storage Development tailrace approximately five (5) miles to the Turners Falls Dam and is dominated by bedrock, which controls much of the stream geometry and substrate features. The geometry of the lower TFI is complex. It is defined by both bedrock and depositional features, and includes a complex of embayment, points, coves, islands, and a wide range of substrates, and features shallow lacustrine littoral habitat with a deeply incised thalweg, in contrast to the riverine habitat found further upstream in the TFI. The lower section of the TFI has several large areas off the channel which are shallow, with SAV and muck bottom habitats characteristic of lentic conditions.

Study No. 3.3.13 (*Impacts of the Turners falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat*) revealed that the littoral zone in the TFI is composed of varied substrates. In some locations the littoral zone is absent due to vertical bedrock cliffs, while in others there are broad horizontal shoals composed of gravel, sand or other fines, particularly in embayed sections (Figure 3.3.3.1-2). The thalweg is deeply incised. Most banks are wooded and composed of predominantly deciduous trees. Shoreline development ranges from residential (seasonal and year round homes) to urban. The least developed shorelines are those furthest upstream from Gill and Turners Falls.

Littoral zone substrates composed of fines (e.g., sand/silt, clay) and cobble collectively accounted for about 50% of all littoral substrate (Table 3.3.3.1-1). Fines comprised 29% of the study area, followed by cobble (21%), then bedrock (17%) and gravel (16%). Littoral areas where cobble substrates were combined with either fines (6%) or boulder (1 %) also occurred. However, these patches were scattered and small. Littoral areas with fines were widely distributed throughout the study area; however, cobble and gravel were most common above the French King Gorge area. Bedrock and wetland areas were most abundant in the reach from French King Gorge downstream. Riprap accounted for approximately 7% of littoral substrates and occurred in patches throughout the study area where either erosion abatement or other infrastructure such as bridges or developed shorefronts were located.

Bypass

The 2.1-mile long bypass reach runs from the base of Turners Falls Dam to the tailrace of Cabot Station. This reach has a low gradient (approximately 0.3%); contains mostly bedrock, boulder, cobble, and gravel substrates; and is primarily comprised of pool mesohabitat, followed by riffle and backwater types. It has minimum flow requirements during certain times of the year as noted in Section 2.1.5. Minimum bypass flows are provided beginning May 1 and continuing until water temperatures fall below 7°C (typically November) to enhance conditions for upstream migratory species and Shortnose Sturgeon. The distribution and abundance of aquatic habitats, including biological and geomorphological characteristics were documented during field surveys of 2012 and were utilized to develop maps depicting the distribution of mesohabitat (Figures 3.3.3.1-3, Maps 1 & 2).

Downstream Riverine Habitat

Habitat downstream of Cabot Station was mapped in 2012. This low-gradient reach forms a wide flood plain with alluvial-dominated substrates, with a meandering channel in many places. Run habitat comprises over 75% of the riverine reach by length, with pool comprising the next most abundant mesohabitat type (13%). Riffle habitat is extremely uncommon and is most concentrated in the stream reach immediately downstream from the Cabot Station discharge. The Deerfield River enters the Connecticut River just downstream of Cabot Station (Figure 3.3.3.1-1). The distribution and abundance of aquatic habitats, including biological and geomorphological characteristics were documented during field surveys of 2012 and were utilized to develop maps depicting the distribution of mesohabitat (Figure 3.3.3.1-3, Maps 3 through 22).

3.3.3.1.1 Aquatic Vegetation

During the summer of 2014 submerged aquatic vegetation (SAV) beds within the TFI were mapped and dominant species were identified. Dominant species identified during the survey are shown in Table 3.3.3.1.1-1. Patches of SAV and wetlands, emergent aquatic vegetation (EAV) such as lily pads or cattail patches occur in areas with finer substrates. Areas with bedrock substrates have limited or no riparian vegetation. Beds of SAV vegetation, outside of the areas near Barton Cove, generally occur as narrow bands located parallel to the TFI shoreline. In some cases shallow shoals within the TFI, often associated with islands, support large beds of SAV. Native species include wild celery, various pondweeds, musk grasses, and coon tail. Wild celery occurs throughout the majority of the identified SAV beds.

Several exotic and invasive aquatic species are currently found within the Project, including variable leaf milfoil, Eurasian milfoil, curly-leaf pondweed, fanwort, and water chestnut. The majority of the exotic species occur immediately upstream of the Turners Falls Dam with fewer occurrences upstream of the French King Bridge. In general, exotic species are not as widespread and occur at lower densities upstream of the French King Bridge.

3.3.3.1.2 Fisheries

The Connecticut River in the Turners Falls Development and Northfield Mountain Pumped Storage Development vicinity supports a variety of cool and warm water resident fish as well as migratory species. The federally endangered Shortnose Sturgeon is also present in the reach between the Turners Falls and Holyoke Dams. These fish species are discussed in the following sections.

Resident Fish Species

The Connecticut River in the vicinity of the Northfield Project supports a variety of warm water resident fish. Dominant family groups include Centrarchidae (sunfishes), Percidae (perches) Catostomidae (suckers), and Cyprinidae (minnows). The centrarchid family includes important warmwater game fishes such as Largemouth and Smallmouth Bass, crappies and sunfish (Hartel *et al.*, 2002). Among the Cyprinidae species reported in the Connecticut River are the Spottail Shiner, Fallfish and Common Shiner. Catostomids are closely related to the Cyprinids and are a highly diverse taxonomic group. Although the Longnose Sucker was historically found in the mainstem Connecticut River, recently only the White Sucker has been reported in the project area. Yellow Perch and Walleye are two common Percids, and Northern Pike and Chain Pickerel are two common Esocids found in the area (Hartel *et al.*, 2002) of the Northfield Project.

Fish Assemblage Study

FirstLight conducted Study No. 3.3.11 *Fish Assemblage Study* to gather baseline information pertaining to the current population(s) within the study area. The study area assessed included the Connecticut River from Vernon Dam to a natural rock formation referred to as Rock Dam in the bypass reach. In order to sufficiently sample representative habitat types throughout the study area, and the range of strata within these reaches, sampling methods included boat electrofishing, gill netting, and seining. Sampling was performed during the early summer in June-July 2015 in the TFI and again in the late summer (September) in the TFI and also in the bypass reach between Turners Falls Dam and Rock Dam (only for the late summer). Twenty-four (24) electrofishing stations were sampled in the TFI (Figure 3.3.3.1.2-1). Gillnets were also deployed in deep holes concurrent with electrofishing, and beach seining was conducted where feasible in the middle and lower TFI strata. In several locations where beach seining was not feasible due to snags or unwadable shorelines, supplemental boat electrofishing was conducted. In addition, the four major mesohabitats in the bypass reach were sampled by boat electrofishing (Figure 3.3.3.1.2-2).

Turners Falls Impoundment

Overall, 28 species (inclusive of hybrid sunfish) were observed during the 2015 field sampling effort (Table 3.3.3.1.2-1). Spottail Shiner, Smallmouth Bass, and Yellow Perch were the dominant species collected during both the early and late summer periods in the TFI. Smallmouth Bass abundance was greater in the upper reaches of the TFI as compared to the lower reaches. Other species that tended to be more dominant in the upper reaches included Fallfish, Rock Bass, Mimic Shiner, Tessellated Darter, and American Eel. Conversely, species such as Bluegill, Pumpkinseed, Largemouth Bass, Banded Killifish, White Sucker, and Yellow Perch tended toward greater abundance in the lower reaches.

The distribution of species in the TFI generally reflected habitat conditions and species preferences. For example, the upstream stratum of the TFI was dominated by Smallmouth Bass and Fallfish, whereas the lowermost stratum of the TFI is dominated by Bluegill, Pumpkinseed and Yellow Perch. Largemouth Bass were more common than Smallmouth Bass in the lower TFI, whereas Smallmouth Bass were more common than Largemouth Bass in the upper TFI. Fallfish and Smallmouth Bass prefer habitat with gravel and cobble substrate, free of fines (Scott & Crossman, 1973), whereas Sunfish and Largemouth Bass prefer lentic conditions (Coble, 1975; Heidinger, 1975; Trial *et al*., 1983), and substrates dominated by fines, as well as aquatic vegetation and dense debris cover, which are characteristic of the lower TFI but absent further upriver. Habitat generalists, including Spottail Shiner and Yellow Perch were both dominant and generally evenly distributed throughout the TFI area.

Boat electrofishing data obtained during the 2015 effort in the TFI were compared to historical data collected during 1971-1975 (MDFG, 1978), as well as 2008-2009 (Yoder *et al*., 2010; MBI, 2014). Massachusetts Division of Fisheries and Game (MDFG, 1978) concluded, based on multiple consecutive years of sampling the TFI, that resident fish species composition and relative abundance were stable. MDFG observed similar spatial trends to those from the 2015 study, such as the widespread spatial dominance of Yellow Perch, and the inverse upstream to downstream distribution of Smallmouth Bass and Largemouth Bass, which appeared to be driven by preferred habitat types. This suggests that the resident fish community composition remains stable, although the number of species has increased somewhat. Fallfish and American Shad were virtually absent from dominance during 1971-75, but were fairly dominant in 2015 surveys. Fallfish require relatively clear water quality; it is possible that since the 1970's, reduction in pollution described by MDFG (1978) has decreased ambient turbidity to the extent that Fallfish can better utilize study area habitat. The relative dominance of American Shad young-of-year (YOY) likely reflects improved recruitment to the study area due to construction of fishways at Turners Falls, Cabot Station and Holyoke that were not present in the 1970's.

Yoder *et al*. (2010), MBI (2014) and the 2015 study reflect more contemporary sampling and provide more quantitative station-specific results. Both the 2008-09 and 2015 datasets exhibit similar trends relative to fish assemblage metrics. Despite the passage of more than three decades, the same general species dominance pattern and spatial distribution were evident among resident species when MDFG (1978) is compared to both of the more contemporary data sets. Salmonid species are less prevalent than in the 1970's, likely due to changes in stocking and management practices combined with the summer sampling design of the more recent studies, which coincides with warmer water temperatures.

Bypass Reach

The four major mesohabitats in the Bypass Reach include:

- A large plunge pool at the toe of the Turners Falls Dam,
- A low-gradient riffle/run/pool complex extending from the plunge pool downstream to the Station No. 1 discharge,
- A higher-gradient riffle-run below Station No. 1 extending downstream to a pool formed by Rock Dam, and
- Rock Dam pool.

During the 2015 late summer sampling effort, 269 individuals representing 16 species (inclusive of hybrid sunfish) were observed throughout the Bypass Reach (Table 3.3.3.1.2-2). Smallmouth Bass dominated observations and accounted for nearly 63% of the total catch, followed by American Eel and Bluegill, which accounted for approximately 10% and 8% of the total catch, respectively. Species diversity was greatest at Rock Dam pool (N=12), followed by the plunge pool below Turners Falls Dam (N=9), although more individuals were collected at the plunge pool (N=101) closer to the Turners Falls Dam as opposed to Rock Dam pool (N=37).

The Bypass Reach from the Turners Falls Dam to Cabot Station was previously sampled in 2009 (Yoder *et al*., 2010) using the same equipment and methods as the 2015 study, although sampling stations were slightly different. For purposes of comparison, the 2015 upper Bypass Reach stations (plunge pool and riffle/run/pool above Station No. 1) and the two stations below Station No. 1 (riffle-run below Station No. 1 and Rock Dam pool) were paired. Table 3.3.3.1.2-3 lists all species collected in declining order of abundance, from both 2009 (MBI, 2014) and the 2015 study. Three of the six most dominant species (Smallmouth Bass, American Eel, and White Sucker) remained the same in both 2009 and 2015. Tessellated Darter and Bluegill were more common in 2015 than in 2009. Sea Lamprey YOY were evident in both surveys, but were not among the most common species. Species richness, abundance and catch per unit effort (CPUE) generally followed the same spatial trends in both studies (Table 3.3.3.1.2-4). The lower Bypass Reach had slightly greater species richness in both studies, and the upper Bypass Reach exhibited greater abundance and CPUE than the lower areas in both studies.

Littoral Zone Fish Spawning and Spawning Habitat

In accordance with the RSP for Study No. 3.3.13 *Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat* (final report to be filed with FERC on October 14, 2016, or as directed by FERC in its process plan and schedule), the Licensee performed a study to identify littoral zone fish spawning and spawning habitat in the mainstem, tributaries and backwater of project-affected areas to supplement information on resident species. Prior to initiating the field surveys, a desktop review was performed to determine the typical timing of spawning, spawning habitats, and spawning behaviors for resident species (Table 3.3.3.1.2-5). Field sampling was then conducted by systematically traversing the littoral zone (depth less than 6 feet) of the TFI via boat and/or foot (wading) to visually identify any fish nests, egg masses/deposits, and/or spawning habitat. Identified habitats, egg deposits and nests were geo-referenced with a GPS unit, and water quality parameters, including temperature, velocity, clarity, and depth, were recorded. Other relevant information collected included sediment grain size associated with nests, presence of aquatic vegetation, occupied/abandoned nests, weather conditions, and other relevant observations or descriptive information.

The early spring survey was performed from May 4-6, 2015, after river flow had receded to safe levels. Water temperature during this period ranged from 10.1 to 11.7°C, except in the lower reaches of tributaries such as Pauchaug Brook and Millers River which were warmer (16-16.7°C). Prevailing naturally routed inflow to the TFI during this period ranged from approximately 12,000 to 15,000 cfs, and water clarity was generally good (6-7.5 ft visibility), allowing clear view of the littoral zone bottom.

The late spring survey was initiated on June 1, 2015, but was aborted due to rising river flow. The survey resumed June 11 and extended to June 13, but relatively high river flow persisted and visibility was reduced to 4-6 ft. Water temperature during late May had slowly climbed to approximately 18°C, but on June 1 was 16°C due to rains and persistent cold weather. After field work resumed on June 11 temperatures ranged from 17 to 21.5°C during the course of the survey.

A total of 18 spawning locations were surveyed during the early spawning season and 16 locations were surveyed during the late spring season. A number of spawning locations, particularly in the late spring featured multiple nests clustered in close proximity to each other. Figure 3.3.3.1.2-3 illustrates the location and distribution of spawning sites that were identified during the two surveys.

Migratory Fish Species

The Connecticut River in the Turners Falls Development and Northfield Mountain Pumped Storage Development vicinity supports a variety of migratory fish species (anadromous and catadromous), including American Shad, Blueback Herring, Striped Bass, Sea Lamprey, and American Eel[37]. Before

[37] At a meeting of the Connecticut River Atlantic Salmon Commission on July 10, 2012 the USFWS announced that it will no longer culture salmon for restoration efforts in the Connecticut River Basin. Agency representatives indicated that they supported the salmon restoration for 45 years, but low return rates and the science supporting salmon restoration have caused them to refocus efforts on other migratory fish (including American Eel).

reaching the Project Area, these migrants must successfully pass the hydroelectric facility at Holyoke (RM 87) using the fish lift or eel passage ladders at this facility. In addition, a population of Shortnose Sturgeon is known to inhabit the Connecticut River between the Turners Falls Dam and Holyoke Dam.

American Shad

American Shad migrate into the lower Connecticut River during late March or April, reaching Cabot Station in late April or early to mid- May as they move upstream to spawn. In 2015, it was reported that over 58,000 shad successfully passed upstream of the Turners Falls Dam. Shad spawning typically occurs from April into June. YOY shad remain in southern New England freshwater rivers throughout summer before initiating seaward migration which typically occurs in September or October. Most daily movement occurs in evening hours until about 2300 hours, but movement can occur around-the-clock (Hartel *et al.*, 2002). The young migrate to areas in the North Atlantic and remain at sea for four to six years before returning to their native river to spawn. American Shad are repeat spawners and can return to their natal rivers more than once.

American Shad tend to spawn in areas dominated by runs and glides, 3 to 18 feet deep, and have been observed to spawn over a variety of substrates, but prefer sand and gravel bottom (Stier & Crance, 1985). This type of habitat most closely corresponds to the runs and glides occurring downstream of Cabot Station, but is very limited in the bypass reach. Female shad broadcast their eggs, about 290,000 per individual, in open water.

Shad spawning surveys were conducted by the Licensee from May through June 2015 as part of Study No. 3.3.6 *Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects*. The surveys were generally conducted 2-3 times per week through June 22, 2015, for a total of 18 survey nights, at four general locations: 1) in the TFI (upstream of Turners Falls Dam to the tailrace of Vernon dam), 2) within the Turners Falls Power Canal, 3) in the vicinity of the Rock Dam and below the Turner Falls Dam in the bypass reach, and 4) from Cabot Station to the Route 116 Bridge in Sunderland. Shad spawning was observed in the river reach downstream of Cabot Station (Figure 3.3.3.1.2-4), in one area of the bypass reach (Rock Dam) and in one area of the lower Turners Falls power canal (Figure 3.3.3.1.2-5), as well as in the TFI, adjacent to Stebbins Island (Figure 3.3.3.1.2-6).

Identified spawning locations in the downstream reach (from Cabot Station downstream to the Route 116 Bridge in Sunderland, MA) ranged from the Deerfield River confluence (RM 118.6) south to just above Third Island (RM 114.4). Spawning was most frequently observed between the Deerfield River confluence and the railroad bridge near RM 116.8. The total estimated area of spawning locations identified in the downstream reach was approximately 106 acres. The 2015 surveys confirmed shad spawning in the vicinity of the areas identified previously in the 1970s (Figure 3.3.3.1.2-4). In general, groups of shad appeared to congregate at a spawning location, with individuals intermittently darting upwards and breaking the water surface, thereby causing splashes. In the downstream reach, the average splash count recorded over a 15-minute interval varied, ranging from 3 to 215.5, with a mean of about 43 splashes.

Spawning observations in the downstream reach (Cabot Station to Route 116 Bridge) occurred when water temperatures ranged from 15.8 to 20.2°C, depths ranged from 3.3 to 16 feet, surface velocities (measured 1 foot below the surface) ranged from 0.05 to 2.84 feet/second, and secchi depth ranged from 5.5 to 9.5 feet. Substrates at the spawning sites in the downstream reach were dominated by cobble and/or gravel.

In the TFI, spawning was observed at a single location toward the downstream end of Stebbins Island, which is approximately 13.7 RM upstream from the Northfield Mountain Intake/Tailrace channel. Spawning was observed over an approximately 39-acre area at this location. Substrate was dominated by gravel and sand, with mesohabitat classified as a mixture of pool, run, and glide. Observations generally occurred between 20:00 and 23:00 (EDT), with average splash counts ranging from 5 to 265 over a 15-minute interval. Water temperature ranged from 15.6 to 18.8 °C, DO ranged from 9.9 to 11.4 mg/L, pH ranged from 6.4 to 8.2, and secchi depth ranged from 5.0 to 7.5 ft. Water depth at the locations of the measurements ranged from 6.8 to 11.0 ft and velocity ranged from 0.1 to 1.6 feet/second.

American Shad eggs were identified in all samples that were collected downstream from observed spawning activity in the TFI. Estimated densities of American Shad eggs in the plankton samples collected downstream of the Stebbins Island spawning site ranged from 7 to 101 eggs per 100 m^3. Two shad larvae were also identified in the samples.

Suspected shad spawning was also documented in the Turners Falls Power Canal in an area approximately 0.9 acres in size located midway along Migratory Way, just downstream from where the canal begins to widen (Figure 3.3.3.1.2-5). Although fish were not seen, splashing consistent with shad spawning behavior was recorded on the evening of June 18, 2015 at approximately 00:24 (3.9 hours after sunset). On the same date, a single spawning event was also observed in the bypass reach, over an area approximately 2.7 acres in size located downstream of Rock Dam and near the downstream end of Rawson Island. Spawning activity appeared more intense in the bypass reach than the canal, with an average of 133 splash counts in a 15-minute period. Time of the observation was 22:17, about 1.8 hours after sunset. Data collected in support of Study No. 3.3.1 *Instream Flow Studies in Bypass Channel and below Cabot Station* indicate backwater habitat comprised mainly of gravel at the observed spawning area.

In accordance with the approved study plan, the Licensee conducted Study No. 3.3.2 *Evaluate Upstream and Downstream Passage of Adult American Shad* to evaluate the upstream and downstream passage of adult American Shad at the Turners Falls and Northfield Mountain Developments. The purpose of the study was to assess effectiveness of existing fish passage facilities, evaluate routes of upstream and downstream passage through the Project area, and evaluate the effects of operation of the Project on upstream and downstream shad migrations. A combination of active and passive telemetry techniques was employed. In total, 793 adult American Shad were collected, tagged and released in the Project area during May and June 2015. The tagged fish were monitored at fixed stations within the Project area, as well as mobile tracked between Mount Herman School and the Holyoke Project from May through early July. Results and analysis of the data collected from this effort will not be finalized until September 2016 and will be discussed in a proposed amended Final License Application slated for filing on April 30, 2017.

To determine if Project operations affect juvenile American Shad outmigration success, the Licensee evaluated the timing, duration, and magnitude of juvenile outmigration during fall of 2015 using hydroacoustics (split beam sonar) equipment that was installed at the Northfield Mountain intakes, Turners Falls Power Canal, and Cabot Station as part of Study No. 3.3.3 Evaluate Downstream Passage of Juvenile American Shad). Radio telemetry equipment was also utilized to evaluate route selection as juveniles migrate downstream past the Northfield Mountain tailrace/intake and Turners Falls Development. External radio transmitters (Lotek NanoTag Series model NTQ – 1) were affixed to 224 juvenile American Shad and their movements through the Project area were tracked. The final component of the study assessed Turners Falls Dam and Cabot/Station No. 1 turbine passage survival utilizing juvenile shad collected from Project waters in fall of 2015. The final report is slated to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

Blueback Herring

Together Blueback Herring and Alewife are known as river herring. Alewife use the lower portion of the Connecticut River, but rarely pass above the Holyoke Dam. Thus, Blueback Herring is the only river herring found in the Project area (Hartel *et al.*, 2002). Pre-spawning Blueback Herring enter the mouth of the Connecticut River at about the same time as American Shad. Blueback Herring broadcast spawn on hard substrate in swift-flowing tributaries to the lower Connecticut River. Presumably, some spawning also occurs in the mainstem Connecticut River, where swift-flowing habitats with hard substrate are available (Hartel *et al.*, 2002). Females may produce 122,000 to 261,000 eggs; larger fish generally produce more eggs.

Blueback Herring elsewhere have been reported to spawn in both swift-flowing, deeper stretches and in slower-flowing tributaries and flooded low-lying areas adjacent to the main stream; substrates may vary from coarse to fine materials (Pardue, 1983). Active spawning may occur over a wide range of water velocities. FirstLight (2012b) identified that the uppermost segments of the reach below Cabot consist of riffle habitat with swift-flowing conditions, but swift-flowing runs are well distributed throughout the 30 mile reach downstream of Cabot tailrace evaluated in 2012, along with portions of the bypass reach below Turners Falls Dam. Most of the runs featuring the hard substrates (e.g., cobble and/or gravel) can be found in the first 14 miles of river below the Cabot tailrace. Fines such as sand dominate the substrates in the remaining downstream reaches. Eggs are initially demersal, but become planktonic. Pardue (1983) reports that larvae in Chesapeake Bay remain near or slightly downstream of presumed spawning areas, and in Nova Scotia are associated with relatively shallow (<6.6 ft), sandy, warm areas in and near areas of observed spawning.

Assuming that suitable plankton and water quality exist downstream from Cabot Station, this reach should provide extensive suitable habitat for this species, especially in the transition area between cobble/gravel and finer substrates.

Juveniles remain in the river, feeding on zooplankton, until the fall of the year then emigrate to the sea (Collette & Klein-MacPhee, 2002). These characteristics of their development parallel those of American Shad and the young of the two species are difficult to distinguish. Juvenile Blueback Herring begin their seaward migration slightly earlier and at higher water temperatures (peaking at 14 to 15°C) than American Shad. Adult Blueback Herring spend three to six years at sea before returning to spawn in their natal streams. The average length of adults is less than 300 mm (Hartel *et al.,* 2002).

Blueback Herring in the Connecticut River and coast-wide experienced a decline in the mid-1990s. Few Blueback Herring have been recorded in the Project Area since the late 1990's. Causes for the decline were thought to be similar to those listed for American Shad with offshore bycatch and predation by Striped Bass most likely accounting for the decline in the Connecticut River.

Blueback Herring are not an important sport or commercial species in the Connecticut River, although some are captured for use as bait in coastal fisheries, and they are harvested at sea for human consumption and animal feed.

A petition to list Blueback Herring as threatened under the federal Endangered Species Act of 1973 (16 U.S.C. §1531 et seq., ESA) was submitted to the NMFS on August 5, 2011 by the Natural Resources Defense Council. In its 90-day review of the 2011 Petition, NMFS concluded that the Petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted (76 FR 67652-67656), and initiated a status review for the species. Upon completion of the status review in August 2013, NMFS determined that listing was not warranted.

Striped Bass

Striped Bass are native to Atlantic coastal waters from the St. Lawrence River in Canada to the St. Johns River in Florida, moving into freshwater to spawn or feed. Major spawning areas include the Hudson River and tributaries to Chesapeake Bay, although spawning occurs in rivers from the Maritimes to the southeastern United States. They may grow to several feet in length and are highly predatory, feeding on a variety of fishes and invertebrates. Adult and juvenile striped bass in freshwater habitats feed largely on other fish, and have been shown to feed on river herring, American Shad, and American Eel. The recent declines in Connecticut River populations of these species (herring, shad, and eel) have been linked to the resurgence of the Atlantic coast Striped Bass population (Savoy & Crecco, 2004).

During the past decade Striped Bass have become abundant in the Connecticut River; over 5,700 Striped Bass have been passed into the Holyoke impoundment below the Turners Falls Development since 2000. From 1980 to 1999, Striped Bass were rarely noted at the upstream passage facilities at the Project. Striped bass spawning has not been documented in the Connecticut River.

A three year study supported by the Connecticut Department of Energy and Environmental Protection (CTDEEP) was begun in 2005 to assess the abundance, temporal and spatial distribution, and population structure of Alewife, Blueback Herring, and Striped Bass, and to describe predator/prey interactions between these species in the Connecticut River (Davis *et al*., 2009). The study found that Striped Bass predation is a large source of mortality for migrating adult Blueback Herring and it was estimated that over 200,000 herring were consumed by Striped Bass in the Connecticut River in May 2008.

Striped Bass supports recreational fishing in the Connecticut River. Commercial fishing is not permitted.

Sea Lamprey

Sea Lamprey is an anadromous species that spawns in the Connecticut River and its tributaries. Sea Lamprey spawn during the spring in shallow areas of moderate current with gravel, and rubble substrate. Subsequent to the larval stage, Sea Lamprey mature into ammocoetes, which burrow into soft sediments and exist as filter feeders, emerging from the sediment surface to feed. This stage lasts up to seven years; the ammocoetes then undergo a transformation into the parasitic adult phase and migrate to sea. Downstream migration occurs in both the spring and fall, but primarily in the spring. Pre- spawning adults create a depression in the substrate by carrying larger rocks out of the nest area and by sweeping smaller particles out using rapid body movements. The female then deposits eggs, fertilized by the male, moving more rocks and gravel as necessary. Spawning in one nest, or redd, may continue for 16 hours to 3.5 days. During the spawning run, adults undergo considerable physiological change and deterioration; they die after spawning.

During late spring and early summer 2015 (as part of Study No. 3.3.15 *Assessment of Adult Sea Lamprey Spawning within the Project Area*), the Licensee assessed spawning activity and habitat within the Project area utilizing radio telemetry techniques and visual surveys of identified redds. The final report is slated to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule. Forty (40) adult Sea Lamprey were collected downstream of the Project at the Holyoke Dam fish lift and implanted with radio tags. Total length for all 40 tagged lamprey ranged from 62-84 cm (mean = 72.2 cm), weight ranged from 430-970 g (mean = 663.6 g), and girth ranged from 12-17 cm (mean = 14.4 cm). The movements of the tagged lamprey were subsequently tracked between the Mount Hermon School and Holyoke Project from June 3 to July 7, 2015. All radio frequencies were shared with TransCanada in the event that fish move from the Turners Falls Development into the Vernon Project vicinity. Although analysis of tracking data remains ongoing, the TransCanada study team reported that 18 of the lamprey tagged and released by the FirstLight field crew were located in the Vernon Project impoundment (NAI, 2016). At least one lamprey was located by the TransCanada study team in the White River as far north as West Hartford, VT (a distance of 100 river miles from release location).

The adults parasitize other fish species, using a sucking disc and rasping teeth and tongue to attach to and penetrate the tissues of prey species. The sucking disc is also used during spawning to construct 1-3 foot diameter nests in the substrate. Similar to other anadromous species, Sea Lamprey do not feed during their upstream spawning migration and thus are not parasitic while in the river (Hartel *et al*., 2002).

Areas within the Project boundary fitting the general description of Sea Lamprey spawning habitat were inspected to identify specific locations suitable for spawning based on substrate and depth; the presence or absence of actively spawning lamprey was noted. Twenty-nine redds were GPS-located in five (5) distinct regions of the Project area as summarized in Table 3.3.3.1.2-6. Beginning on June 12, 2015 and continuing until water temperature exceeded 22°C, the redds were monitored weekly for water temperature, velocity, depth, and substrate. Tables 3.3.3.1.2-7 and 3.3.3.1.2-8 summarize physical and water quality characteristics observed at the redds throughout the monitoring period. The mean depth of all 29 redds ranged from 1.5 ft to 4.6 ft and mean velocity ranged from 0.8 to 3.0 ft/s. Throughout the six-week monitoring period, the maximum mean velocity (3.0 ft/sec) and maximum mean depth (4.6 ft) were recorded at the Stebbins Island sites, located just downstream of Vernon Dam. The minimum mean velocity (0.8 ft/sec) and minimum mean depth (1.5 ft) were recorded at the Fall River site. Substrate characteristics of the redds were similar and consisted of a circular or oval area of bare sand and/or gravel with cobble and gravel around the perimeter.

Five (5) of the 29 redds were capped using a 4 x 4 ft, weighted PVC framed collection net (1-mm mesh) that funneled into a collection jar on the downstream end in order to capture emerging larvae. Caps were deployed only after Sea Lamprey spawning was initially observed and revisited for multiple days to ensure lamprey were no longer actively spawning on the site. Caps remained in place for 14 to 21 days, at which point samples were collected in jars, fixed with formaldehyde and transported to the lab to be further analyzed. Lamprey ammocoetes were recovered from two of the five traps set. The Hatfield S Curve cap (retrieved July 7) produced a larvae measuring approximately 47 mm (total length) and the Fall River cap (retrieved July 2) produced a much smaller ammocoete measuring approximately 7.4 mm in total length. No larvae were observed in the samples from the Ashuelot River and the cap near Stebbins Island was displaced from the redd and never recovered.

The Sea Lamprey is not of recreational or commercial value in the Connecticut River.

<u>American Eel</u>

The American Eel is a catadromous species whose young enter estuarine or freshwater to feed and mature, and then the adults return to the sea to spawn. After spending five (5) to 20 years in fresh or coastal waters, eels migrate to spawning grounds located in the Sargasso Sea in the South Atlantic (Collette & Klein-MacPhee, 2002). Eggs are fertilized and released in the water column. The eggs and larvae are pelagic, drifting via the Florida current and the Gulf Stream to coastal North America and Europe. The young eels ultimately leave these currents and move shoreward and either reside in estuarine coastal waters or move into fresh water, following cues that are not well understood.

Eels moving into the estuaries are called glass eels because of their transparent appearance. Once they become pigmented they are referred to as elvers until they gain the yellow cast typical of eels. Eels may reside in an estuary throughout their entire life or move upstream in freshwater during the first few years. At maturation, the species undergoes another color change to the silver eel stage and migrates downstream, usually at night during fall.

In accordance with the FERC approved RSP (Study No. 3.3.4 *Evaluate Upstream Passage of American Eel*), the Licensee conducted a study during 2014 to determine the presence of eels as well as to identify areas where eels congregated or attempted to ascend wetted Project structures. Eleven (11) nighttime surveys were performed between June 11 and October 9, 2014. Several areas within the Project, including the Cabot Station discharge area and fishway, Station No. 1 discharge area, various canal discharge areas, the Turners Falls Dam and spillway fishway, were routinely surveyed and the approximate number of eels, the date and time, eel behavior, and the environmental conditions (e.g., weather, leakage, discharge) were recorded. The Turners Falls spillway fishway accounted for 94%, of the 6,263 total eels observed during the study period.

In 2015, FirstLight conducted the second year study, installing temporary eel passes at three locations as follows: in the Spillway Fishway; in the Cabot Fishway; and at the Cabot Emergency Spillway. The temporary passes were constructed of ¾-in marine plywood with ramp sections approximately 24-in wide by 5-in tall and included plywood covers to prevent avian predation. Each ramp was fitted with two sizes of milieu-type substrate mounted side-by-side to pass eels of varying sizes. Three-foot tall plastic holding tanks were placed at the upper ends of the ramps to collect eels that successfully traversed the temporary passes. Two Medusa traps were deployed at the Station No. 1 discharge in July 2015 to monitor eels in that area. These traps were designed to passively collect juvenile eels seeking refuge and consisted of submerged 5-gallon buckets containing mop heads. The ramps and Medusa traps were operated continuously between July 10 and November 2, 2015 with collections quantified every 2-3 days. Table 3.3.3.1.2-9 summarizes the number of eel collected at each location during the study. The majority, 87.7% (n=5,235), were collected at the Spillway Fishway, followed by the Cabot Emergency Spillway and Cabot Fishway, which collected

7.1% (n=424) and 5.2% (n=319), respectively. No eels were collected at the Medusa traps deployed at Station No. 1. Temporally, eel collections occurred from July 10 through October 4, with the peak occurring toward the end of July. Water temperature at the onset of the monitoring period was 21.7°C (July 10) and decreased to 14.9°C on the last day eels were observed (October 4). Most of the eels measured between 10 and 20 cm (total length). The Pearson Correlation Coefficient test suggested no correlation between the rate of eel collection and precipitation (r=-0.1962) or daily river flow (r=0.0429). The Licensee has also conducted a study to assess downstream passage of adult outmigrating silver American Eel (Study No. 3.3.5 *Evaluate Downstream Passage of American Eel*) to better understand migration timing as it relates to environmental factors and operations at the Turners Falls Development and Northfield Mountain Pumped Storage Development.

A combination of split beam sonar and a dual frequency identification sonar (DIDSON) was used to monitor entrainment and determine the timing, duration and magnitude of the downstream run through the Project area from August 1 to October 31, 2015. The sonar equipment was deployed at the Northfield Mountain Pumped Storage Development tailrace/intake, within the Turners Falls Power Canal, and in front of the Cabot Station intake. The sonar units collected data continuously throughout the duration of their deployment.

The Licensee has also assessed downstream passage of adult American Eel using radiotelemetry techniques at the Turners Falls Development and Northfield Mountain Pumped Storage Development beginning in late October 2015. The passage route studies required a large number of adult eel to achieve an adequate sample size (n=432). Because of a concern about the feasibility of collecting this quantity of eel within the Connecticut River drainage, the Licensee proposed and received agency approval to import adult eel from a commercial fishery in Newfoundland, Canada. A permit was issued for importation into the State of Massachusetts; the permit requires that the eels be determined to be pathogen-free before use in the Connecticut River studies.

The eels were examined to confirm that they were in the silver phase, the criterion being eye diameter measurements (e.g., eye diameter relative to body size - Pankhurst Index of approximately 6.5 or greater). Migration routes were assessed with the use of radiotelemetry techniques. Fixed receivers were located as indicated in Table 3.3.3.1.2-10; tagged eel were also tracked with mobile gear. Monitoring of tagged eels occurred until water temperatures reached 5 °C. Data analyses are ongoing and results will be included in a final report slated for filing with FERC by March 1, 2017 or as directed by FERC in its process plan and schedule (for the second year study).

A petition to list American eel as threatened under the federal Endangered Species Act of 1973 (16 U.S.C. §1531 et seq., ESA) was submitted to the USFWS and NMFS on November 18, 2004. After initially finding that the petition presented substantial information indicating that listing the American eel may be warranted, the USFWS made a final determination in February, 2007 that listing of the eel under the ESA was not warranted. On April 30, 2010 the Council for Endangered Species Act Reliability submitted another petition to list American eels as threatened under ESA. Upon completion of this status review in October 2015, USFWS determined that listing was not warranted.

Shortnose Sturgeon

Shortnose Sturgeon is a federally listed endangered species that typically inhabits slow moving riverine waters or near shore marine waters and periodically migrates into faster moving fresh water areas to spawn. They are long-lived (30-40 years) and mature at late ages (5-13 years for males and 7-18 years for females) in the northern extent of their range (Dadswell *et al*., 1984; SSSRT, 2010). Shortnose Sturgeon exhibit three distinct movement patterns associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8 ºC, pre-spawning Shortnose Sturgeon move from overwintering grounds to spawning areas. Spawning occurs from April to May and may last from a few days to several weeks depending upon water temperature, photoperiod (day-length) and bottom water velocity (Dadswell *et al.*

1984; Kynard *et al*., 2012. Shortnose Sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS, 1998). Female Shortnose Sturgeon are thought to spawn every three to five years while males spawn every two years, but they may spawn annually in some rivers (Kieffer & Kynard, 1996). Fecundity estimates range from 27,000 to 208,000 eggs/female (Dadswell *et al*., 1984).

Sturgeon eggs become adhesive after fertilization and larvae begin downstream migrations at about 15-mm total length (Kynard, 1997; SSSRT, 2010). Laboratory studies suggest that young sturgeon move downstream in two steps; a 2 to 3-day migration by larvae followed by a residency period by YOY, then a resumption of migration by yearlings in the second summer of life (Kynard, 1997).

Adults normally depart from their spawning grounds soon after spawning and movements include rapid, directed movements to downstream feeding areas in spring followed by local meandering in summer and fall (Dadswell *et al*., 1984; Buckley & Kynard, 1985; O'Herron *et al*. 1993). Post-spawning migrations are associated with rising spring water temperature and river discharge (Kieffer & Kynard, 1993).

Historically in the Connecticut River, Turners Falls is believed to mark the extent of the upstream range of sturgeon due to the height of the natural falls. Completion of the downstream Holyoke Dam in 1849 blocked sturgeon from migrating beyond RM 87. The first successful fishway to pass fish upstream, an elevator, was installed at the tailrace at Holyoke in 1955. In 1976, the existing tailrace fish lift at Holyoke was improved, and a lift was installed in the bypass area at the Holyoke Dam. These improvements allowed Shortnose Sturgeon to pass above Holyoke Dam and access the Connecticut River up to their historic limit at Turners Falls; however, over the past decade or so NMFS would not allow Shortnose Sturgeon to be lifted above Holyoke Dam until safe downstream passage was in place. When a Shortnose Sturgeon would enter the lift, it was manually removed from the fish lift flume and placed downstream of the dam. A new downstream fish passage system has been constructed at Holyoke Dam and is slated to be operational in spring 2016. After studies have verified that the downstream fish passage system can provide safe, timely and effective passage for Shortnose Sturgeon, these fish will be allowed to pass upstream to utilize habitats between the Holyoke and Turners Falls Dams. Shortnose Sturgeon have not been observed in the Turners Falls fishways, and none has been observed or captured upstream of Turners Falls Dam.

Researchers found five distinct sites used year after year by wintering Shortnose Sturgeon in the Connecticut River between Holyoke Dam and Turners Falls Dam: Whitmore (RM 113.7), Second Island (RM 111.8), S-turn (RM 105.6), Hatfield (RM 105.6), and Elwell Island (RM 98.2; SSSRT, 2010; Kynard *et al*., 2012). Among the five areas, the most prominent was the Whitmore site. This area was located nearby the Montague spawning site and had both the greatest numbers of adults (as observed with an underwater video camera) and the greatest concentration of pre-spawning adults (as observed with radio tracking).

During summer, the Shortnose Sturgeon population above Holyoke Dam congregates near the confluence of the Deerfield River; this group overwinters a few miles downstream from Cabot Station. The concentration area used by adult fish in the Connecticut River is in reaches where natural or artificial features cause a decrease in river flow, possibly creating suitable substrate conditions for freshwater mussels (Kieffer & Kynard, 1993), a major prey item for adult sturgeon (Dadswell *et al*., 1984). Both adults and juveniles have been found to use the same river reaches in the Connecticut River and have ranges of about 10 km during spring, summer and fall (Savoy, 1991; Seibel, 1991). In the winter, sturgeon move less than 2 km and assemble together in deep water (Seibel, 1991). The migration of juvenile and adult Shortnose Sturgeon from the Holyoke impoundment to points downstream of the Holyoke Dam appears to be a natural event coincidental with increased river discharges (Seibel, 1991; Kynard, 1997).

Shortnose Sturgeon in the upper river population spawn from the last week of April to mid-May, after the spring freshet (Taubert, 1980; Buckley & Kynard, 1985; Kynard, 1997). The spawning period is estimated to last from three to 17 days, occurring during the same 26-day period each year (April 27 – May 22), which corresponds to the time of year when photoperiod ranges from 13.9 to 14.9 h (Kynard *et al*., 2012). Shortnose Sturgeon are believed to spawn at discrete sites within the river (Kieffer & Kynard, 1993) in channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell *et al.,* 1984; NMFS, 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the spring freshet, water temperatures ranging from 6.5-15.9°C, daily mean discharge ranged from 121-901 m^3/s, depth ranging from 1.2-5.2 m, and bottom water velocities of 0.3 to 1.2 m/s (Dadswell *et al.*, 1984; NMFS, 1998; SSSRT, 2010). The Shortnose Sturgeon Status Review Team (SSSRT) (2010) indicated that while temperature and river discharge affect spawning, photoperiod was the dominant factor influencing the timing of spawning.

Successful spawning has been documented at two sites in Montague, located about 4 km downstream of the Turners Falls Dam near the Cabot Station tailrace (SSSRT, 2010). The main site in the Cabot tailrace was estimated to be 2.7 ha (6.7 acres) and the smaller site at Rock Dam was estimated to be about 0.4 ha (1 acre) in area. These sites are just downstream of the species' historical limit in the Connecticut River at Turners Falls (RM 122) (NMFS, 2005). Sturgeon eggs and larvae were captured at the sites in 1993, 1994, and 1995 (Vinogradov, 1997). These sites are within the 0.9 mi reach that spans from Rock Dam to 656 feet downstream of Cabot Station, where all common types of river habitat are present. Much of the river bottom in the area is rock and rubble. The 0.3-mi.-long reach downstream of Cabot Station contains rubble/boulder shoals that can be exposed briefly in spring during low river discharge and low Cabot Station generation (Kieffer & Kynard, 2007).

Shortnose Sturgeon spawning in this area typically occurs from April to mid-May and the egg incubation period is about two weeks when water temperatures are between 8 and 12 °C. Upon hatching, larval Shortnose Sturgeon hide for about 15 days under available cover at the spawning site while absorbing the yolk-sac, before migrating downstream to deeper water between the mouth of the Deerfield River and Holyoke (SSSRT, 2010).

Upstream Passage

Upstream passage facilities for Connecticut River migratory fish are provided at a number of hydroelectric projects. Migrating fish first encounter the Holyoke Project (RM 87) where they are passed upstream through a fish lift. Turners Falls Dam is the second dam on the Connecticut, 37 mi upstream of Holyoke. The Deerfield River is a major tributary that enters the Connecticut River over two miles downstream of Turners Falls Dam and provides an additional migration route. Fish passing the Turners Falls Development (RM 122) can continue upstream migrating through the TFI, passing the Northfield Mountain Pumped Storage Development (RM 127) before encountering the Vernon Hydroelectric Project (RM 142), 20 miles upstream of Turners Falls Dam. Fish passage facilities at the Vernon Project allow migrants to continue upstream.

Upstream fish passage facilities began operating in 1980 at the Turners Falls Development pursuant to a Settlement Agreement signed by FirstLight's predecessor, Western Massachusetts Electric Company, state and federal resource agencies, and non-government organizations. There are three fish ladders at the Turners Falls Development: the Cabot Fish Ladder adjacent to Cabot Station; the Spillway Fish Ladder at Turners Falls Dam; and the Gatehouse Fish Ladder at the upstream end of the power canal. The Cabot and Spillway Fish Ladders are modified "ice harbor" designs and the Gatehouse Fish Ladder is a vertical slot ladder. These fish ladders were designed in consultation with state and federal resource agencies, based on Columbia River salmon fish ladder designs.

Fish ascending the Cabot Fish Ladder enter the power canal, then pass through the Gatehouse Fishway into the TFI. Alternatively, they can swim through the bypass reach to the base of the Turners Falls Dam, ascend the Spillway Fish Ladder, pass through the Gatehouse collection gallery that crosses the power canal, and enter the TFI through the Gatehouse Fishway, along with the fish passed through the Cabot Fishway.

The Connecticut River Atlantic Salmon Commission (CRASC[38]) establishes an annual schedule for the operation of upstream fish passage facilities at the Connecticut River dams. The schedules are based on the projected movement of migratory fish and may be adjusted in season to address actual observations. Table 3.3.3.1.2-11 lists the 2016 schedule for upstream fish passage operations at the Turners Falls Development.

Table 3.3.3.1.2-12 provides a summary of fish passage records for the Turners Falls fish passage facilities for the period of 1980 through 2015. The dates of peak passage have varied throughout the years, ranging from early to mid-May to mid to late June. American Shad and Sea Lamprey have been the dominant anadromous species observed at the passage facilities through the period of record. Substantial Blueback Herring passage was recorded for the 15-year period from 1983 to 1997, but few herring have been recorded since 1997. Use of the passage facilities by Atlantic Salmon has been low since most are collected downstream at Holyoke Dam; salmon were noted in 28 of the 31 years, but few individuals were recorded (1 – 29 annually). The 31-year period of record does not show any usage of the facilities by Shortnose Sturgeon.

Travel of adult American Shad through the TFI was studied from 1973 through 1976 (Layzer, 1976). During that time, 6,373 shad were transported to the TFI from the Holyoke Dam fish lift. Of those, 125 shad were tagged with ultrasonic transmitters and their movements were monitored. Most shad were found to exhibit one of four behavior patterns: 1) 45% of the tagged fish never migrated through the narrow turbulent area below the French King Bridge; 2) 18% remained within two miles of the Northfield Mountain Pumped Storage Development tailrace; 3) 21% migrated upstream passing the Northfield Mountain Pumped Storage Development tailrace with little or no delay; and 4) 16% exhibited greater movement up and downstream than fish in the other groups including some movement up to Vernon Dam. Layzer (1976) reported that the distance traveled in the TFI was related to water temperature. Shad that were tracked displayed a preference for deeper sections of the river. The Northfield Mountain Pumped Storage Development intake/tailrace had no clear effect on shad movement through the TFI. Some shad turned back upon reaching the Northfield Mountain Pumped Storage Development intake/tailrace both during operational and non-operational periods. Others milled at the Northfield Mountain Pumped Storage Development intake/tailrace; however, similar milling behavior occurred in other portions of the TFI outside the influence of the Project.

The ratio of American Shad passage at Holyoke Dam to the number that passed upstream to Turners Falls Dam (Table 3.3.3.1.2-13) is low and except for 1991 was less than 10%. The areas between Holyoke Dam and Turners Falls Dam is a known spawning area for shad so many may have spawned below Turners Falls and returned downstream. The Deerfield River is also below Turners Falls and shad may have entered the Deerfield River to spawn.

The ratio of American Shad passage at Vernon Dam to the number that passed upstream of Turners Falls Dam (Table 3.3.3.1.2-14) was highly variable but often high, with a mean of 41% for all years (when counts were available). Design improvements (repairs to baffles, silt removal, automating entrance elevation, etc.) to the Vernon ladder appeared to increase effectiveness in 2012 and thereafter.

As part of relicensing, FirstLight is conducting several studies associated with upstream fish passage including the following:

- Study No. 3.3.2 Upstream and Downstream Passage of Adult American Shad
- Study No. 3.3.4 Upstream Passage of American Eel
- Study No. 3.3.8 Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrance and Powerhouse Forebays
- Study No. 3.3.9 Two–Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace

[38] CRASC membership consists of the USFWS, NMFS, and state fishery agencies from CT, MA, NH, and VT.

The purpose of Study No. 3.3.2 was to assess effectiveness of existing fish passage facilities, evaluate routes of upstream and downstream passage through the Turners Falls and Northfield Mountain Pumped Storage Developments, and evaluate the effects of Project operation on upstream and downstream shad migrations. A combination of active and passive telemetry techniques were employed. In total, 793 adult American Shad were collected, tagged and released in the Project area during May and June 2015. The tagged fish were monitored at fixed stations within the Project area, as well as mobile tracked between Mount Herman School and the Holyoke Project from May through early July. Results and analysis of the data collected from this effort will be incorporated into a final report to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule. These findings will subsequently be included in an amended Final License Application to be filed with FERC on April 30, 2017.

As discussed previously, Study No. 3.3.4 was conducted over two years (2014 and 2015) to assess upstream passage of American Eel through the Project area. Both the preliminary presence/absence surveys of 2014 and monitoring of temporary traps in 2015 revealed that the majority of juveniles were between 10 and 20 cm (total length) and continued to migrate past Cabot Station, through the bypass reach to the Turners Falls Dam. As compared to the Turners Falls Dam Spillway, very few eels apparently recruit to the Cabot Station's Fishway or Emergency Spillway during upstream migration.

The purpose of Study No. 3.3.8 (Computational Fluid Dynamics (CFD) Modeling in the Vicinity of the Fishway Entrance and Powerhouse Forebays) was to assess the hydraulics near the Spillway and Cabot fishway entrances to assess upstream fish passage[39]. Prior to initiation of the relicensing process, a separate CFD model and supporting report was developed for the Gatehouse fish ladder by Alden Research Laboratory in 2013 (Alden, 2013). The most recent study, therefore, did not re-assess this same area. Nine flow scenarios were modeled at the two fishway entrance study areas: five scenarios for the Cabot Fishway Entrance area, and four scenarios for the Spillway Fishway Entrance area. The study report characterized the hydraulics of existing conditions in the vicinity of the fishway entrances and general tailrace areas. However, the hydraulic assessment represents only a partial picture of potential Project operation impacts. Relative to upstream passage, one other study is being conducted to evaluate the impact of Project operations on shad (Study No. 3.3.2 *Evaluate Upstream and Downstream Passage of Adult American Shad)*. The field data for these studies were collected in 2015; however, the analysis and final report will be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule. These studies include telemetry data to determine how tagged American shad adults and juveniles respond to different operating conditions. These telemetry studies, coupled with the CFD hydraulic evaluation, will collectively be used to determine the impact of Project operations on migratory fish movement.

The purpose of Study No. 3.3.9 was to evaluate the effects of the Northfield Mountain Pumped Storage Development operations on fish migration for a 10[40] kilometer reach of the Connecticut River using a 2-dimensional hydraulic model called River2D. As part of the study, 60 hydraulic modeling scenarios were evaluated by varying three variables as follows: the TFI level, base flows through the TFI, and Northfield Mountain Pumped Storage Development operations (pumping or generating). Model results indicate that velocities in excess of 10 fps may occur through the French King Gorge under certain conditions (i.e. low TFI level, high base flow through the TFI, and the Northfield Mountain Pumped Storage Development generating). However, the maximum velocity does not extend across the entire channel width, and there are areas along the river margins with lower velocities that migrating fish can utilize. Model results also indicated instances of flow reversals due to Northfield Mountain Pumped Storage Development operations. The area upstream of the Northfield Mountain Pumped Storage Development tailrace/intake may experience flow reversals while it is generating. Conversely, the area downstream of the tailrace/intake may experience flow reversals while it is pumping. Each of these flow reversal scenarios are more predominant

[39] As described later, the study also evaluated hydraulics near the entrance to the Station No. 1 and Cabot powerhouse intakes.

[40] The 10 km extended 5 kms upstream and downstream from the Northfield Mountain Pumped Storage Development intake.

under conditions of high TFI levels and low base flow through the TFI. Northfield Mountain Pumped Storage Development operations may also introduce additional eddies in the Connecticut River. Velocity field data collected while the Northfield Mountain Pumped Storage Development was pumping and generating was used to supplement model results in the immediate vicinity of the tailrace/intake. The field data suggest that attraction flows while Northfield is pumping and generating may affect fish migration, and entrainment during pumping may also occur. The study indicates that migratory fish delay is possible during Northfield operations due to velocity barriers, flow reversal, eddies, attraction flows, and entrainment. The results of this study were based solely on a comparison of hydraulic modeling results with reported fish swim speeds. Relative to upstream and downstream passage the results of other migratory fish studies (Study Nos. 3.3.2 *Upstream and Downstream Passage of Adult American Shad*, Study No. 3.3.3 *Evaluate Downstream Passage of Juvenile American Shad*, Study No. 3.3.5 *Evaluate Downstream Passage of American Eel*, and Study No. 3.3.15 *Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area)* will also be assessed to provide a complete picture of how Project operations may impact migratory fish. Results for Study Nos. 3.3.2, 3.3.3, and 3.3.15 are slated to be filed with FERC on October 14, 2016, while Study No. 3.3.5 is slated to be filed with FERC on March 1, 2017 or as directed by FERC in its process plan and schedule.

Downstream Passage

Migratory fish in the TFI or entering the TFI after passing downstream of the Vernon Project migrate downstream through the Turners Falls Development and thence to the Holyoke Project as they return to the sea. These migratory fish include post-spawning adult and juvenile American Shad, Sea Lamprey, and adult American Eel. Other possible downstream migrants include Atlantic Salmon smolts and post-spawning adults, and post-spawning adult and juvenile Blueback Herring, and post-spawning and juvenile Striped Bass, but downstream passage of these three species would be uncommon as few adults have migrated upstream of the Turners Falls Development in recent years. Shortnose Sturgeon have not been recorded as passing upstream of the Project.

Fish passing downstream leave the TFI either by passing over the spillway (bascule gates) or via the tainter gates at Turners Falls Dam to the bypass reach or by exiting through the Gatehouse into the power canal. Migrants entering the power canal have three avenues of outmigration: 1) Station No. 1 turbines, 2) Cabot turbines or 3) a log sluice adjacent to the Cabot Station.

From the power canal there is an approximate 700-foot-long by 100-foot-wide branch canal. At the end of the branch canal is the entrance to Station No. 1, consisting of eight bays, each 15 feet wide for a total intake width of 120 feet. Trashracks are mounted across the entire entrance, totaling 120 feet wide by 20.5 feet high. With a normal canal elevation of approximately 173.5 feet, the effective trashrack opening is approximately 114 feet wide by 15.9 feet high, resulting in a gross area of 1,812.6 square feet (ft^2). The bar thickness is 0.375 inches and the bars are 3 inches on center, thus the clear spacing between bars is 2.625 inches.

Cabot Station is located at the downstream terminus of the power canal. The trashrack opening is 217 feet wide by 31 feet high, resulting in a gross area of 6,727 ft^2. The trashracks are angled, and include upper and lower racks. The top 11 feet of the upper racks have clear bar spacing of 0.94 inches (15/16-inch), and the bottom 7 feet of the upper racks have clear bar spacing of 3 9/16 inches. The entire 13 feet of the lower racks have clear bar spacing of 3 9/16 inches.

The downstream fish passage facility is located at Cabot Station, at the downstream terminus of the power canal. Assuming no spill is occurring at Turners Falls Dam, fish moving downstream pass through the gatehouse (which has no racks) and into the power canal. The Downstream fish passage facilities at Cabot Station consist of: reduced bar-spacing in the upper 11 feet of the intake racks; a broad-crested weir with an elliptical floor developed specifically to enhance fish passage at the log sluice; the log sluice itself, which has been resurfaced to provide a passage route; above-water lighting; and a sampling facility. Although the log sluice gate is approximately 16 feet wide, there is an 8 foot wide weir that is inserted in the sluice opening during downstream fish passage season. The sluiceway is 6 feet high and 180 feet long. With the weir in place, the amount of flow conveyed downstream varies based on the power canal elevation, but typically ranges from 110 to 253 cfs. During fish passage season, the gate is set 3.5 feet open if/when the weir is removed, which results in a flow of approximately 130 cfs. As described for upstream passage, the CRASC also establishes an annual schedule for the operation of downstream fish passage facilities at the Connecticut River dams. Table 3.3.3.1.2-15 lists the 2016 schedule for downstream fish passage operations at the Project.

As part of relicensing, FirstLight is conducting several studies associated with downstream fish passage including the following:

- Study No. 3.3.2 Upstream and Downstream Passage of Adult American Shad
- Study No. 3.3.3 Evaluate Downstream Passage of Juvenile American Shad
- Study No. 3.3.8 Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrance and Powerhouse Forebays
- Study No. 3.3.9 Two–Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace

The purpose of Study No. 3.3.2 is described above under the Upstream Fish Passage section.

The purpose of Study No. 3.3.3 is to evaluate downstream passage of juvenile shad via an assessment of survival over the Turners Falls Dam bascule gates, and through the Station No. 1 and Cabot Station turbines. Study No. 3.3.3 is slated to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

The purpose of Study No. 3.3.8 is to assess the hydraulics near the Cabot Station and Station No. 1 forebay intake racks and the surrounding areas to assess downstream fish passage. Six flow scenarios were modeled at the two forebay study areas: three scenarios for the Station No. 1 forebay, and three scenarios for the Cabot Station forebay. Relative to downstream passage, other studies (Study Nos. 3.3.2 and 3.3.3) are being conducted to evaluate the impact of Project operations on juvenile and adult American Shad. The field data for Study No. 3.3.2 was collected in 2015; however, the analysis and final report will be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule. The field data for Study No. 3.3.3 was collected in 2015 and portions of the study will be repeated in 2016. The final report will be filed with FERC on March 1, 2017 or as directed by FERC in its process plan and schedule. These studies include telemetry data to determine how tagged American Shad adults and juveniles respond to different operating conditions. These telemetry studies, coupled with the CFD hydraulic evaluation, will collectively be used to determine the impact of Project operations on migratory fish movement.

The purpose of Study No. 3.3.9 is described above under the Upstream Fish Passage section.

Historical studies that investigated downstream passage of Atlantic Salmon smolts and juvenile Clupeids (Harza & RMC 1992a, 1992b, 1994a, 1994b; Nguyen & Hecker, 1992; NUSCO 1994, 1995, 1998a, 1998b; RMC, 1994, 1995) indicated that 90% of juvenile Clupeids that entered the power canal exited through the log sluice. Similarly, 73-90% of salmon smolts utilized the downstream passage facilities at Cabot; the majority of American Eels passed through the turbines (Brown, 2005).

3.3.3.2 Environmental Effects

Several issues pertaining to fish and aquatic resources were identified in the scoping process for the Northfield Mountain Pumped Storage Development and Turners Falls Development. In SD2, the following issues were identified:

- Effects of project operations and maintenance (including fluctuations in water levels, and downstream releases) on aquatic habitat and resources in the projects' vicinity (e.g., resident and migratory fish populations; fish spawning, rearing, feeding, and overwintering habitats; mussels and habitat).

- Effects of project facilities and operations, (including reservoir fluctuations, and generation releases) on fish migration through and within project fishways, canals, bypassed reaches, reservoirs, and the downstream riverine corridors.
- Effects of entrainment on fish.

3.3.3.2.1 Effect of Project Operations

Habitat Assessment

The Connecticut River and its tributaries in the Turners Falls Development area and in downstream reaches are composed of a variety of habitats for aquatic vegetation and for game and non-game fish species, including Spottail Shiner, White Sucker, Yellow Perch, Smallmouth Bass, Bluegill, Fallfish, Rock Bass, Pumpkinseed, Tessellated Darter, Walleye, Common Shiner, American Eel, Largemouth Bass, Golden Shiner, Black Crappie, Channel Catfish, Brown Bullhead, Common Carp, Chain Pickerel, Sea Lamprey, Mimic Shiner, Northern Pike, American Shad and other important minnow and forage species.

Turners Falls Impoundment

The Licensee has undertaken Study No. 3.3.14 *Aquatic Habitat Mapping of the Turners Falls Impoundment* to determine the types of aquatic habitats present within the TFI, and the distribution and abundance of those habitats (Section 3.3.3.1), and to identify any potential effects of operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development on those habitats. Study No. 3.3.14 was filed with FERC on September 14, 2015.

The upstream reach of the TFI, extending from Vernon Dam tailrace to the Northfield Mountain Pumped Storage Development tailwater/intake, is located within a broad flood plain and is relatively uniform and generally shallow, with gentle bends. There are a few narrow islands comprised of alluvial materials such as gravel, cobble and fines.

The downstream reach from the Northfield Mountain Pumped Storage Development tailrace/intake approximately five miles downstream to the Turners Falls Dam is dominated by bedrock, which controls much of the stream geometry and substrate features. The lower reach impoundment geometry is complex. It is defined by both bedrock and depositional features, and includes a complex of embayment, points, coves, islands, and a wide range of substrates, and features shallow lacustrine littoral habitat with a deeply incised thalweg, in contrast to the riverine habitat in the upper reaches.

As indicated previously in Section 3.3.3.1, Study No. 3.3.13 *Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat* identified the timing and locations of fish spawning in the littoral zone of the TFI, and qualitatively described the shallow water habitat types (i.e., substrate composition, vegetation presence and type, elevation, water velocity, etc.) during field efforts of 2015. Data analyses remain ongoing to determine potential impacts of water level fluctuations on these aquatic habitats in the TFI due to operations of the Turners Falls and Northfield Mountain Pumped Storage Developments. Results will be incorporated into a final report that will be filed with FERC by October 14, 2016.

Bypass Reach and below Cabot Station

The Licensee has conducted instream flow studies (Study No. 3.3.1 *Instream Flow Studies in Bypass Channel and below Cabot Station*) in the following locations: a) in the bypass reach from the Turners Falls Dam to the Montague USGS Gage, and b) from the USGS Gage to the Sunderland Bridge (below Cabot Station). In addition, in the reach between the Sunderland Bridge and the Dinosaur Footprints Reservation, a habitat assessment may be conducted on state or federally listed mussels pending a screening analyses (not completed) as described in the RSP.

Aquatic habitat suitability was evaluated using techniques described in the Instream Flow Incremental Methodology (IFIM) developed by the National Ecology Research Center of the National Biological Survey (Bovee, 1982; Bovee, *et al*., 1998; Milhouse *et al*., 1989). These techniques included standard field procedures and Physical Habitat Simulation (PHABSIM) modeling. The IFIM quantifies habitat for selected species over a range of flows using habitat suitability index (HSI) criteria that are based on depth, velocity and substrate

The study reaches identified in consultation with stakeholders were:

- Reach 1: Turners Falls Dam downstream to the tailrace of Station Number 1 (~0.75 miles)
- Reach 2: Tailrace of Station No. 1 downstream to Rock Dam (~1 mile)
- Reach 3: Rock Dam downstream to the confluence with the Deerfield River (including Cabot tailrace) near the Montague USGS stream flow gage (~1.5 miles)
- Reach 4: USGS Montague Gage downstream to Route 116 in Sunderland, MA (~9 miles)
- Reach 5: Sunderland Bridge downstream to Dinosaur Footprint Park (~22 miles)

Based on the results of literature reviews and consultation with stakeholders, HSI criteria were established for multiple life stages of American Shad, Blueback Herring, Shortnose Sturgeon, White Sucker, Fallfish, Walleye, Sea Lamprey, Longnose Dace, Tessellated Darter, benthic macroinvertebrates, and the following habitat use fish guilds: shallow-slow, shallow-fast, deep-slow, and deep-fast.

In Reach 1 and Reach 2, a one-dimensional model was developed to predict changes in depth and velocity as discharge varies. In addition, a two-dimensional model was developed to simulate hydraulics in the lowermost extreme of Reach 2, and also Reach 3 (the vicinity of the Cabot Station tailrace, from the upstream end of Rawson Island downstream to just below the Deerfield River confluence). Data collected to calibrate the model, included hydraulic data, bed profiles, substrate and cover data, and velocity/current data. Reach 4 will be modeled using the one-dimensional model approach. Field data collection for Reach 4 was completed in September 2015 and the results of the instream flow studies will be included in a final report slated for filing with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

Tributary Streams

The Licensee performed systematic surveys in the spring, summer, and fall of 2014 (Study No. 3.3.17 *Assess the Impact of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat*) to assess the effects of operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development on tributary and backwater area habitat and access to that habitat under a range of hydrologic conditions. The confluences of 19 tributaries to the Connecticut River located between Vernon Dam and the Route 116 Bridge in Sunderland, MA were surveyed to determine if water level fluctuations from the operation of the Turners Falls Development and Northfield Mountain Pumped Storage Developments resulted in reductions of available aquatic habitat. During field sampling the maximum and minimum water levels ranged from 184.2 feet to 178.33 feet as measured at the Turners Falls Dam. Potential barriers to migration/movement were observed at three of the 19 tributaries, namely Merriam Brook, Pine Meadow Brook, and Fourmile Brook; however, it appeared that the barriers were attributable to natural phenomena, such as woody debris accumulation, sediment deposition, or seasonal flow characteristics, rather than to Project-related water level fluctuations. As the observed barriers appeared temporary and localized, it appears that Project operations do not substantially impact access to and habitat within the tributaries. The tributary access report was filed with FERC on September 14, 2015.

Power Canal

While typical Project operations do not materially affect water levels in the power canal, the Licensee performs week-long annual canal drawdowns to facilitate inspections and maintenance, typically during late September or early October. The Licensee conducted a canal drawdown study during the 2014 drawdown (Study No. 3.3.18 *Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms*). A field survey was conducted in the lower portion of the canal during the 2014 drawdown to gain an understanding of the effects of the drawdown on aquatic species. Since the upper portion of the canal, just before it widens, remains wetted for the duration of the outage, the aquatic species survey was performed only in the lower portion of the canal, where it begins to widen along Migratory Way. The topography of the lower portion of the canal varies with large areas of silt deposits, areas of exposed bedrock, and areas with fines and cobble.

A survey was performed in the soft sediments in the lower portion of the Turners Falls Canal during the 2014 drawdown to document the presence of ammocoetes and to determine if the annual drawdown of the canal exposes Sea Lamprey burrowing substrate. Thirty-two 1 m x 1 m quadrats were sited within soft sediments and systematically searched for the presence of lamprey ammocoetes. The quadrat sampling was performed on the day immediately following the release of water from the canal (initial survey), as well as the day prior to rewatering. Of the 64 quadrats sampled (32 during initial survey and 32 during day-prior-to-rewatering survey), only 11 ammocoetes and one transformer (individuals transitioning from ammocoete to juvenile stage) were identified, all of which were alive. The lamprey specimens were all found buried in the substrate, which likely serves to prevent desiccation and support survival until the canal is refilled.

In addition to lamprey ammocoetes, quadrat sampling identified mudpuppies and two species of mussels, Eastern Elliptio and Alewife Floaters. Almost all of the mussels found were Eastern Elliptio (n=534); only one Alewife Floater was observed. Mussels tended to be concentrated at sites proximal to the canal's thalweg. All mussels observed during the sampling events were alive, and 2 of the 3 mudpuppies observed were dead.

The pools that remain in the lower portion of the canal subsequent to draining were sampled by electrofishing or seining. Twenty-two fish and one amphibian species were observed in the pools. Spottail Shiner, Tessellated Darter, and juvenile American Shad were the most abundant fish species observed. All fishes captured in the pools were alive at the time of collection, suggesting that observed mortalities at the time of sample processing were likely due to handling and temporary holding associated with sampling.

Based on results of the 2014 sampling effort, it appears that the annual drawdown has little effect on Connecticut River aquatic species. As the canal drawdown is initiated, the turbine bays at Cabot Station and Station No. 1, as well as various gates within the canal allow egress for fish. Canal geometry is such that the upper portion of the canal, just before it widens, remains wetted for the duration of the drawdown, and Keith's Tunnel is open with substantial flow through it during the duration of the drawdown. This area provides a refuge area for fishes that remain following the release of water from the lower canal. In addition, a series of pools remain in the lower portion of the canal that provide wetted habitat for fishes and mussels that remain trapped within the canal for the week-long drawdown. Although the size of some of the pools decreased over the course of the week spanning the drawdown, most of the pools (11 of the 14 identified) were observed to be hydraulically connected and allowed fish to progress downstream toward a larger pool that remains upstream of the Cabot intake.

Results of the meander survey conducted in the lower portion of the canal during the 2014 drawdown revealed an estimated 766 fish, representing nine species, were stranded following release of the canal water. American Shad and sunfish species (e.g., Bluegill, Pumpkinseed, Largemouth Bass, and Rock Bass) accounted for nearly 50% of the observed stranded fishes. Overall, these results suggest minor impacts to Connecticut River fish populations, and the absence of freshly dead mussels suggests that the drawdown did not adversely affect Connecticut River mussel populations.

The Canal Drawdown report (Study No. 3.3.18) was filed with FERC in September 2014 and an addendum was subsequently submitted on March 1, 2016.

Migratory Fish

Several studies have been conducted to examine potential effects of Project operation on migratory fish.

American Shad

The following studies addressed American Shad in Project area

- Study No. 3.3.2 Evaluation of Upstream and Downstream Passage of Adult American Shad,
- Study No. 3.3.3 Evaluation of Downstream Passage of Juvenile American Shad,
- Study No. 3.3.6 Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects, and
- Study No. 3.3.20 Ichthyoplankton Entrainment Assessment at the Northfield Project.

Data analyses for Study Nos. 3.3.2 and 3.3.3 remain ongoing and results will be included in final reports to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

As described previously, Study No. 3.3.6 identified shad spawning locations in Connecticut River reach extending from the Cabot Station tailrace to the Route 116 Bridge in Sunderland, MA between May 13 and June 22, 2015 via visual and aural surveys. Additional spawning was documented in the TFI, the Power Canal, and near Rock Dam and the plunge pool just below the Turners Falls Dam in the bypass reach. The assessment of Project operation effects was limited to the areas identified downstream of Cabot Station. Projects effects were assessed by counting the number of splashes (to provide an index of shad spawning activity) before and after changes in operations at Cabot Station. In accordance with the RSP, the changes in generation that were assessed included increasing or decreasing generation by one and two units.

The 2015 surveys confirmed that some of the same general areas observed by researchers in the 1970s remain active spawning grounds for shad. Spawning activity was observed downstream of Cabot Station under a variety of operational and environmental conditions. Spawning activity appeared to be most influenced by photoperiod, with peak activity identified when photoperiod ranged between 14.8 and 15.0 hours. Time-since-sunset was also identified as having a greater effect on spawning activity than Cabot Station generation, with results suggesting that spawning activity decreases over the course of a night regardless of Cabot Station operations.

Throughout the 2015 study period, shad spawning areas comprised approximately 106 acres in the downstream reach between Cabot Station and the Route 116 Bridge. Based on the changes in Cabot Station generation that were assessed (increasing and decreasing generation by 1 and 2 units), the surface areas of the downstream spawning sites exhibited little to no changes, with an estimated maximum decrease in spawning area of 2% at a spawning site in the vicinity of RM 118. Considering the range of flow conditions in the Connecticut River throughout the entire 2015 study period, water surface elevations (WSELs) at the spawning sites in the downstream reach fluctuated by a maximum of 10.7 ft (difference between minimum and maximum WSEL over the course of the entire season), with the WSELs on the surveys dates when shad spawning was observed ranging from 105.7 ft to 115.3 ft (a difference of 9.6 ft). Layzer (1974) reported that although water levels fluctuated up to 6 ft throughout the 1972 spawning period, with corresponding changes in water velocity, shad continued to spawn at these sites. It should be noted that Cabot Station and Station No. 1 have no ability to regulate flow when Montague Gage readings exceed approximately 18,000 cfs as this represents the approximate hydraulic capacity of the Turners Falls Power Canal and additional flow from the Deerfield River.

The relationships between Cabot Station generation and effects on downstream habitat in terms of WSEL, velocity and depth was determined to be positive, such that as generation increased, WSEL, velocity and depth also increased at each of the downstream spawning sites and vice versa. Measured surface velocities ranged from 0.1 to 2.8 fps, while modeled mean channel velocities ranged from 2.0 to 6.6 fps throughout the 2015 study period. As shad spawning was observed under a range of velocities, it is likely that surface velocity may not be an important factor in site use. Alternatively, Layzer (1974) suggested that water velocity closer to the substrate may be more important than surface velocity for shad spawning as sufficient velocity along the bottom is required to promote egg survival. Water velocity measurements in the field were collected about 1 ft below the surface, generally towards the river banks, and the modeled channel velocities represent mean channel conditions.

Similarly, the depths of the spawning areas varied at the times of observation as well as throughout the spawning period. Measured depths at spawning locations, which were typically recorded closer to the banks, ranged from 5.5 to 9.5 ft and modeled mean channel depths were estimated to range from 7.0 to 25.2 ft at the downstream spawning sites. With previous research documenting spawning at a variety of depths, it is likely that depth is not a critical factor in site selection for spawning shad. Stier & Crance (1985) indicate the optimum depth range for all life stages (spawning, egg, incubation, larvae, and juvenile) is approximately 4.9 to 20 ft.

It appears that photoperiod and time since sunset are more influential on shad spawning activity than physical changes at spawning sites related to Project operations. American Shad appeared to spawn over large areas, both longitudinally and laterally, often encompassing a range of conditions. Physical habitat variables, such as depth, velocity, and substrate often vary longitudinally and laterally within rivers, and with spawning documented under a range of physical conditions, temporal variables (time of day or year) appear more influential in terms of predictors of shad spawning. The final report for Study No. 3.3.6 was filed with FERC on March 1, 2016.

The Licensee undertook Study No. 3.3.20 to quantify entrainment of various life stages of American Shad ichthyoplankton (eggs, yolk-sac and post yolk-sac larvae) at the Northfield Mountain Pumped Storage Development from May 28 to July 17, 2015. Ichthyoplankton samples were collected both in the powerhouse during pump-back (pumping water from Connecticut River to the Upper Reservoir for storage) operations as well as in the river adjacent to the intake/tailrace channel. At least once per week samples were collected every two (2) hours during a pumping cycle. These were designated as ***Random*** samples because the number of pumps operated during sampling was not controlled. In addition, pump-back operations were manipulated to specifically sample operations with 1 2, 3, and 4 pumps running (***Scenario*** samples). To validate that ichthyoplankton collection densities were representative of densities in the intake tunnel, paired samples from inside of the powerhouse (entrainment) and from the intake/tailrace channel (offshore) were collected for each scenario (1, 2, 3 and 4 units pumping). The ichthyoplankton samples were sorted in a laboratory by biologists trained in the identification of the life stages of species common to the Connecticut River.

In terms of American Shad life stages, no larvae and only eggs were observed in the powerhouse samples. Densities (no. organisms per 100 m^3) of eggs in the samples ranged from 0 to 31 eggs per 100 m^3. While the shad ichthyoplankton densities in samples collected at the Northfield Mountain Pumped Storage Development powerhouse were low, when extrapolated by the entire volume of water pumped during the spawning season, just over 3 million shad eggs and 500,000 shad larvae were estimated to be entrained in 2015. However, to put these numbers in perspective, American Shad spawning strategy includes broadcasting large numbers of eggs which experience high natural mortality. American Shad spawn between 150,000-500,000 eggs per female, and fecundity increases with age, length, and weight (Savoy *et al.*, 2004). Fecundity estimates are higher for broadcast spawners, which do not build protective nests to guard their young from predators. As such, the survival fractions for broadcast spawners tend to be low.

Since only about 1 out of every 100,000 eggs survives to become a spawning adult, high fecundity is critical for sustaining the stock (Savoy *et al.*, 2004). American Shad eggs in the Connecticut River experienced annual mortality ranging from 24% to 44% per day between 1979 and 1987 (Savoy & Crecco, 1988). As a consequence, between 5% and 19% of the fertilized eggs survive to hatching (Savoy & Crecco, 1988). American Shad larval mortality rates are highest (17-26% per day) among first-feeding larvae, and then decline throughout larval development (Crecco *et al.*, 1983). The larval stage for American Shad lasts between 4 and 6 weeks, during which the larvae grow fairly rapidly (0.4 mm day) to about 22-26 mm TL

(Savoy & Crecco, 1988). Based on the 1979-1984 survivorship data, 60-80% of newly hatched larvae die within 3 to 7 days after feeding begins.

The number of equivalent juvenile and adults lost to entrainment at the Northfield Mountain Pumped Storage Development annually was estimated to be 696 juvenile shad or 94 adult American Shad for the 2015 shad spawning season based on the entrainment estimates and published survival fractions. To put these numbers into perspective, the number of American Shad passed in 2015 at the Turners Falls Gatehouse fishway and the Vernon fishway were 58,079 and 39,791, respectively. The final report for Study No. 3.3.20 was filed with FERC on March 1, 2016.

The Licensee conducted a study (Study No. 3.3.2), in accordance with the RSP, to evaluate the upstream and downstream passage of adult American Shad at the Turners Falls Development and Northfield Mountain Pumped Storage Development. The purpose of the study was to assess effectiveness of existing fish passage facilities at Turners Falls Development, evaluate routes of upstream and downstream passage through the Turners Falls Development and Northfield Mountain Pumped Storage Development, and evaluate the effects of Project operation on upstream and downstream shad migrants.

A combination of active and passive telemetry techniques were employed to assess impacts of the Project on adult shad migrating upstream. In total, 793 adult American Shad were collected, tagged and released in the Project area during May and June 2015. The upstream passage of the tagged fish was monitored at fixed stations within the Project area, as well as mobile tracked between Mount Hermon School and the Holyoke Project from May through early July. The report for the adult shad passage study is slated to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

A study conducted from 1973 through 1976 (Layzer, 1976) indicated that the Northfield Mountain Pumped Storage Development intake/tailrace had no clear effect on shad movement through the TFI. During that time, 6,373 shad were transported to the TFI from the Holyoke Dam fish lift. Of those, 125 shad were tagged with ultrasonic transmitters and their movements were monitored. Most shad were found to exhibit one of four behavior patterns: 1) 45% of the tagged fish never migrated through the narrow turbulent area below the French King Bridge (RM 126); 2) 18% remained within two miles of the Northfield Mountain Pumped Storage Development tailrace; 3) 21% migrated upstream passing the Northfield Mountain Pumped Storage Development tailrace with little or no delay; and 4) 16% exhibited greater movement up and downstream than fish in the other groups including some movement up to Vernon Dam. Layzer (1976) reported that the distance traveled in the TFI was related to water temperature. Shad that were tracked displayed a preference for deeper sections of the river.

In addition to studies by the Licensee, the USFWS Connecticut River Coordinator and the USGS Conte Anadromous Fish Research Laboratory have recently released radio tagged adult shad at various points in the river and tracked their movements from the release point to Vernon Dam. Results from that study will be available once data analysis has been completed.

To assess any effect of the Project on outmigrating juvenile American Shad, the Licensee evaluated the timing, duration, and magnitude of juvenile outmigration during fall of 2015 using hydroacoustics (split beam sonar) equipment that was installed at the Northfield Mountain Pumped Storage Development intake/tailrace, Turners Falls Canal, and Cabot Station. Radio telemetry was used to evaluate route selection as juveniles migrated downstream past the Northfield Mountain intakes and Turners Falls Development. External radio transmitters (Lotek NanoTag Series model NTQ – 1) were affixed to 224 juvenile American Shad and their movements through the Project area were tracked.

American Eel

Currently, there are no passage facilities for American Eel at the Turners Falls Development although some young eels apparently enter the TFI by ascending the fishways or other wetted structures associated with the Project.

In accordance with the FERC approved RSP (Study No. 3.3.4), the Licensee conducted a study during the 2014 upstream eel migration season to identify and assess potential locations for upstream eel passage at the Turners Falls Development. The objectives of the study were to identify areas where eels congregated or attempted to ascend wetted structures, to assess whether eels could be passed in substantial numbers, and to identify sites for permanent eel passage structures. Eleven nighttime surveys were performed between June 11 and October 9, 2014. Several areas within the Project, including the Cabot Station discharge area and fishway, Station No. 1 discharge area, various canal discharge areas, and the Turners Falls Dam and Spillway fishway were routinely surveyed and the approximate number of eels, the date and time, eel behavior, and the environmental conditions (e.g., weather, leakage, discharge) were recorded. The Spillway Fishway accounted for 94% of the 6,263 eels observed during the study period.

Temporary eel passes were installed in 2015 at the Spillway fishway, Cabot fishway, and the emergency spillway at Cabot to quantify the eel passage at the Project and to help select a location or locations for permanent passage structures. In addition, two Medusa traps were deployed at the Station No. 1 discharge in July 2015 to monitor eels attempting to migrate up through Station No. 1. The traps consisted of mop heads contained within submerged, perforated 5-gallon buckets, designed to passively collect juvenile eels seeking refuge. The ramps and Medusa traps were operated continuously between July 10 and November 2, 2015 with collections quantified every 2-3 days. Recorded data included location, trapping interval, numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period. All eels collected were transported to and released in the TFI following processing. Table 3.3.3.1.2-9 summarizes the number of eel collected at each location during the study. The majority, 87.7% (n=5,235), was collected at the Spillway Fishway, followed by the Cabot Emergency Spillway and Cabot Fishway, which collected 7.1% (n=424) and 5.2% (n=319), respectively. No eels were collected at the Medusa traps deployed at Station No. 1. Temporally, eel collections occurred from July 10 through October 4, with the peak occurring toward the end of July. Water temperature at the onset of the monitoring period was 21.7°C (July 10) and decreased to 14.9°C on the last day eels were observed (October 4). Most of the eels measured between 10 and 20 cm (total length). The Pearson Correlation Coefficient test suggested no correlation between the rate of eel collection and precipitation (r=-0.1962) or daily river flow (r=0.0429).

In addition to evaluating upstream passage at the Turners Falls Development, the Licensee has conducted a study to assess downstream passage of outmigrating silver American Eels relative to environmental factors and operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development (Study No. 3.3.5). A combination of split beam sonar and dual frequency identification sonar (DIDSON) was used to monitor eel entrainment and movement through the Project area from August 1 to October 31, 2015. The split beam sonar equipment was deployed at the Northfield Mountain Pumped Storage Development tailrace/intake, within the Turners Falls Canal, and in front of the Cabot Station intake. Both the DIDSONs and the split beam sonar collected data continually throughout the duration of their deployment.

The downstream fish bypass at Cabot Station was sampled on 12 to 18 nights in September and October to ground-truth the hydroacoustic data and compare the percent of eels passing via the Cabot log sluice and Cabot Station. Analysis of these will be included in a final report to be filed with FERC on March 1, 2017 or as directed by FERC in its process plan and schedule.

In addition to assessing migration timing, the Licensee assessed the routes selected during downstream passage and the entrainment survival of adult American Eel using radiotelemetry techniques at the Turners Falls Development and Northfield Mountain Pumped Storage Development, beginning in October 2015. Fixed radio receivers were located as indicated in Table 3.3.3.2.2-1 and tagged individuals released downstream of the Northfield Mountain Pumped Storage Development were mobile-tracked as well. The movements of tagged eels were monitored until water temperature had declined to 5°C.

The passage route and survival studies required a large number of adult eel to achieve an adequate sample size (n=432). There was concern that collecting this quantity of eel within the Connecticut River drainage might not be achievable. For that reason, the Licensee proposed and received agency approval to import silver eel from a commercial fishery in Newfoundland, Canada. A permit was issued for importation into the State of Massachusetts; the permit required a quarantine inspection to ensure that eels for use in the Connecticut River studies would be pathogen-free. The eye diameter and length of the study eels were measured to confirm that they were in the silver phase (i.e.., eye diameter relative to body size - Pankhurst Index of approximately 6.5 or greater). Analysis of the data collected during this study will be incorporated in a final report to be filed with FERC on March 1, 2017 or as directed by FERC in its process plan and schedule.

Sea Lamprey

The Licensee identified spawning locations within the Project area and monitored redds in 2015 to assess whether operations of the Turners Falls Development and Northfield Mountain Pumped Storage Development potentially impact these spawning areas. These data will be considered in conjunction with the hydraulic model and IFIM results to determine if Project-induced flow alterations adversely affect Sea Lamprey spawning in the Project area. The analysis remains ongoing and results will be included in a final report slated to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

Shortnose Sturgeon

In support of relicensing, the Licensee conducted a study to assess the impact of sediment disturbance and excessive velocities resulting from emergency water control gate discharge and bypass flume spill events on Shortnose Sturgeon spawning and incubation habitat in the Cabot Station tailrace and downstream areas. The goal of this study was to determine the frequency of spill events during sturgeon spawning, and, if deemed necessary, determine appropriate protocols for operation of the emergency water control gates and bypass flume.

In addition to performing an analysis to describe the frequency and magnitude of flows through the emergency spill gates and log sluice during the sturgeon spawning period, the Licensee developed a two-dimensional model to evaluate the impact of these flows on sediment transport and bottom velocities within known Shortnose Sturgeon spawning and rearing habitat below Cabot Station. The initial report for Study No. 3.3.12 was previously filed with FERC in September 2014. The previously filed report updated to include the sediment impacts as noted was filed with FERC on March 1, 2016.

With River2D, ten baseline scenarios were modeled including Cabot Station generating without flows from the emergency spillway gates, with varying flows in the bypass reach and from the Deerfield River. To model emergency spillway gate operations, nine scenarios were modeled including flows from the emergency spillway gates and Cabot Station generating or not generating, with varying flows in the bypass reach and from the Deerfield River. These scenarios produced WSELs, velocity, shear stress, and other variables throughout the modeled area. The potential for substrate mobilization (relative shear stress) was determined by dividing shear stress by critical stress. Relative shear stress is very sensitive to particle size since smaller particles have a smaller critical stress meaning that higher relative shear stress represents higher substrate mobilization potential. FirstLight analyzed the changes in the velocity and relative shear stress between baseline conditions and emergency spillway gate operations among scenarios with the same total river flow. These analyses indicated that higher velocities and relative shear stress generally occur on the western side of the main channel during operation of the emergency spillway gates. However, the location and magnitude of these values and changes are dependent on the relative amount of flow from the emergency spillway gates, Cabot Station, and the bypass reach.

Flow events from the emergency spillway at Cabot Station have the potential to mobilize sandy substrate at all spill flows modeled, with some variability resulting from different operational conditions. Mobilized substrate has the potential to affect sturgeon eggs and larvae. However, mobilization of sand and fine-grained substrates in the study area may also occur in the absence of discharge from the emergency spillway, with large areas of mobilization predicted during relatively common springtime bypass reach flows. These conditions occur naturally, at comparable magnitudes to conditions modeled over a range of emergency spillway discharges. High bypass flows will also occur over longer time periods than the brief discharge events from the emergency spillway.

During recent years, FirstLight has modified operation of the emergency spillway gates, such that spill events of the greatest magnitude only result from emergencies. In these cases, spill was necessary to ensure station viability and/or public safety. It is anticipated that release of high flows from the emergency spillway in the future will only be due to emergency events.

A draft biological assessment will be filed with FERC as part of an amended Final License Application once the impact analysis and the IFIM are completed.

3.3.3.2.2 Effect on Fish Passage

The history of the passage of anadromous fish (primarily American Shad and Atlantic Salmon) at the Turners Falls Development since 1980, the first year of upstream passage facility operation at the development, is divided into four periods as follows:

- From the first year of upstream passage facility operation (1980) to the signing of an agreement to develop downstream passage facilities (1990);
- From 1990 through 1998, when downstream passage facilities were designed, constructed, and evaluated;
- From the beginning of an overall evaluation of upstream passage at the project (1998) through the installation of a new entrance to the Gatehouse fishway (2007); and
- From the first year of new entrance operation (2008) to the present.

Each of the four periods was influenced by a different set of priorities; activities in each period were driven by a mix of the following:

- Connecticut River Atlantic Salmon Commission (CRASC) and resource agency actions;
- Research supported by FirstLight and its predecessors to evaluate fish passage, some required or recommended by the regulatory agencies, some not; and
- FirstLight's observations on fish passage and the relationship between fish passage and Project operations.

The following summarizes regulatory events, fish passage, passage evaluation, and changes in infrastructure and operations within each period. The CRASC, its predecessor, and its member agencies have provided agency oversight of fish passage at Turners Falls. CRASC comprises two representatives of each of the four Connecticut River basin states (Vermont, New Hampshire, Massachusetts (MDFW) and Connecticut), USFWS, and NMFS. CRASC presided over the Connecticut River Atlantic Salmon Restoration Program from its inception until 2013, when the program was abandoned.

In 1976, Western Massachusetts Electric Company (the Company), the state and federal agencies that later formed CRASC, the Environmental Defense Fund, Inc., For Land's Sake, Massachusetts Public Interest Group, Inc., and Trout Unlimited signed the Settlement Agreement leading to construction of upstream fish passage facilities at Turners Falls. The fishways were designed in consultation with state and federal agencies, and were constructed, and operated for the first time in 1980. The MDFW monitored fish passage, providing fish counts throughout this period. Shad counts at the Gatehouse fishway are depicted in Figure 3.3.3.2.2-1, with counts during the first decade of upstream passage facility operation highlighted. Since most (~90%) of the adult Atlantic Salmon returning to the Connecticut River were trapped at the Holyoke fishway and removed from the Connecticut River, salmon passage at Turners Falls did not have high priority. Of those salmon that were released at Holyoke, many also passed through the Turners Falls fishways with relative ease.

Shad passage through the Cabot fishway was disappointing during the first two years of operation (687 passed in 1980, 224 in 1981), and a FERC-required evaluation indicated that many shad were entering the

Cabot fishway but failing to pass through it. Since the Cabot fishway and power canal were expected to be the primary route of passage to the Gatehouse fishway and subsequently into the TFI, company and agency representatives met in 1982 to develop modifications that would improve passage through Cabot.

The result was an aggressive modification of the original Ice Harbor design to close off one of the two overflow sections in each weir on alternating sides, and to close one of the two orifices in each weir and reduce the size of the open orifice, again on alternating sides. The objective was to reduce eddies in the fishway pools that appeared to confuse upstream migrants. Results were immediate; over 26,000 shad passed through the Cabot fishway in 1983. After the success at Cabot, the Spillway fishway was similarly modified prior to the 1984 migration season, with similar though less dramatic results.

Meanwhile, passage through the Gatehouse fishway failed to meet expectations. Although variability between years was high, it appeared that, of the shad passing through the Cabot fishway, only about half continued on to pass through the Gatehouse fishway into the TFI. Then, in 1985, the company submitted an Application for Amendment to FERC to add a seventh generating unit at Cabot Station. At that time, and as a result of consultations on the Application, the company supported the following studies to address agency concerns:

- Movement of adult shad in the Cabot canal using radio telemetry and hydroacoustic techniques;
- Statistical analysis of the relationship between shad counts, canal flow, and water surface elevation in the TFI;
- Video monitoring of shad movement through the Gatehouse fishway entrances and through a potential additional entrance; and
- Hydraulic modeling of the upper canal to develop concepts for operational and structural changes that would reduce turbulence in the approach to the Gatehouse fishway entrances.

Based on the results of these studies, the company took steps to try to improve shad passage through the Gatehouse fishway. First the hydraulic modeling and field observation led to modification of headgate operation to spread flow into the canal more evenly across the gatehouse and reduce turbulence immediately downstream. In addition, the upstream edges of the piers separating the three openings at the fishway entrance were rounded (prior to the 1987 passage season) to reduce flow separation at the entrances, and sills at the bottom of each of the three openings were lowered (after the 1987 season) to enlarge the effective size of the openings and to accommodate low water surface elevations in the canal. Alteration of the headgate operation protocol did not appear to affect shad passage and was eventually abandoned.

The company also proposed to install a 40-ft wall extending downstream from the entrances into the power canal to eliminate turbulence in the approach to the entrances; the wall was suggested by the results of the hydraulic modeling. The agencies reviewed the company's proposal but advised against it, questioning the potential efficacy of the reduction in turbulence relative to shad passage. They also suggested that the resources that would have to be put into the wall would be better used to install a new gatehouse fishway entrance on the side of the canal opposite the existing entrances. The company dropped the wall proposal and its plan to add a seventh unit at Cabot Station, and did not pursue evaluation of the potential for a new entrance until 2004.

Activities related to the proposed seventh unit at Cabot aside, the number of shad passing through the fishways during the period from 1983 to 1990 continued to exceed the numbers seen in the first three years of fishway operation with a somewhat upward trend. The numbers still failed to meet expectations. In addition to modification of the Cabot and Spillway fishways (lower fishways), changes during the period included overhaul of automated fishway controls at all the fishways, and, prior to the 1990 migration season, redistribution of rock rubble that had accumulated on the bottom of the left side of the canal, downstream of the Gatehouse fishway entrances. The redistribution was not carried out specifically to enhance fish passage, but proportionally more shad passing through the lower fishways passed through the Gatehouse fishway in 1990 than in any other year of fishway operation. The high rate of passage in 1990 may have been at least partially attributable to the redistribution of that rubble.

Since attention had been focused on the Gatehouse fishway during the latter part of this period, the lower fishways were largely left as they were configured in 1984, with only minor adjustments.

Downstream passage was not included in the 1976 Settlement Agreement, but company and agency attention began to turn to downstream passage of Atlantic Salmon smolts and juvenile and spent adult shad as upstream passage improved, and as the Connecticut River salmon restoration program ramped up. During this period, the restoration program included raising salmon from the egg to smolt life stages and releasing smolts in the river and its tributaries. The entrance gallery at the Turners Falls Gatehouse fishway was one of the places where pre-smolts were released. The entrance gallery was blocked/screened off at either end, and flow was provided, then pre-smolts were introduced. MDFW monitored the behavior of the fish until they began to show signs of transforming to the smolt stage, then screens were removed and the fish were allowed to leave the entrance gallery and transit to the river via the Spillway fishway. Stocking and release occurred before the upstream passage season started; the practice continued from 1982 through 1987.

Downstream passage was provided for adult and juvenile shad beginning in 1983. The sluice adjacent to Cabot Station was opened during expected migration periods; passage of shad was observed by Massachusetts Cooperative Fisheries Research Unit personnel, who provided estimates of adult shad passing through the sluice in 1983 through 1988. Except for 1984, when only 6,394 shad passed upstream through the lower fishways, the estimated number of adult shad passed downstream through the sluice ranged from 11,488 to 18,764; annual estimates were discontinued after 1988. CRASC first issued guidelines for operation of the sluice in 1988. Guidelines such as dates to open and close the sluiceway have been issued every year since then.

In 1989, USFWS requested that FERC require downstream passage facilities at Turners Falls; FERC did not act on the USFWS request. The company recognized the need for the facilities and entered discussions with CRASC and its member agencies. Following negotiation, the company and CRASC signed a Memorandum of Agreement (MOA) establishing a schedule for the development of downstream passage facilities for shad and salmon at Turners Falls.

Relatively minor changes were made at the fishways during the next period from 1990 to 1998. Fishway controls, which allow automated operation, were updated. Observations at the Cabot fishway led to the conclusion that shad passage was being hampered by a tendency for fish to accumulate in the fishway turn pools, and that the percentage of shad successfully passing through the fishway once they had entered it was low. Chain-link fencing was installed in the turn pools and in the exit flume along the axis of the fishway in a way that restricted the accessible area at those points to about half the original area. The purpose of the chain-link fencing was to reduce the tendency for shad to accumulate in the turn pools and swim back and forth in the exit flume before entering the canal. The effect of the chain-link fencing has been unclear (except for the fencing in the exit flume, which nearly eliminated the milling that had occurred there), but the chain-link fencing has remained in place to the present.

In addition to the changes at the fishways, the company and USFWS cooperated on a radiotelemetry study of shad movement between Holyoke and Turners Falls in 1993 to understand how many of the shad passing through the Holyoke fish lift were reaching the Cabot Station area, and what their path was once arriving there. About 40% of the fish tagged and released from Holyoke reached Cabot, and 60% of tagged shad arriving at Cabot entered the Cabot fishway. Less than 10% of the number entering the fishway eventually passed through it.

The number of shad passing through the Gatehouse fishway was higher at the start of this period (1990 to 1992) than it had been in previous years (Figure 3.3.3.2.2-2). The total number of shad passed in 1992 was the highest ever passed. The number of shad passed at the Holyoke fish lift, downstream of Turners Falls, also peaked in those years. Shad passage at Turners Falls declined sharply after 1992 prompting USFWS to request that the company meet with the agencies to discuss ways to improve shad passage in 1998. The company responded positively to the request, resulting in development of a long-term plan (described in the next section) to evaluate and enhance passage.

Another change that occurred during this period was the automation of canal operation in 1995 and subsequent years. This change appears to have had effects on passage that were not recognized until the evaluations that were part of the long-term passage plan (described below) began to produce results.

After the MOA was signed in 1990, the company commissioned a pre-feasibility study of potential downstream passage facilities at Cabot Station. The pre-feasibility study, previous experience, and 1991 studies of the passage of salmon smolts and juvenile shad passing via the Cabot log sluice (sluice) rather than through the Cabot generating units suggested that substantial passage through the sluice could be achieved with modification of the sluice and intake racks.

As a result, the company evaluated two changes in 1992: 1) cutting three openings through the intake racks near the surface to provide a path for fish into a trough behind the racks which leads to the sluice; and 2) making the entrance to the sluice deeper and narrower, using a bulkhead insert. Passage of salmon smolts was evaluated using standard radiotelemetry techniques. Juvenile shad passing through the turbines were sampled using nets deployed downstream of the racks; those passing through the sluice were collected using a specially designed fish sampler. While the 1992 juvenile shad study was being conducted, observers noted that fish behavior was apparently influenced by the status of lighting on the station headworks. This led to ad hoc manipulation of the lights while sampling was being conducted.

Evaluation of the sluice and trash rack openings relative to downstream passage of salmon smolts was continued in 1993. A unit outage at Cabot Station limited study of the downstream passage of juvenile shad to evaluating the effect of above-water lighting on passage. The studies confirmed that substantial numbers of smolts and juvenile shad would pass through the log sluice, but that too many smolts were still passing through the units. Passage of juvenile shad through the sluice, on the other hand, had been shown to be acceptable, and above-water lighting had a positive effect on shad passage.

The 1993 salmon smolt results led the company to install inserts between the bars in the top 11 feet of the Cabot Station intake racks to reduce spacing from 4 inches to about 0.94 (15/16-inch) inches in 1994. The company also resurfaced and smoothed the sluice to reduce the potential for injury to fish passing downstream through it. The positive effect of above-water lighting on the passage of juvenile shad through the sluice was also observed with salmon smolts during the 1994 and 1995 evaluations. Evaluation of the rack openings as a downstream passage route was discontinued prior to the 1994 smolt season because evaluation had indicated that the sluice provided adequate downstream passage for juvenile shad and had the potential to provide adequate passage for smolts.

Downstream migrants, especially salmon smolts and adult shad, approaching the entrance to the sluice had demonstrated a tendency to hesitate before passing over the crest of the sluice gate. Observers attributed the hesitation to the sharp acceleration in flow velocity near the crest, which appeared to cause the fish to pause at the crest or go back upstream. Alden Research Laboratory (Alden) was called upon to develop concepts for modifying the crest to slow the acceleration, in the belief that reducing the acceleration would enhance passage. Alden was also asked to develop design recommendations for a sampler that could be used to collect data on downstream migration. The result was the NU-Alden weir, which was put into operation in 1997, and the sluice sampler, both of which are still in use. Passage through the weir was evaluated in 1997 and 1998; the evaluations indicated that adequate passage had been achieved for salmon smolts.

In addition to using the sluice sampler to evaluate downstream passage, annual mark/recapture estimates of the size of the smolt population were conducted from 1993 through 2012. At first, these estimates were used to support evaluation of the impact of smolt entrainment at the Northfield Mountain Pumped Storage Development. The post-1994 estimates were done in cooperation with USFWS (Sunderland office of Fisheries Assistance) and/or CRASC to help the resource agencies evaluate the progress of the salmon restoration program.

During 1998 to 2008, successful downstream passage for shad and salmon smolts had been achieved by the beginning of this period, but upstream passage for adult shad was still problematic. USFWS sent a letter to the company in 1998, requesting a meeting with the resource agencies to discuss improving upstream passage of American shad at Turners Falls, which had begun to decline in 1995 (Figure 3.3.3.2.2-3). Too low a percentage of shad arriving at Turners Falls from Holyoke were passing through the lower fishways, and too few shad from lower fishways were moving through the Gatehouse fishway into the TFI. The company opened a dialogue with the resource agencies about fish passage at Turners Falls. A plan to identify measures to improve shad passage was developed in consultation with the agencies.

Top priority was assigned to passage through the Gatehouse fishway, since all shad from the other two fishways needed to pass through it to reach the TFI. The efficiency of Cabot fishway was next in priority, since most shad used the Cabot fishway to move upstream, rather than moving through the bypass reach between Cabot Station and Turners Falls Dam and passing through the Spillway fishway.

The company enlisted the aid of the Conte Anadromous Fish Research Center to evaluate passage through the fishways, especially at Cabot and the Gatehouse. The evaluation began in 1999 and continued through 2012. Radio and PIT telemetry were the primary methods used in the investigations.

Evaluation of passage through the Gatehouse fishway suggested operational changes that were implemented on a trial basis. The protocol for operating the 14 headgates was changed to once again spread flow more evenly across the canal and to reduce turbulence below the gatehouse, and 'low-flow windows' were created. During the low-flow windows, generation at Cabot was reduced to try to elicit a positive response in shad passage. Neither of these measures produced better upstream passage; both efforts were abandoned after two years of evaluation.

Telemetry data indicated that tagged shad tended to concentrate on the river side of the canal, opposite the original gatehouse fishway entrance; this had been noted in earlier studies as well. These results led to the installation of a false entrance on the river side of the canal; the entrance was located just downstream of the Spillway fishway attraction water gates. Evaluation determined that shad entered and passed through the false entrance in substantial numbers, so a permanent new entrance flume was installed on that side of the canal in 2007, first operated in 2008. The entrance led to the gallery on the downstream side of the gatehouse that serves fish moving upstream from the Spillway fishway to the Gatehouse fishway. The addition resulted in only a slight increase in passage in 2008.

Meanwhile, evaluation of the Cabot fishway had led to several experimental modifications of the fishway pools beginning in 2000. The overflow portions of weirs in up to four turn-pool to turn-pool sections of the fishway were reconfigured and/or moved to produce hydraulics believed to be more amenable to passage. Some of the changes were modeled at CAFRC before implementation. Some of the in-fishway trials produced positive results but none of the improvements appeared likely to be sufficient to raise per pool efficiency to the levels needed to produce acceptable passage through the fishway. For example, given that the fishway has 66 pools, a per-weir efficiency of 99.5% yields an overall passage success rate of about 72%. A per-weir efficiency of 99.0% yields an overall success rate of about 52%. The highest estimates of per-weir efficiency during the evaluations was 99.3% (implied overall success rate = 63%) in a modified section of the fishway in the year 2000; all other trials resulted in efficiencies well below that level.

Evaluation of passage through the Cabot fishway was discontinued in 2005 because the numerous attempts to raise per-weir efficiencies to acceptable levels had failed. Discussion of a replacement for the pool-and-weir Cabot fishway began in 2008.

A new phase in upstream passage at Turners Falls began in 2008, the first year of operation at the new entrance to the Gatehouse fishway. Shad passage through the gatehouse began to recover (Figure 3.3.3.2.2-4). Design work on a fish lift to replace the Cabot fishway also began in that year.

Conceptual design drawings of the fish lift at Cabot were developed by FirstLight and revised after discussion with the agencies. As designed, the lift system would utilize the existing fishway entrance and exit, conveying fish from the station tailrace to the Cabot power canal. After a long period of review and consultation, and after an attempt to resolve issues related to the potential passage of Shortnose Sturgeon through the lift, further refinement of the design was suspended in 2012 when the relicensing of the Northfield Project began.

Work at the Gatehouse fishway continued. CAFRC had deployed an array of radio antennae downstream of the Gatehouse to paint a more detailed picture of shad movement immediately downstream of both the 'old' and new entrances. Hundreds of tagged fish were released at Holyoke as well as at the downstream end of the power canal. FirstLight also monitored passage at all three fishways to understand the relationships between shad passage and Project operations.

Passage through the Gatehouse fishway during the first two years of new entrance use (2008 and 2009) was a little better than it had been in the previous seven years (Figure 3.3.3.2.2-4) but the improvement was not as great as had been hoped, and the CAFRC telemetry study indicated that entry rates were still low. In order to raise entry rates at the new entrance, FirstLight added guide screens at the inboard side and bottom of the entrance prior to the 2010 season to prevent fish from veering away from or under the entrance opening, in addition to an existing guide structure between the entrance and the canal wall that had been installed to straighten the flow and minimize fish movement through the gap. It also closed one of the remaining two old entrance openings and raised the amount of water flowing through the entrance and to the new entrance and Spillway fishway.

The addition of the new entrance and all the other changes described above resulted in passage that matched passage before the 2000 to 2007 slump, especially in 2010 and thereafter. Still, even though the number of shad passed had recovered, the proportion of shad passed at the lower fishways combined passed at the Gatehouse fishway remained around 50% in 2010 and following years, similar to the proportion passed pre-slump (Figure 3.3.3.2.2-5). Passing 50% of the upstream migrants through the lower fishways had not been satisfactory pre-2000, and it still was not. In addition, the proportion of shad passed at the Holyoke fish lift subsequently passed at the Gatehouse fishway was still relatively low (Figure 3.3.3.2.2-6). Replacing the Cabot fishway with a fish lift was expected to raise the number of shad needing effective passage through the Gatehouse. Passage through the Gatehouse fishway would need to improve if the proportion of the shad from Holyoke reaching the TFI were to approach satisfactory levels. So FirstLight moved to develop further operational and structural changes to enhance Gatehouse fishway passage.

To start, telemetry data had indicated that after 2008 most fish passing through the Gatehouse fishway from the canal were entering the Gatehouse fishway through the new entrance. So effectively, adding the new entrance, while it improved passage relative to the 2000 to 2007 period, did not produce better passage overall than had been the case in the best years prior to 2000. One notable exception was that the highest passage at the Gatehouse fishway relative to passage at Holyoke occurred in 2015. The higher Gatehouse passage may have been attributable to abnormally high flow over the dam relative to flow discharged at Cabot Station and more shad passing through the Spillway fishway; flow was being manipulated to accommodate relicensing studies of upstream passage.

While the overall results were positive, opening the new entrance and optimizing flow through it while maintaining flow through the Spillway fishway had made it necessary to raise the water surface elevation in the gallery leading from the Spillway fishway and the new entrance to the Gatehouse fishway. This was done by adding a weir inside the old entrance to divert more flow to those areas. The weir appears to have been successful in enhancing conditions for passage at the new entrance and Spillway fishway. However, at the same time, the addition of the weir appeared to have created unfavorable conditions (high velocity and excessive turbulence) at the old entrance. The installation of the new entrance, the closing of two of the original three openings at the old entrance over the years, and the opening of Headgate No. 6 (closed since before the fishways had been built) had also changed structure and flow distribution at the Gatehouse.

Because of the passage shortfall and all the changes described above, and because telemetry results had shown that many of the shad reaching the upper end of the canal still failed to enter the Gatehouse fishway, FirstLight commissioned a CFD study of flow patterns in the Gatehouse fishway, in the gallery leading to the Spillway fishway and new entrance, at the two entrances, and in the upper canal. The first result of that study was to find that eddies created downstream of both Gatehouse fishway entrances might be interfering with shad trying to find the entrances; the model also indicated that the location of the eddies could be changed by altering the operation of the canal headgates.

Monitoring of shad passing through the Gatehouse fishway had previously shown that passage was better at relatively high canal flows (greater than about 10,000 cfs) and at relatively low flows (less than about 4,000 cfs) than it was at intermediate flows. The CFD model showed that the eddies were most pronounced at those intermediate flows, given the way the Gatehouse had been operated. Normal operation resulted in most of the canal flow coming through the middle gates, creating eddies downstream at the sides of the canal. So FirstLight personnel, from the bridge above the canal, observed the location of the eddies under various alternative headgate configurations. The result was a recommendation to de-emphasize the middle gates and allow more flow through the gates at the sides of the canal. This change was implemented in 2013. FirstLight attributes the incremental passage improvements in 2013 through 2015 to this change.

The CFD model also resulted in recommendations for structural changes within the Gatehouse fishway that would reduce the velocity and turbulence at the old entrance while routing sufficient flow through the gallery leading to the new entrance and Spillway fishway. The changes involved separating attraction and fishway flow into two streams: one to the old entrance; and one to the gallery. These changes have not been implemented pending the outcome of relicensing studies.

Lastly, FirstLight had noted that the number of shad passing through the Gatehouse fishway appeared to be affected by changes in canal flow. Passage often increased following a daytime increase in canal flow (due to generation at Cabot Station), and often decreased following a daytime reduction in canal flow. This observation, plus earlier observations of water surface elevation fluctuations in the canal (caused partly by long-period waves that travel up and down the canal after changes in generation) by CAFRC and FirstLight, led FirstLight to review the protocol for operation of the automated headgates. The purpose of the ongoing review is to develop a new headgate control sequence that will dampen the fluctuations.

3.3.3.2.3 Entrainment

Resident and migratory fish may be subject to entrainment and turbine passage. At the Turners Falls Development, fish may pass through the turbines at Station No. 1 or Cabot Station. At the Northfield Mountain Pumped Storage Development, fish entrained during pump-back pass through the intake tunnel and turbine(s) before being discharged to the Upper Reservoir. Features that determine the likelihood of entrainment include the velocity at the intakes, and the fish species and habitat available in the area.

As fish pass through the turbines, mortality may occur due to (1) collision with blades, wicket gates, or vanes; (2) shear forces; and/or (3) pressure changes. Turbine passage mortality of resident fish was assessed in studies approved by FERC and by using empirically validated blade strike models to estimate potential mortality (Franke *et al.*, 1997). Field studies of adult American Eel and juvenile American Shad are being used to supplement the blade strike analyses. Both the analysis of data from the field studies and the blade-strike analyses will be incorporated in the final report for Study No. 3.3.7 *Fish Entrainment and Turbine Passage Mortality* to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

Resident Fish

Some resident fish species in the Turners Falls Development area may be subject to entrainment at Cabot, Station No. 1, or the Northfield Mountain Pumped Storage Development (during pump-back). A qualitative scale of entrainment potential ranging from “Low” to “High” was developed for each resident fish species documented in the TFI during the baseline fish assemblage assessment. Data analyses for entrainment of resident fish remains ongoing and results will be included in a final report for Study No. 3.3.7 *Fish Entrainment and Turbine Passage Mortality* to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

Migratory Fish

American Shad

The Licensee undertook Study No. 3.3.20 to quantify entrainment of various life stages of American Shad ichthyoplankton (eggs, yolk-sac and post yolk-sac larvae) at the Northfield Mountain Pumped Storage Development from May 28 to July 17, 2015. Ichthyoplankton samples were collected both in the powerhouse during pump-back (pumping water from Connecticut River to the Upper Reservoir for storage) operations as well as in the river adjacent to the intake/tailrace channel. At least once per week samples were collected every two (2) hours during a pumping cycle. These were designated as ***Random*** samples because the number of pumps operated during sampling was not controlled. In addition, pump-back operations were manipulated to specifically sample operations with 1 2, 3, and 4 pumps running (***Scenario*** samples). To validate that ichthyoplankton collection densities were representative of densities in the intake tunnel, paired samples from inside of the powerhouse (entrainment) and from the intake/tailrace channel (offshore) were collected for each scenario (1, 2, 3 and 4 units pumping). The ichthyoplankton samples were sorted in a laboratory by biologists trained in the identification of the life stages of species common to the Connecticut River.

In terms of American Shad life stages, no larvae and only eggs were observed in the powerhouse samples. Densities (no. organisms per 100 m^3) of eggs in the samples ranged from 0 to 31 eggs per 100 m^3. While the shad ichthyoplankton densities in samples collected at the Northfield Mountain Pumped Storage Development powerhouse were low, when extrapolated by the entire volume of water pumped during the spawning season, just over 3 million shad eggs and 500,000 shad larvae were estimated to be entrained in 2015. The number of equivalent juvenile and adults lost to entrainment at the Northfield Mountain Pumped Storage Development annually was estimated to be 696 juvenile shad and 94 adult American Shad for the 2015 shad spawning season based on the entrainment estimates and published survival fractions. The final report for Study No. 3.3.20 was filed with FERC on March 1, 2016.

Impacts to adult shad migrations were assessed by a telemetry study employing radio and passive integrated transponder (PIT) technologies to assess behavior, approach routes, passage success, survival, and delay by adult American Shad as they encounter the Turners Falls Development and the Northfield Mountain Pumped Storage Development during both upstream and downstream migration. Analyses of these data will be incorporated in a final report to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

Impacts to juvenile shad outmigration at the Project were evaluated using a combination of methodologies and technologies including hydroacoustics, radio telemetry and HI-Z Turb'N tags. Analyses of these data will be incorporated in a final report slated to be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule.

Atlantic Salmon

Entrainment studies have been conducted at the Northfield Mountain Pumped Storage Development to evaluate and mitigate the impacts of the operations on Atlantic Salmon smolts. The studies determined that an estimated 28.6% of Atlantic Salmon were entrained (NUSCO, 1999; LMS, 1993a; LMS 1993b).

In an effort to mitigate entrainment of Atlantic Salmon smolts, a fixed-position guide net was installed annually beginning in 1995 to reduce entrainment of Atlantic Salmon smolts at the Northfield Mountain Pumped Storage Development. After an evaluation of the net returned encouraging results, field testing of modified netting configurations was completed in 1996 and 1997. A radio telemetry study was conducted in 1999 to determine the guidance efficiency of the net (NUSCO, 1999). A limited number of 6.7% radio-tagged smolts became entrained at Northfield Mountain. Fourteen migrating smolts (not radio tagged) became entangled in the net. Results also indicated that radio-tagged smolts moved quickly along the net.

Following the 1999 testing, the fixed-position guide net to reduce Atlantic Salmon smolt entrainment has been deployed annually. The net is typically installed in mid-to-late-April after the spring freshet. Portions of the net occasionally need to be repaired or replaced because of damage due to debris. Due to cessation of the Atlantic Salmon restoration program in the Connecticut River, the Licensee is not required to install the guide net in the future.

American Eel

Entrainment of outmigrating adult American Eel at the Northfield Mountain Project was estimated using radio telemetry techniques in fall of 2015. Tagged eels were released about 5 km upstream of the Northfield Mountain Pumped Storage Development intake/tailrace just before pumping began, as well as about 6 km upstream of the Turners Falls Dam. Releases occurred in batches over a range of operating conditions. Eel were subsequently tracked by fixed station receivers and mobile receivers until tagged eel left the area or water temperatures dropped to 5°C. In addition, turbine and dam passage survival evaluations were conducted by the Licensee in the fall of 2015. HI-Z Turb'N tags were used to evaluate passage survival of 300 adult eels injected into the turbines of Station No. 1 and Cabot Station, as well as into spill over the Turners Falls Dam. Analyses remain ongoing and results will be included in a final report slated for filing with FERC on March 1, 2017 or as directed by FERC in its process plan and schedule.

3.3.3.3 Cumulative Effects

This section will be developed following completion of the data analyses and reporting for the ongoing studies.

3.3.3.4 Proposed Environmental Measures

Environmental measures will be developed following completion of the data analyses and reporting for the ongoing studies.

3.3.3.5 Unavoidable Adverse Impacts

This section will be developed following completion of the data analyses and reporting for the ongoing studies.

Table 3.3.3.1-1: Relative Abundance of Littoral Zone Habitat Identified in the TFI

Habitat Type	Length (ft)	Length (miles)	% of Total
Fines	53,715	10.2	29%
Cobble	39,115	7.4	21%
Bedrock	30,850	5.8	17%
Gravel	30,555	5.8	16%
Riprap	12,945	2.5	7%
Fines / Cobble Patch	10,895	2.1	6%
Wetlands	7,045	1.3	4%
Boulder / Cobble Patch	1,260	0.2	1%

Table 3.3.3.1.1-1: Observed Submerged Aquatic Vegetation

Common Name	Scientific Name
Pondweed	*Potamogeton ssp.*
Milfoil	*Myriophylum spp.*
Coontail	*Ceratophyllum demersum*
Wild celery (Eelgrass)	*Vallisneria americana*
Clasping leaf pondweed	*Potamogeton perfoliatus*
Waterweed	*Elodea nuttallii*
Eurasian milfoil	*Myriophyllum spicatum**
Muskgrass	*Chara ssp.*
Fanwort	*Cabomba caroliniana**
Large leaf pondweed	*Potamogeton amplifolius*
Variable leaf milfoil	*Myriophylum heterophyllum**
Water chestnut	*Trapa natans**
Curly-leaved pondweed	*Potomageton crispus**

*Exotic Species

Table 3.3.3.1.2-1: Species Collected During 2015 Effort for the Fish Assemblage Survey at Turners Falls Development

Common Name	Scientific Name	TFI		Bypass
		June-July	September	September
American Eel	*Anguilla rostrata*	X	X	X
American Shad	*Alosa sapidissima*	X	X	
Banded Killifish	*Fundulus diaphanus*		X	
Black Crappie	*Pomoxis nigromaculatus*	X	X	
Bluegill Sunfish	*Lepomis macrochirus*	X	X	X
Brown Bullhead	*Ictalurus nebulosus*	X	X	X
Chain Pickerel	*Esox niger*	X	X	
Channel Catfish	*Ictalurus punctatus*	X	X	
Common Carp	*Cyprinus carpio*	X	X	
Common Shiner	*Luxilis cornutus*	X		
Fallfish	*Semotilus corporalis*	X	X	
Golden Shiner	*Notemigonus crysoleucas*	X	X	
Hybrid Sunfish	-			X
Largemouth Bass	*Micropterus salmoides*	X	X	X
Longnose Dace	*Rhinichthys cataractae*			X
Mimic Shiner	*Notorpis volucellus*	X	X	X
Northern Pike	*Esox lucius*	X	X	X
Pumpkinseed Sunfish	*Lepomis gibbosus*	X	X	X
Rock Bass	*Ambloplites rupestris*	X	X	
Rosyface Shiner	*Notropis rubellus*		X	
Sea Lamprey	*Petromyzon marinus*	X	X	X
Smallmouth Bass	*Micropterus dolomieui*	X	X	X
Spottail Shiner	*Notropis hudsonius*	X	X	X
Tessellated Darter	*Etheostoma olmstedi*	X	X	X
Walleye	*Stizostedion vitreum vitreum*	X	X	X
White Perch	*Morone americana*		X	
White Sucker	*Catostomus commersoni*	X	X	X
Yellow Perch	*Perca flavescens*	X	X	X

Table 3.3.3.1.2-2: Species Abundance at Each Boat Electrofishing Station within the Turners Falls Bypass Reach during Late Summer 2015

Species	Upper Bypass Reach		Lower Bypass Reach		Total	% of Total
	Plunge Pool	Riffle-Run-Pool Above Station No. 1	Riffle-Run Below Station No. 1	Rock Dam Pool		
Smallmouth Bass	48	67	30	23	168	62.5%
American Eel	16	1	7	2	26	9.7%
Bluegill Sunfish	12	9		1	22	8.2%
Pumpkinseed	8	8			16	5.9%
White Sucker	10		2	1	13	4.8%
Tessellated Darter	4	2	2	4	12	4.5%
Sea Lamprey	1		1	1	3	1.1%
Largemouth Bass	1				1	0.4%
Yellow Perch				1	1	0.4%
Spottail Shiner				1	1	0.4%
Mimic Shiner				1	1	0.4%
Walleye	1				1	0.4%
Northern Pike				1	1	0.4%
Brown Bullhead				1	1	0.4%
Hybrid Sunfish		1			1	0.4%
Longnose Dace			1		1	0.4%
Total	**101**	**88**	**43**	**37**	**269**	

Table 3.3.3.1.2-3: Comparison of Fish Species Abundance in the Turners Falls Bypass Reach in 2009 and 2015

Upper Bypass Reach		Lower Bypass Reach	
2009	**2015**	**2009**	**2015**
Smallmouth Bass	Smallmouth Bass	Smallmouth Bass	Smallmouth Bass
Longnose Dace	American Eel	Spottail Shiner	Bluegill Sunfish
American Eel	Tessellated Darter	Longnose Dace	American Eel
Atlantic Salmon	White Sucker	Tessellated Darter	Pumpkinseed
White Sucker	Sea Lamprey	White Sucker	White Sucker
Rock Bass	Yellow Perch	American Eel	Tessellated Darter
Sea Lamprey	Spottail Shiner	Brown Trout	Largemouth Bass
Tessellated Darter	Mimic Shiner	Common Carp	Walleye
	Bluegill Sunfish	Rock Bass	Sea Lamprey
	Northern Pike	Bluegill Sunfish	Hybrid Sunfish
	Brown Bullhead		
	Longnose Dace		
	Largemouth Bass		

Table 3.3.3.1.2-4: Comparison of Species Richness, Abundance, and Catch-Per-Unit–Effort (CPUE) from 2009 and the Present Study

	Species Richness		Abundance		CPUE (fish/m)	
	2009	**2015**	**2009**	**2015**	**2009**	**2015**
Upper Bypass Reach stations	7	10	94	189	0.085	0.11
Lower Bypass Reach stations	9	11	78	80	0.078	0.07

Table 3.3.3.1.2-5: Summary of Spawning Information for Resident Species Obtained from Desktop Literature Review

Common Name	Spawning Strategy	Notes	Spawning Period	Temperature Range
Yellow Perch	Broadcast spawn in shallow weedy areas	Eggs adhesive, no guardianship	April and May	6.7-12.2°C
Pumpkinseed	Nest scoured in sand/fines	Male adult guardianship	Late spring to mid-summer	20°C
Smallmouth Bass	Sand/gravel nest near object cover	Male adult guardianship	Late spring to early summer	16.1-18.3°C
Largemouth Bass	Sand/fines nest near object cover	Male adult guardianship	Mid-spring to early summer	16.7-18.3°C
Bluegill	Sand/fines nest	Male adult guardianship	Mid-May to mid-summer	17 -31°C
Spottail Shiner	Broadcast spawn on sand at mouths of streams	No guardianship	May to mid-June	15-20°C
White Sucker	Gravel bars in tributary or shoals	No guardianship	Mid-April to May	10°C
Walleye	Cobble riffle or shoals	Broadcast spawn, no guardianship	April	7-11°C
Golden Shiner	Submerged vegetation in shallow water	Broadcast spawn, eggs are adhesive, no guardianship	May to August	20°C
Black Crappie	Nest scoured in sand/fines	Male adult guardianship	Mid-spring to early summer	19-20°C
White Perch	Broadcast spawn	Eggs planktonic	Mid-spring	11-15°C
Rock Bass	Sand/gravel nest near object cover	Male adult guardianship	June	15.6-21.1°C
Brown Bullhead	Sand/fines nest	Male adult guardianship	Late May through June	21.1°C
Chain Pickerel	Broadcast spawn glutinous egg strings in marshes	Eggs adhesive, no guardianship	March to May	8.3-11.1°C
Fallfish	Gravel in low velocity stream margins	Nest builder, no guardianship	Late April through May	12-16.6°C
Common Carp	Shallow vegetation	Broadcast spawn, no guardianship	Late spring to late summer	22-27°C

Table 3.3.3.1.2-6: Locations of Monitored Sea Lamprey Redds in Project Area

Location	Number of redds monitored	Number of capped redds
Connecticut River mainstem within close proximity of Vernon Dam (both sides of Stebbins Island)	7	1
Ashuelot River confluence with the Connecticut River	10	1
Millers River confluence with the Connecticut River	5	1
Fall River confluence with the Connecticut River	2	1
Hatfield S curve below Rt. 116 Bridge	5	1
Total	30	5

Table 3.3.3.1.2-7: Lamprey Redd Data Recorded During 2015 Monitoring Period (X = present, XX = present and dominant)

Site*	Water Depth (ft)			Water Velocity (ft/sec)			Substrate					
	Min	Max	Mean	Min	Max	Mean	Silt	Sand	Gravel	Cobble	Boulder	Bedrock
Millers571	1.5	2.9	2.08	0.82	3.24	2.1		X	X	XX	X	X
Millers572-1	1.5	2.8	2.04	1.57	4.25	2.6		X	X	XX	X	
Millers572-2	1.2	2	1.65	0.77	3.44	2.35		X	X	XX	X	
Millers572-3	1.35	2.4	1.69	0.48	3.3	1.86		X	X	XX	X	
Millers572-4	1.1	2.9	2.11	0.21	1.91	1.02		X	X	XX	X	
Ashuelot573	1.9	6.4	3.43	0.06	1.99	0.87		X	XX	XX		
Ashuelot574-1	1.6	5.2	3	0.12	3.02	1.17		X	XX	XX		
Ashuelot574-2	1.75	5.4	3.39	0.07	2.41	1.33		X	XX	XX		
Ashuelot574-3	1	4.7	2.86	0.22	2.22	1.24		X	XX	XX		
Ashuelot574-4	1.4	5.1	3.1	0.3	2.68	1.48		X	XX	XX		
Ashuelot574-5	1.7	5.3	3.1	0.14	2.52	1.35		X	XX	XX		
Ashuelot574-6	1.8	5.8	3.29	0.2	2.56	1.26		X	XX	XX		
Ashuelot574-7	1.6	5.2	3.12	0.14	2.05	1.16		X	XX	XX		
Ashuelot574-8	1.2	5.2	3.16	0.19	1.74	0.96		X	XX	XX		
Ashuelot574-9	**0.6**	4.5	2.46	0.34	2.43	1.49		X	XX	XX		
Ashuelot574-10	1.4	1.5	1.45	1.2	1.72	1.37		X	XX	XX		
Hatfield130-1	2.8	7.9	4.24	1.41	2.84	2.08		X	X	X		
Hatfield130-2	3.9	3.9	3.9	1.54	1.61	1.57		X	X	X		
Hatfield130-3	3.5	3.5	3.5	1.7	1.75	1.72		X	X	X		
Hatfield130-4	4.2	4.2	4.2	1.66	1.8	1.74		X	X	X		
Stebbins182	1.3	7.3	3.7	1.08	3.65	2.68		X	X	XX		
Stebbins217	2.6	**8.8**	5.24	1.77	4.43	3.11		X	X	XX		
Stebbins219	1.7	8.6	5.03	0.11	5.6	3.2		X	X	XX		
Stebbins219-1	1.8	8.2	4.26	0.22	4.26	2.56		X	X	XX		
Stebbins220	2.3	8.3	5.27	0.85	**6.08**	3.3		X	X	XX		
Stebbins221	2.4	7.3	4.3	2.05	4.3	3.21		X	X	XX		
Stebbins222	2.9	7.5	4.33	1.43	4.27	2.9		X	X	XX		
Fall1	0.7	3.4	1.15	0.11	2.38	0.83	X	X	XX	XX		
Fall2	**0.6**	4.8	1.91	**0.02**	1.69	0.82	X	X	XX	XX		

*Site identification based on GPS waypoint

Table 3.3.3.1.2-8: Summary of Water Quality Parameters at Lamprey Spawning Sites Grouped by Location

Site	Mean Temperature (°C)	Mean Conductivity (µS/cm)	Mean pH	Mean Turbidity (NTU)	Mean DO (mg/l)
Millers River	21.8	130.8	7.4	3.8	9.2
Ashuelot River	20.8	110.4	7.4	4.6	9.3
Hatfield S Curve	20.7	93.3	7.5	4.9	8.9
Stebbins Island	19.4	91.9	7.4	8.1	9.8
Fall River	19.1	190.5	7.8	5.2	7.3

Table 3.3.3.1.2-9: Summary of Eel Collections at Temporary Ramps during 2015 Monitoring Period

Date of Collection	Number of Eels Trapped			
	Spillway Ladder	Cabot Emergency Spillway	Cabot Ladder	Station No. 1 Medusa Traps
7/10/2015	2	0	0	-
7/13/2015	117	10	15	-
7/15/2015	702	6	23	-
7/17/2015	182	11	17	-
7/20/2015	280	1	29	-
7/22/2015	602	88	51	-
7/24/2015	520	59	13	0
7/27/2015	135	3	7	0
7/29/2015	119	102	10	0
7/31/2015	308	8	24	0
8/3/2015	264	7	29	0
8/5/2015	89	17	19	0
8/7/2015	148	6	1	0
8/10/2015	187	7	1	0
8/12/2015	130	4	0	0
8/14/2015	162	10	0	0
8/17/2015	135	7	14	0
8/19/2015	7	12	10	0
8/21/2015	10	11	15	0
8/24/2015	155	5	0	0
8/26/2015	116	7	0	0
8/28/2015	137	12	2	0
8/31/2015	173	6	0	0
9/2/2015	178	2	4	0
9/4/2015	35	4	2	0
9/8/2015	197	12	15	0
9/10/2015	38	2	2	0
9/14/2015	14	2	3	0
9/16/2015	6	0	1	0
9/18/2015	9	0	0	0
9/21/2015	6	0	1	0
9/25/2015	11	0	0	0
9/28/2015	1	1	0	0
9/30/2015	5	0	0	0
10/1/2015	45	2	4	0

Date of Collection	Number of Eels Trapped			
	Spillway Ladder	Cabot Emergency Spillway	Cabot Ladder	Station No. 1 Medusa Traps
10/4/2015	10	0	1	0
10/14/2015	0	0	0	0
10/19/2015	0	0	0	0
10/26/2015	0	0	0	0
11/2/2015	0	0	0	0
Total	**5,235**	**424**	**313**	**0**

Table 3.3.3.1.2-10: Location and Types of Telemetry Equipment Used to Evaluate Silver Eel Emigration at the Turners Falls and NMPS Projects, Turners Falls and Northfield MA

Location	RM	Receiver Station
Montague Wastewater	119.5	A Lotek SRX receiver with double yagi antennae monitored the full width of the River
Cabot Station Tailrace	120	A Lotek SRX with yagi antenna monitored the full river width. An Orion receiver and double yagi antennae monitored the tailrace immediately downstream of the station.
Cabot Station Forebay	120	Two radio receivers monitored the forebay area: 1) An Orion with double yagi and dropper antennae monitored the full width of the forebay area 2) An Orion with dipole antenna monitored the entrance to the Cabot downstream bypass
Station 1 Forebay	121	An Orion with yagi and dropper antenna monitored the full width of the forebay area
Station 1 Tailrace	121	A Lotek SRX with yagi antenna monitored the tailrace area. Detection zone monitored the full width of the bypass reach. A detection power analysis will differentiate those test fish that are attracted to the tailwater from those that continue upstream
Below Turners Falls Dam	122	Two Lotek SRX receivers with double yagi antennae monitored the area below the dam, one on either side of the river bank such that approach to the dam can be differentiated from either the right or left sides of the River
Upstream of Gatehouse	122	An Orion receiver with yagi and dropper antennas was used to monitor the area immediately upstream of Gatehouse
Upstream End of the Canal	122	An Orion with a yagi antenna monitored the full width of the canal at a location downstream of the Gatehouse in the upper canal to monitor fish entering the canal from upstream
NMPS Gill Bank	126.5	A Lotek with double yagi antennae monitored the full width of the impoundment
NMPS Intake	127	An Orion with double yagi antenna monitored the intake area
NMPS Upper Reservoir	127	An Orion receiver with yagi and dropper antennas was used to monitor the upper reservoir
Shearer Farms	127.5	A Lotek with a yagi antenna monitored the full width of the impoundment

Table 3.3.3.1.2-11: Upstream Fish Passage Schedule for Cabot, Gatehouse, and Spillway Fishways

Development	Species	Life Stage	Dates of Operation	Hours of Operation
Turners Falls	Salmon	Adult	Apr 7-Jul 15	24 hours/day
	Salmon	Adult	Sep 15-Nov 15	24 hours/day
	Shad & Herring	Adult	Apr 7-Jul 15	24 hours/day

Source: CRASC letter to FirstLight, 3/4/2016

Table 3.3.3.1.2-12: Anadromous Fish Passage Recorded at the Turners Falls Fish Passage Facilities, Connecticut River, Massachusetts, 1980 to 2015

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
1980	Cabot	687	0	11	187	0	
	Spillway	5	0	0	0	0	
	Gatehouse	298	0	1	66	1	
1981	Cabot	224	0	0	1,622	7	
	Spillway**						
	Gatehouse	200	0	0	935	8	
1982	Cabot						
	Spillway**						
	Gatehouse	11	4	0	210	0	
1983	Cabot	26,697	106	6	859	0	
	Spillway	263	1	1	649	0	
	Gatehouse	12,705	28	7	703	0	
1984	Cabot	1,831	4	0	334	1	
	Spillway	4,563	12	0	851	1	
	Gatehouse	4,333	21	0	683	1	
1985	Cabot	31,000	1,726	0	3,198	2	
	Spillway	843	243	0	3,185	3	
	Gatehouse	3,855	301	0	1,809	3	
1986	Cabot	22,144	7,091	0	1,424	5	
	Spillway	5,857	6,248	0	2,230	4	
	Gatehouse	17,858	9,578	0	1,961	10	
1987	Cabot	33,114	2,866	0	1,324	2	
	Spillway	3,679	2,841	0	2,921	3	

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
	Gatehouse	18,959	5,091	0	2,590	12	
1988	Cabot	28,546	349	0	335	2	
	Spillway	3,354	865	0	1,912	2	
	Gatehouse	15,787	1,079	0	1,175	7	
1989	Cabot	14,403	199	0	578	1	
	Spillway	1,494	279	0	947	0	
	Gatehouse	9,511	510	1	868	2	
1990	Cabot	31,056	711	0	1,304	8	1
	Spillway	5,898	768	0	1,013	2	0
	Gatehouse	27,908	1,585	0	1,301	16	13
1991	Cabot	87,168	6,433	1	2,089	2	0
	Spillway	6,282	2,718	0	3,026	2	0
	Gatehouse	54,656	7,522	3	4,090	4	1
1992	Cabot	94,046	1,765	1	1,836	9	0
	Spillway	11,760	884	0	3,275	6	0
	Gatehouse	60,089	2,157	2	2,710	14	7
1993	Cabot	21,045	243	0	711	7	0
	Spillway	898	90	0	2,082	3	0
	Gatehouse	10,221	278	0	1,637	7	0
1994	Cabot**						
	Spillway	1,507	17	0	1,740	1	0
	Gatehouse	3,729	97	0	1,702	5	0
1995	Cabot	33,938	4,234	0	1,417	2	1
	Spillway	543	31	0	1,372	0	0
	Gatehouse	18,369	2,957	0	1,813	4	4
1996	Cabot**						
	Spillway	2,293	13	0	2,651	4	0
	Gatehouse	16,192	515	0	4,556	3	3
1997	Cabot	22,518	231	0	2,374	2	4
	Spillway	3,473	15	0	2,219	1	3
	Gatehouse	9,216	128	0	2,265	2	2

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
1998	Cabot	14,947	2	0	8,707	6	1
	Spillway	4,721	0	0	8,642	2	2
	Gatehouse	10,527	4	0	7,579	5	2
1999	Cabot	11,501	5	0	2,014	2	543
	Spillway	4,215	0	8	1,449	2	440
	Gatehouse	6,751	2	0	916	0	275
2000	Cabot	12,289	0	0	1,455	0	9
	Spillway	2,240	0	0	1,962	4	358
	Gatehouse	2,590	0	0	1,350	5	199
2001	Cabot	20,933	0	0	3,678	0	0
	Spillway	2,344	0	0	5,280	0	0
	Gatehouse	1,540	0	0	2,144	0	0
2002	Cabot	7,922	0	0	14,709	0	0
	Spillway	5,372	0	0	12,367	4	7
	Gatehouse	2,870	0	0	10,160	4	2
2003**							
2004	Cabot	5,933	0	0	13,352	0	0
	Spillway	1,980	0	0	5,821	0	0
	Gatehouse	2,192	0	0	8,418	0	0
2005	Cabot	5,404	2	7	12,974	5	0
	Spillway	1,626	0	7	9,990	1	2
	Gatehouse	1,581	2	2	215,843	5	0
2006	Cabot	11,991	1	198	5,377	4	9
	Spillway	2,577	0	153	5,133	8	0
	Gatehouse	1,810	0	46	3,005	7	0
2007	Cabot	11,130	**	**	11,061	5	0
	Spillway	1,793	**	**	5,555	3	0
	Gatehouse	2,248	**	**	15,438	5	0
2008	Cabot	15,089	**	**	**	6	**
	Spillway	627	**	**	**	5	**
	Gatehouse	3,995	**	**	32,035	10	**

Year	Location	American Shad	Blueback Herring	Striped Bass	Sea Lamprey	Atlantic Salmon	Gizzard* Shad
2009	Cabot	13,391	**	**	**	0	**
	Spillway	919	**	**	**	5	**
	Gatehouse	3,814	**	**	8,296	8	**
2010	Cabot	30,232	**	**	**	2	**
	Spillway	2,735	**	**	**	4	**
	Gatehouse	16, 768	**	**	6,352	8	**
2011	Cabot	27,077	**	**	**	2	**
	Spillway	1,966	**	**	**	6	**
	Gatehouse	16,798	**	**	2,032	7	**
2012	Cabot	51,901	**	**	**	2	**
	Spillway	10,608	**	**	**	3	**
	Gatehouse	26,727	**	**	4,503	2	**
2013	Cabot	46,886	**	**	**	0	**
	Spillway	10,571	**	**	**	1	**
	Gatehouse	35,494	**	**	6,016	0	**
2014	Cabot	40,666	**	**	**	3	**
	Spillway	24,262	**	**	**	8	**
	Gatehouse	39,914	**	**	5,553	11	**
2015	Cabot	47,588	**	**	**	1	**
	Spillway	41,835	**	**	**	1	**
	Gatehouse	58,079	**	**	8,423	0	**

* Observations of Gizzard Shad using ladders was first reported in 1990.
** not monitored
(Slater, 2011; Robert Stira, per. comm., 2015).

Table 3.3.3.1.2-13: American Shad Passage Recorded at the Holyoke Dam Fish Passage Facilities, Connecticut River, Massachusetts, 1981 to 2015 and the Passage Ratio for the Numbers Passed at Holyoke Versus Turners Falls Gatehouse.

Year	Holyoke	Passage Ratio
1981	377,014	0.00
1982	294,842	0.00
1983	528,185	0.02
1984	495,909	0.01
1985	487,158	0.01
1986	352,122	0.05
1987	276,835	0.07
1988	294,158	0.05
1989	354,180	0.03
1990	363,725	0.08
1991	523,153	0.10
1992	721,764	0.08
1993	340,431	0.03
1994	181,038	0.02
1995	190,295	0.10
1996	275,607	0.06
1997	299,448	0.03
1998	315,728	0.03
1999	193,780	0.03
2000	225,042	0.01
2001	273,206	0.01
2002	374,534	0.01
2003	286,814	*
2004	191,555	0.01
2005	116,511	0.01
2006	155,000	0.01
2007	158,807	0.01
2008	156,492	0.03
2009	160,649	0.02
2010	164,439	0.10
2011	244,177	0.07
2012	490,431	0.05
2013	392,494	0.09
2014	370,506	0.11
2015	412,656	0.14

*Passage not monitored at Turners Falls.

Table 3.3.3.1.2-14: American Shad Passage Recorded at the Vernon Dam Fish Passage Facilities, Connecticut River, Massachusetts, 1981 to 2015 and the Passage Ratio for the Numbers Passed at Vernon Versus Turners Falls Gatehouse.

Year	Vernon	Passage Ratio
1981	97	0.49
1982	9	0.82
1983	2,597	0.20
1984	335	0.08
1985	833	0.22
1986	982	0.05
1987	3,459	0.18
1988	1,370	0.09
1989	2,953	0.31
1990	10,894	0.39
1991	37,197	0.68
1992	31,155	0.52
1993	3,652	0.36
1994	2,681	0.72
1995	15,771	0.86
1996	18,844	1.16
1997	7,384	0.80
1998	7,289	0.69
1999	5,097	0.75
2000	1,536	0.59
2001	1,744	1.13**
2002	356	0.12
2003	268	*
2004	653	0.30
2005	167	0.11
2006	133	0.07
2007	65	0.03
2008	271	0.07
2009	16	0
2010	290	0.02
2011	46	0
2012	10,386	0.39
2013	18,220	0.52
2014	27,706	0.69
2015	39,771	0.68

*Passage not monitored at Turners Falls.
** Counting error

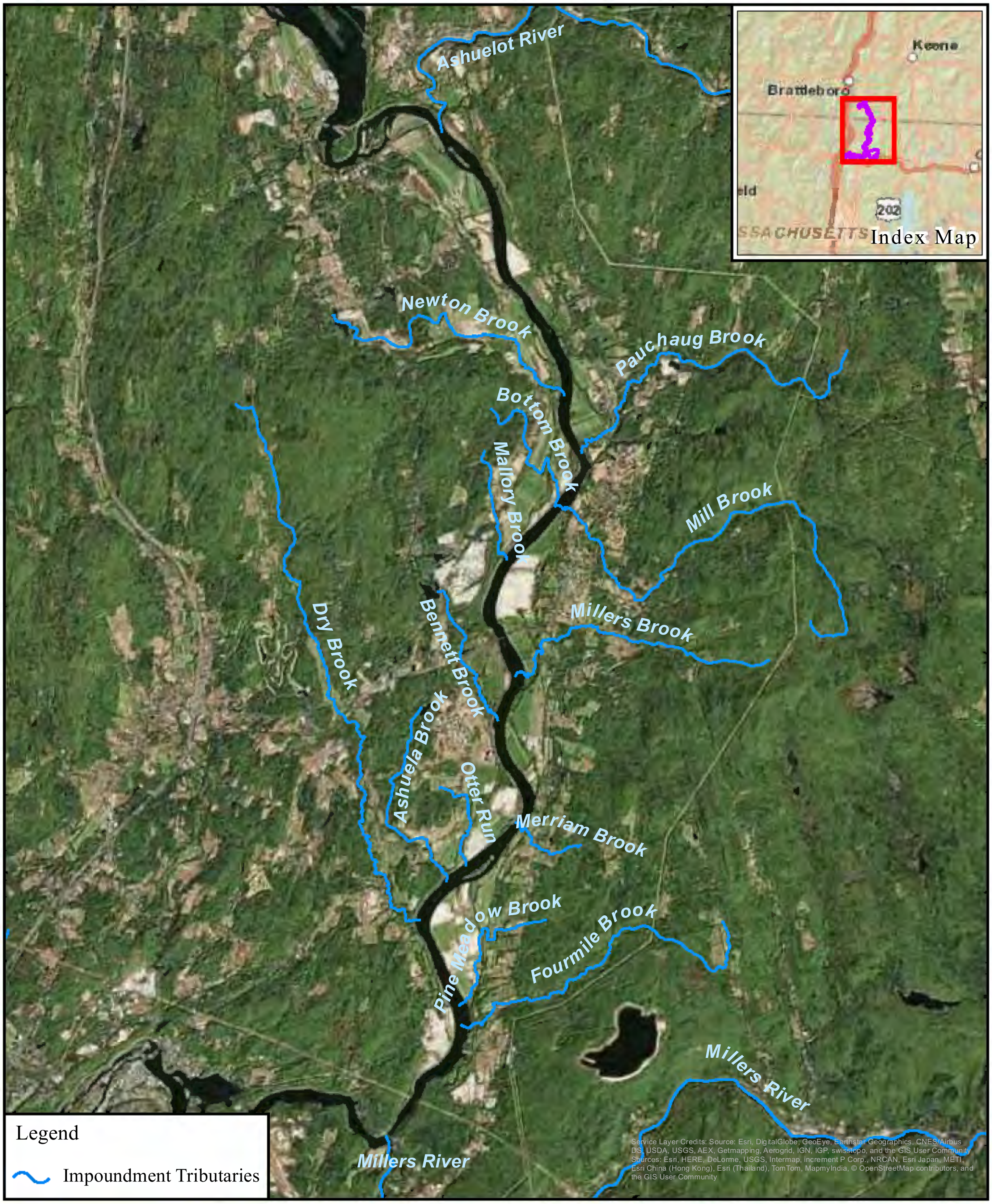
Table 3.3.3.1.2-15: Downstream Fish Passage Schedule

Development	Downstream Fish Passage Exit	Species	Life Stage	Dates of Operation	Hours of Operation
Turners Falls	Log sluice and trash sluice	salmon salmon shad shad eels	smolt adult adult juvenile adult	Not required Oct 15-Dec 31[1] Apr 7-Jul 31 Aug 1-Nov 15 Sep 1-Nov 15	24 hours/day 24 hours/day 24 hours/day 24 hours/day 24 hours/day

[1]Downstream passage operation, for adults will only be required if 50 or more adults are documented as passing upstream of a dam/facility.
Source: CRASC letter to FirstLight, 3/4/2016

Table 3.3.3.2.2-1: Location and Types of Telemetry Equipment Used to Evaluate Silver Eel Migration at the Turners Falls and Northfield Mountain Developments

Location	RM	Receiver Station
Montague Wastewater	119.5	A Lotek SRX receiver with double yagi antennae monitored the full width of the River
Cabot Station Tailrace	120	A Lotek SRX with yagi antenna monitored the full river width. An Orion receiver and double yagi antennae will monitor the tailrace immediately downstream of the station.
Cabot Station Forebay	120	Two radio receivers monitored the forebay area: 1) An Orion with double yagi and dropper antennae monitored the full width of the forebay area 2) An Orion with dipole antenna monitored the entrance to the Cabot downstream bypass
Station 1 Forebay	121	An Orion with yagi and dropper antenna monitored the full width of the forebay area
Station 1 Tailrace	121	A Lotek SRX with yagi antenna monitored the tailrace area. Detection zone monitored the full width of the bypass reach. A detection power analysis will differentiate those test fish that are attracted to the tailwater from those that continue upstream
Below Turners Falls Dam	122	Two Lotek SRX receivers with double yagi antennae monitored the area below the dam, one on either side of the river bank such that approach to the dam can be differentiated from either the right or left sides of the River
Upstream of Gatehouse	122	An Orion receiver with yagi and dropper antennas was used to monitor the area immediately upstream of Gatehouse
Upstream End of the Canal	122	An Orion with a yagi antenna monitored the full width of the canal at a location downstream of the Gatehouse in the upper canal to monitor fish entering the canal from upstream
NMPS Gill Bank	126.5	A Lotek with double yagi antennae monitored the full width of the impoundment
NMPS Intake	127	An Orion with double yagi antenna monitored the intake area
NMPS Upper Reservoir	127	An Orion receiver with yagi and dropper antennas was used to monitor the upper reservoir
Shearer Farms	127.5	A Lotek with a yagi antenna monitored the full width of the impoundment



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0 0.75 1.5 3 Miles

Figure 3.3.3.1-1:
Location of Target Tributaries in the Turners Falls Impoundment for FirstLight's Tributary and Backwater Access Study

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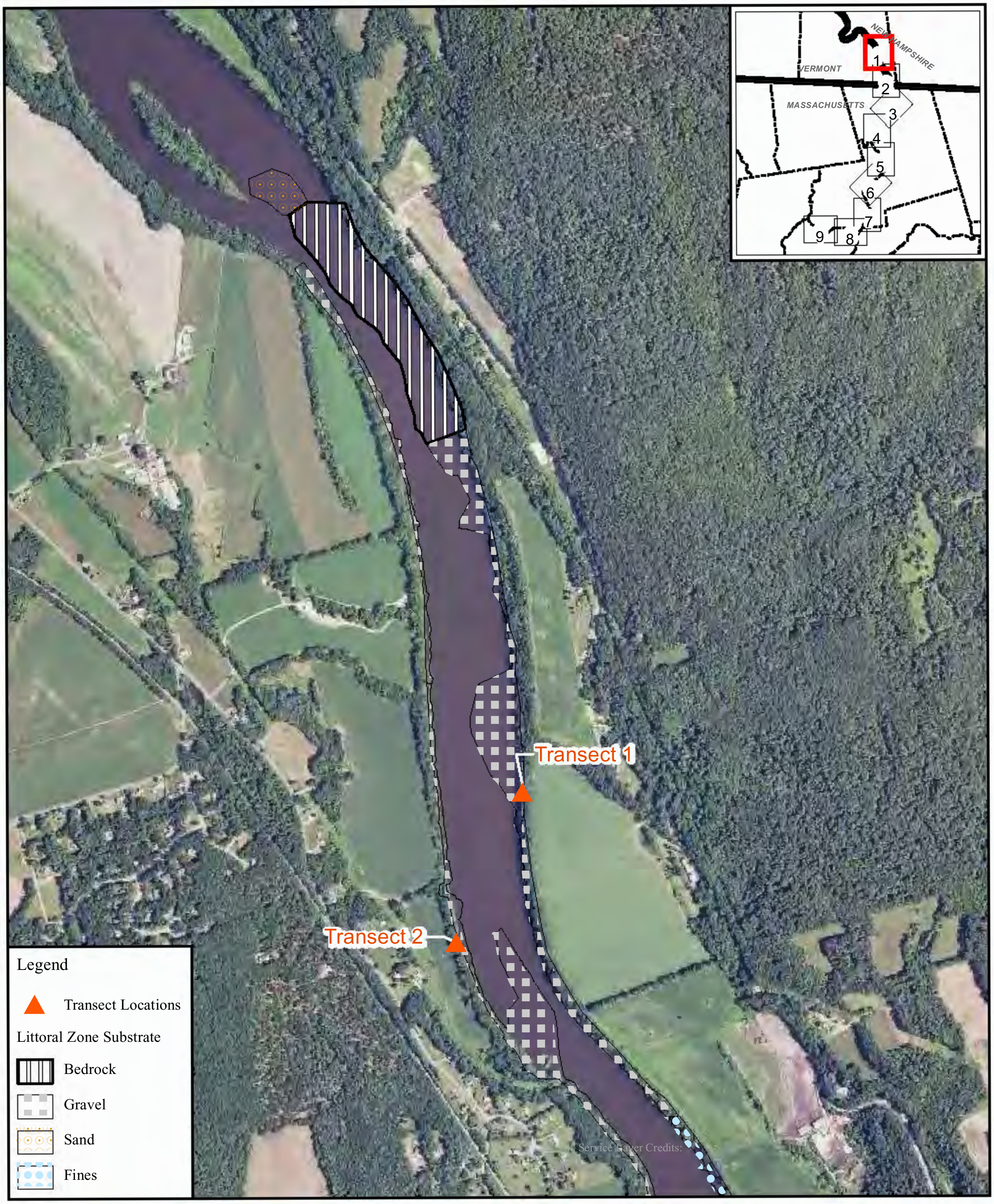

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Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 1

Path: W:\gis\maps\Exhibit_E\figure_3_3_3_1-2.mxd

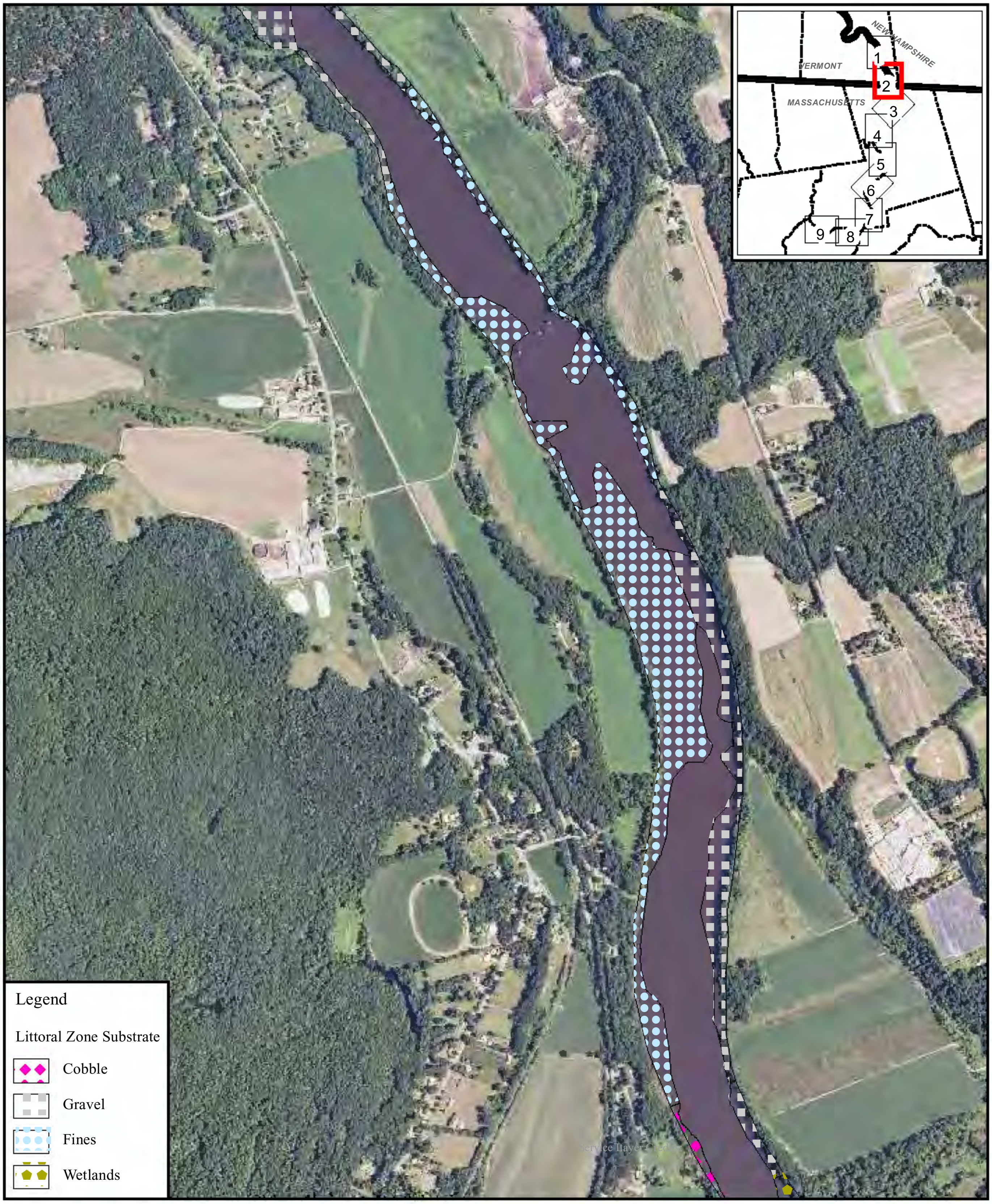

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Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 2

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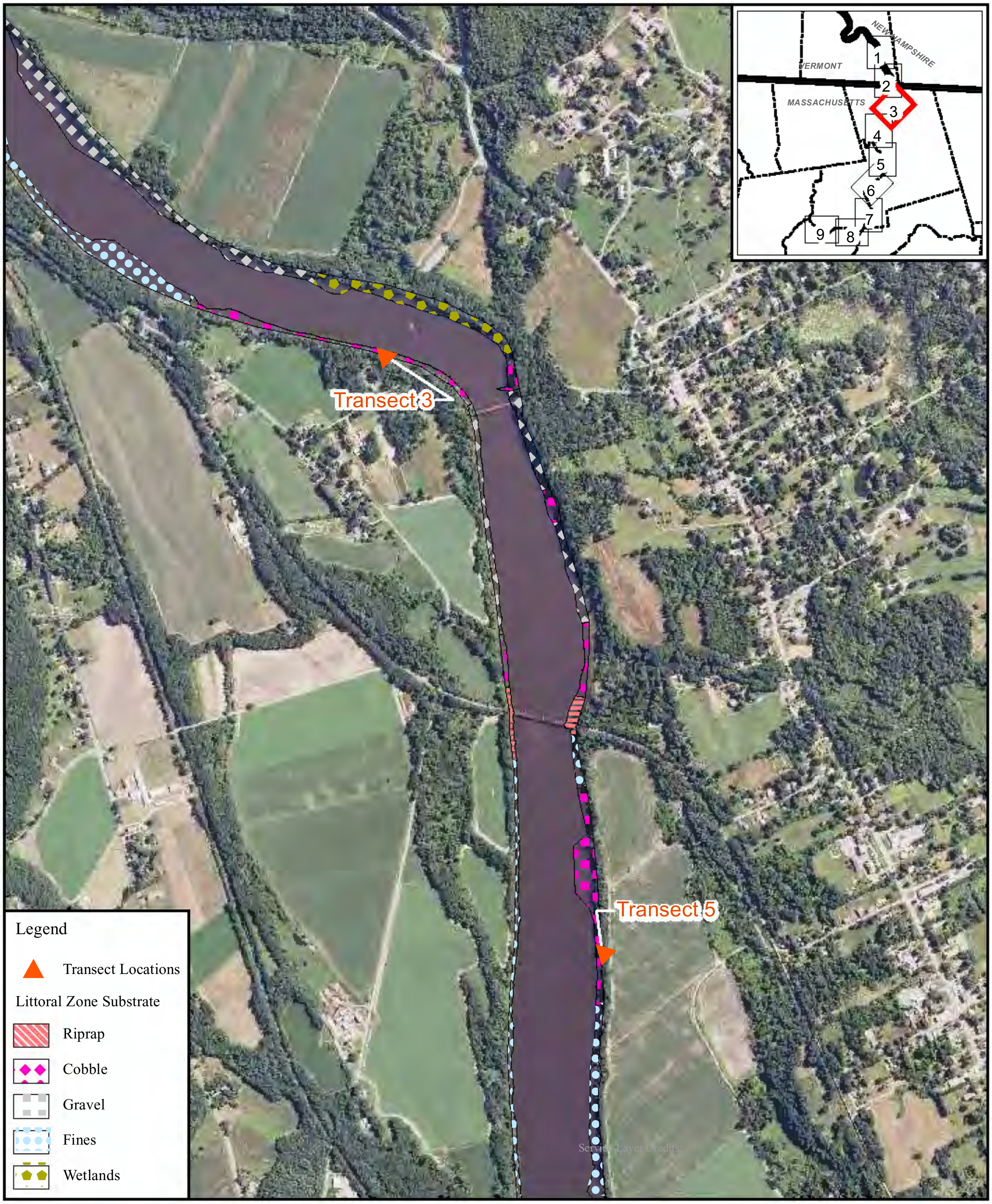

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Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 3

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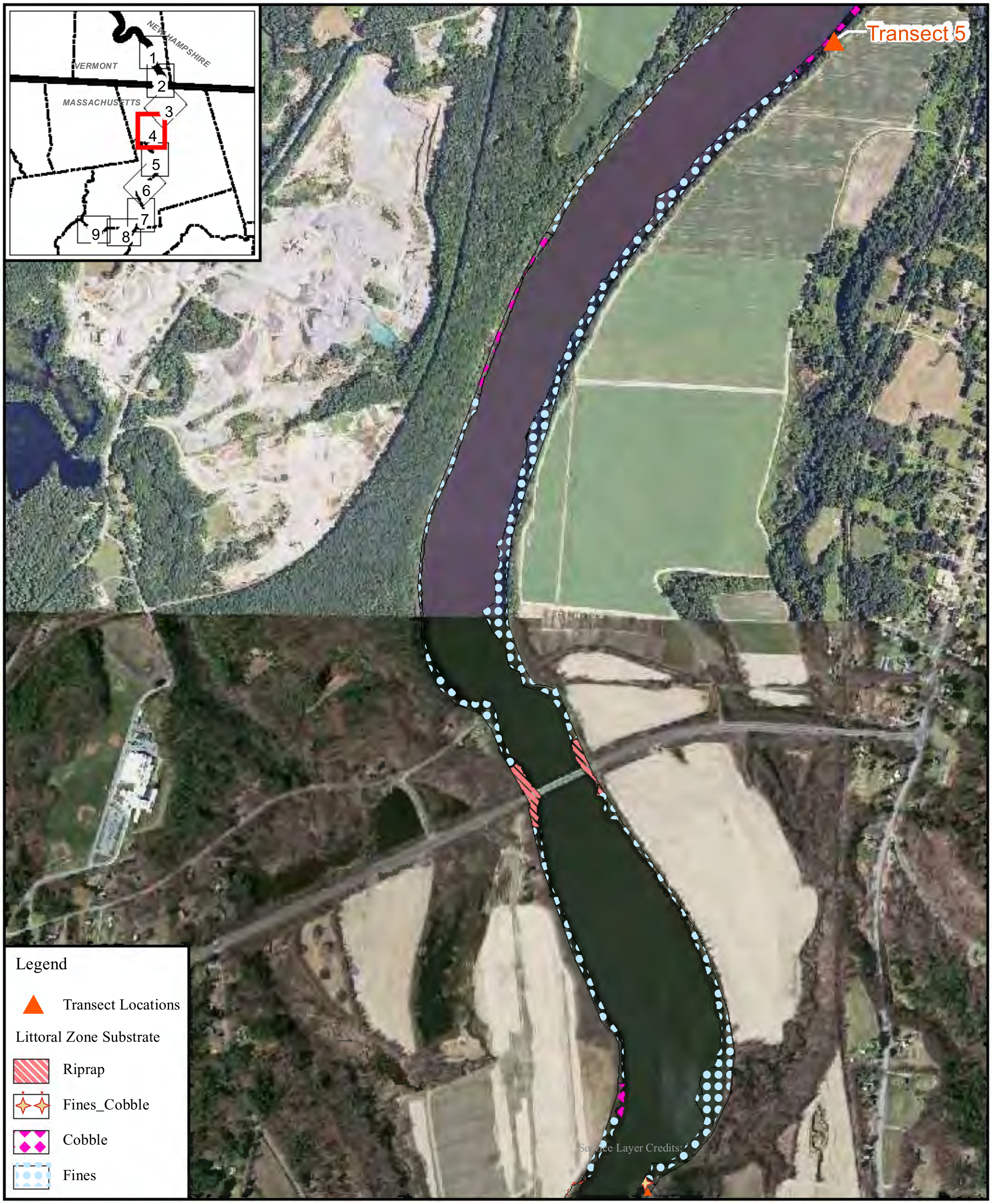

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0 500 1,000 2,000
Feet

Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 4

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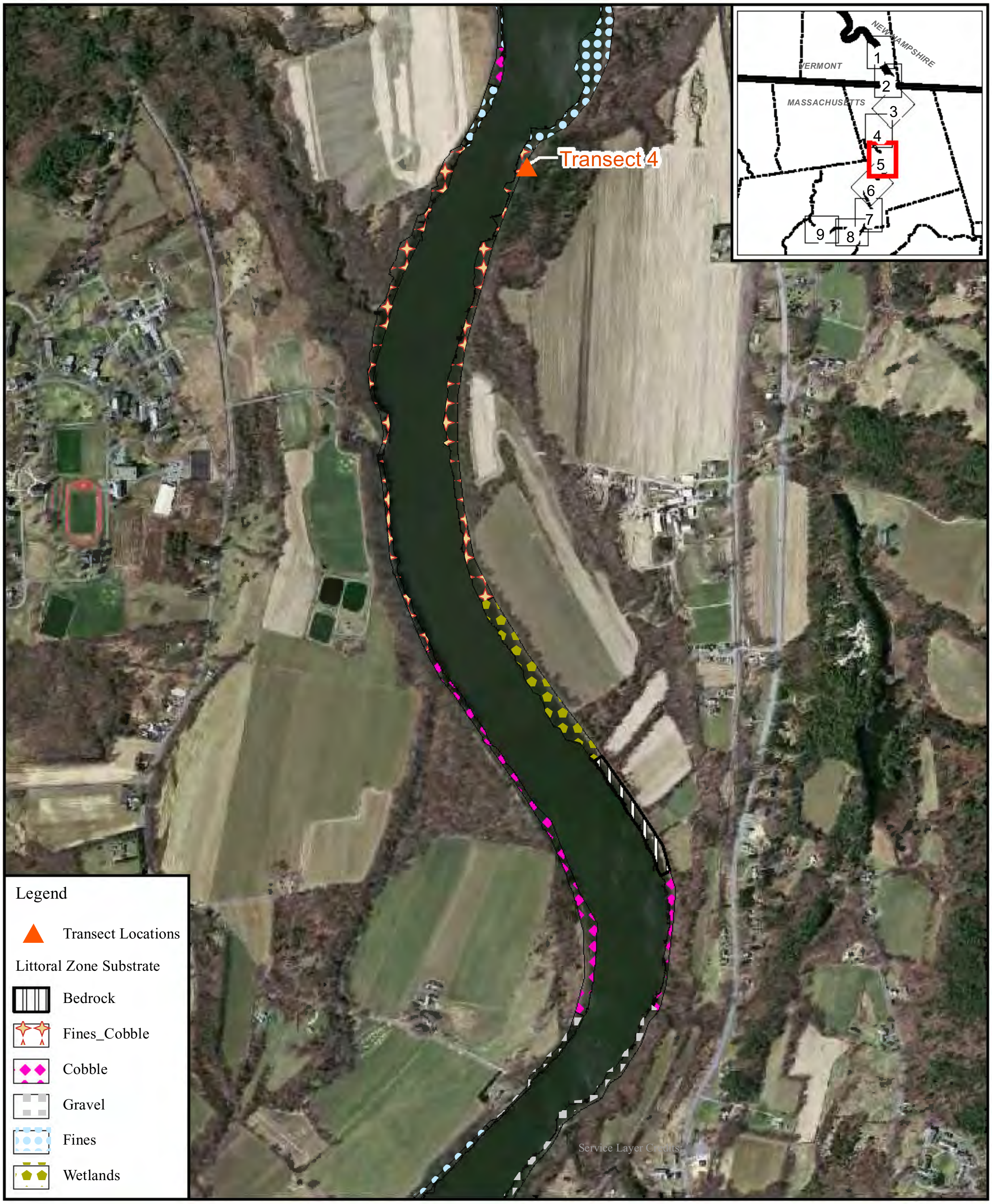

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Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 5

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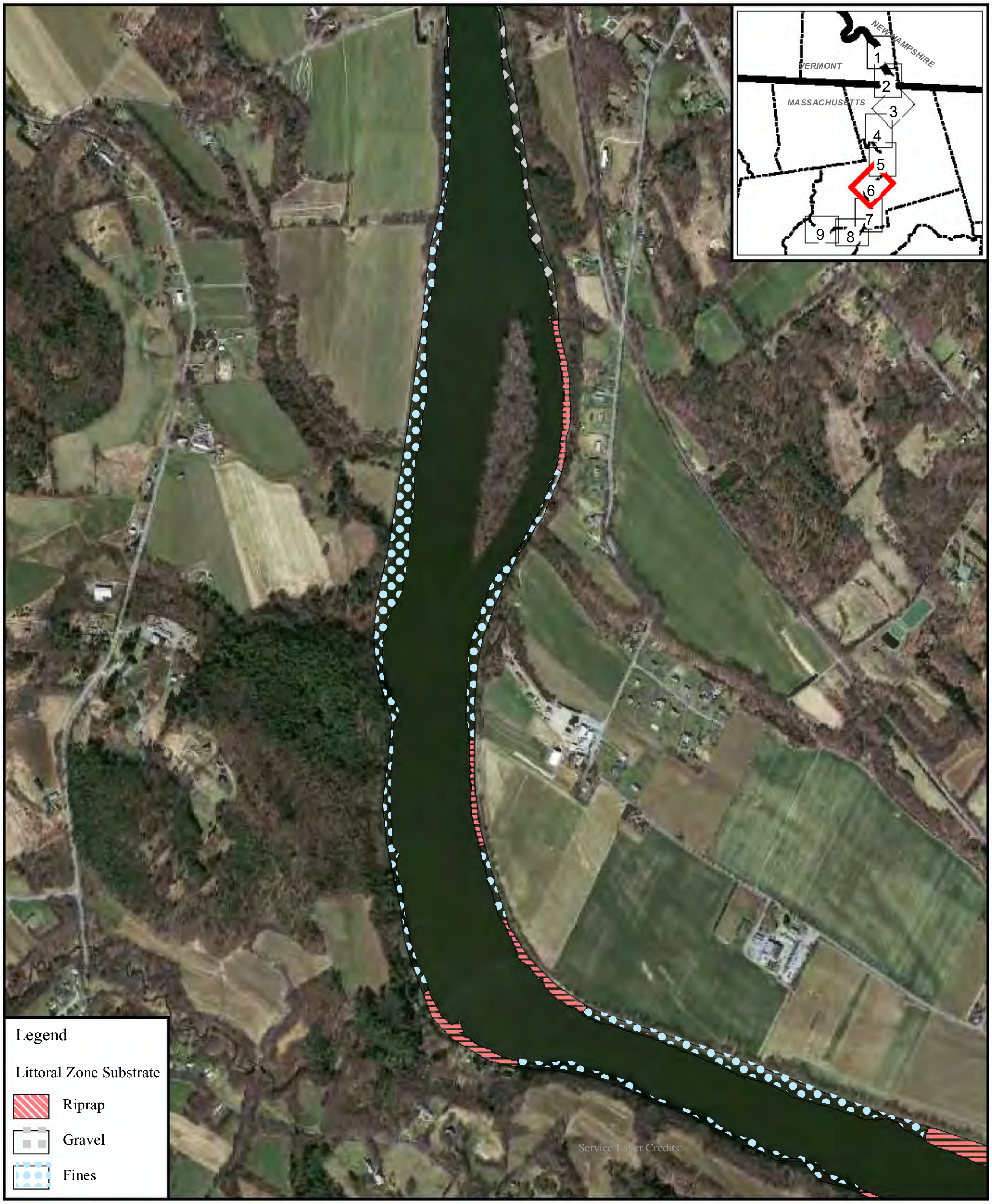

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0 500 1,000 2,000 Feet

Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 6

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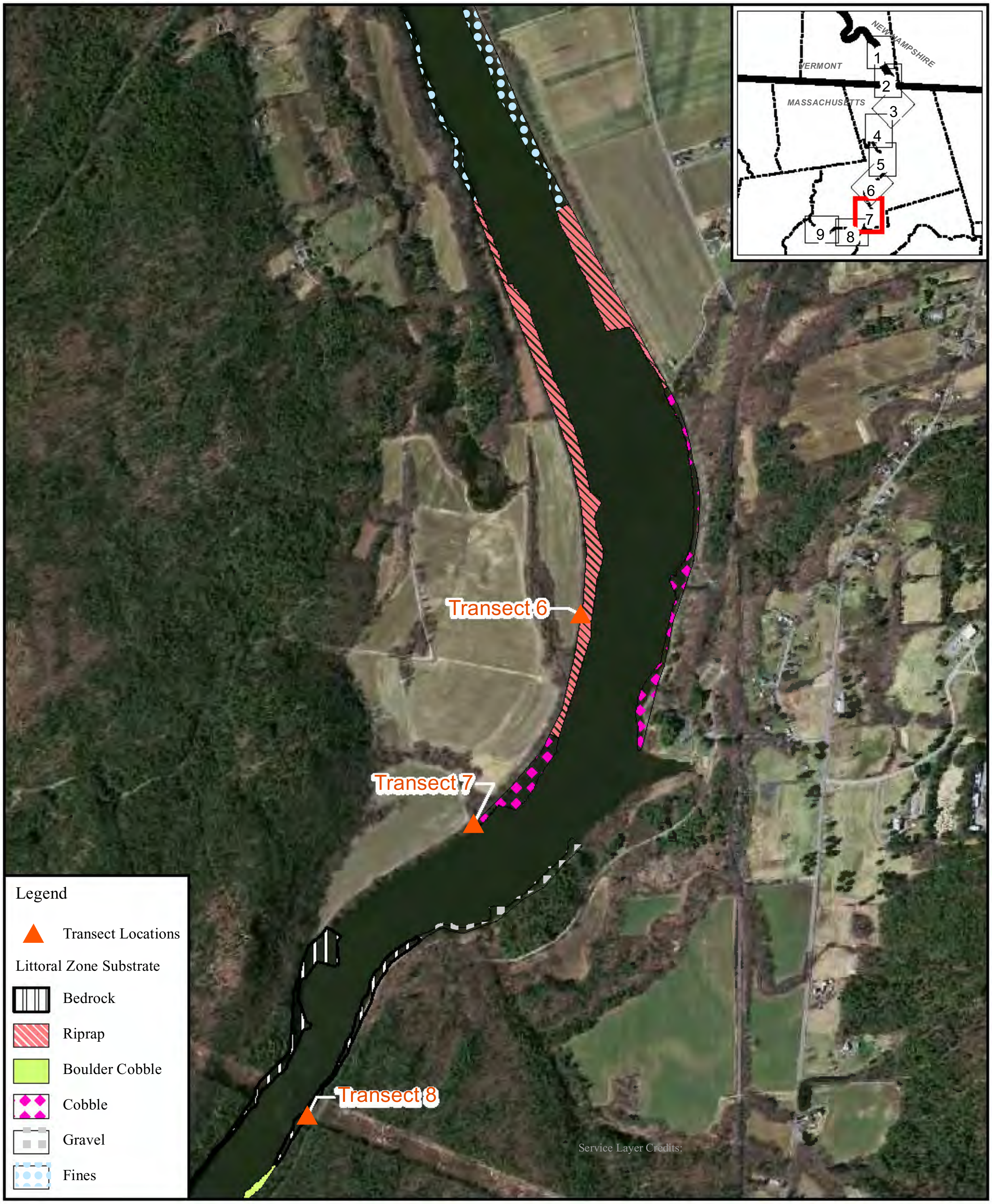

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Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 7

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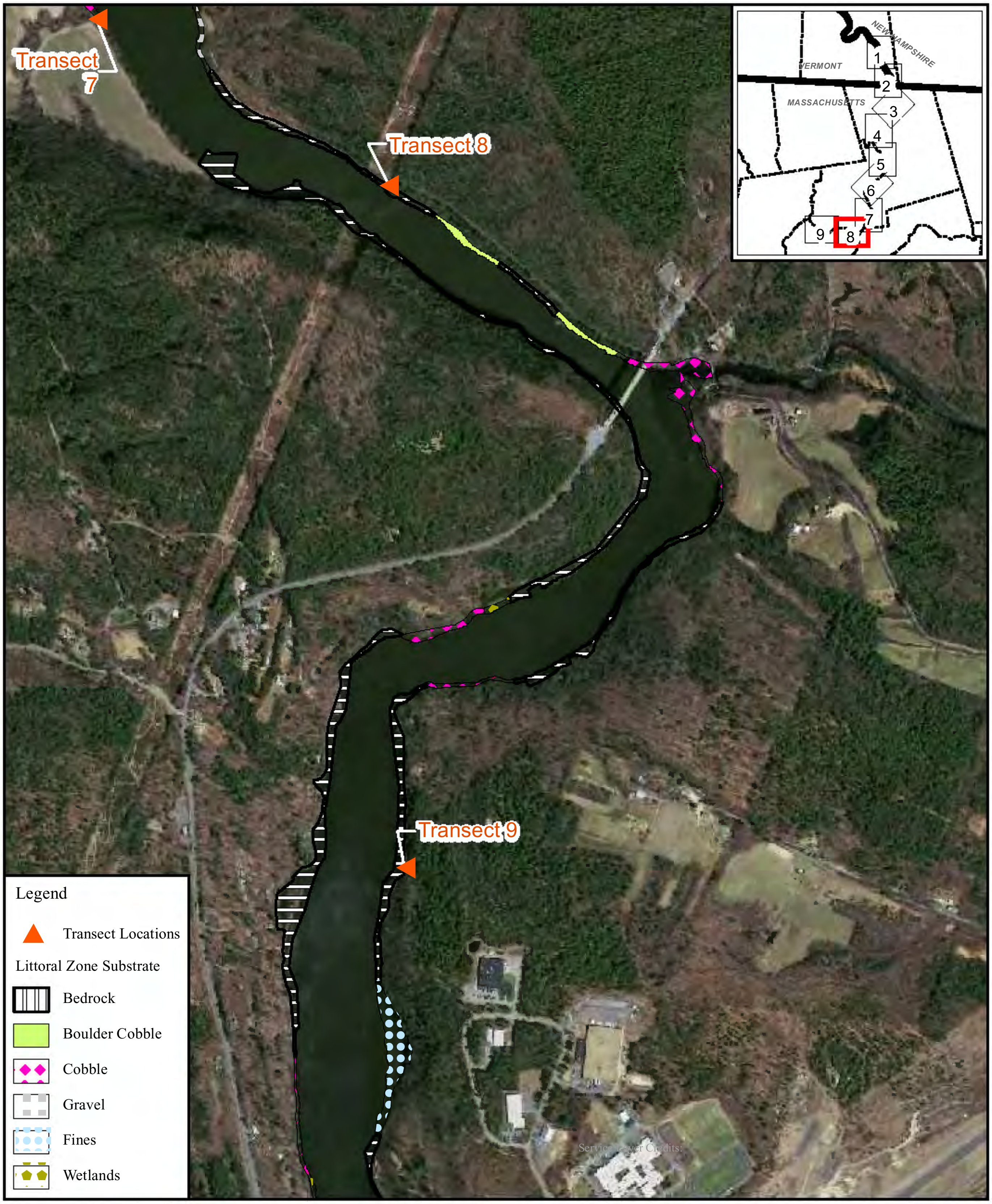

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Feet

Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 8

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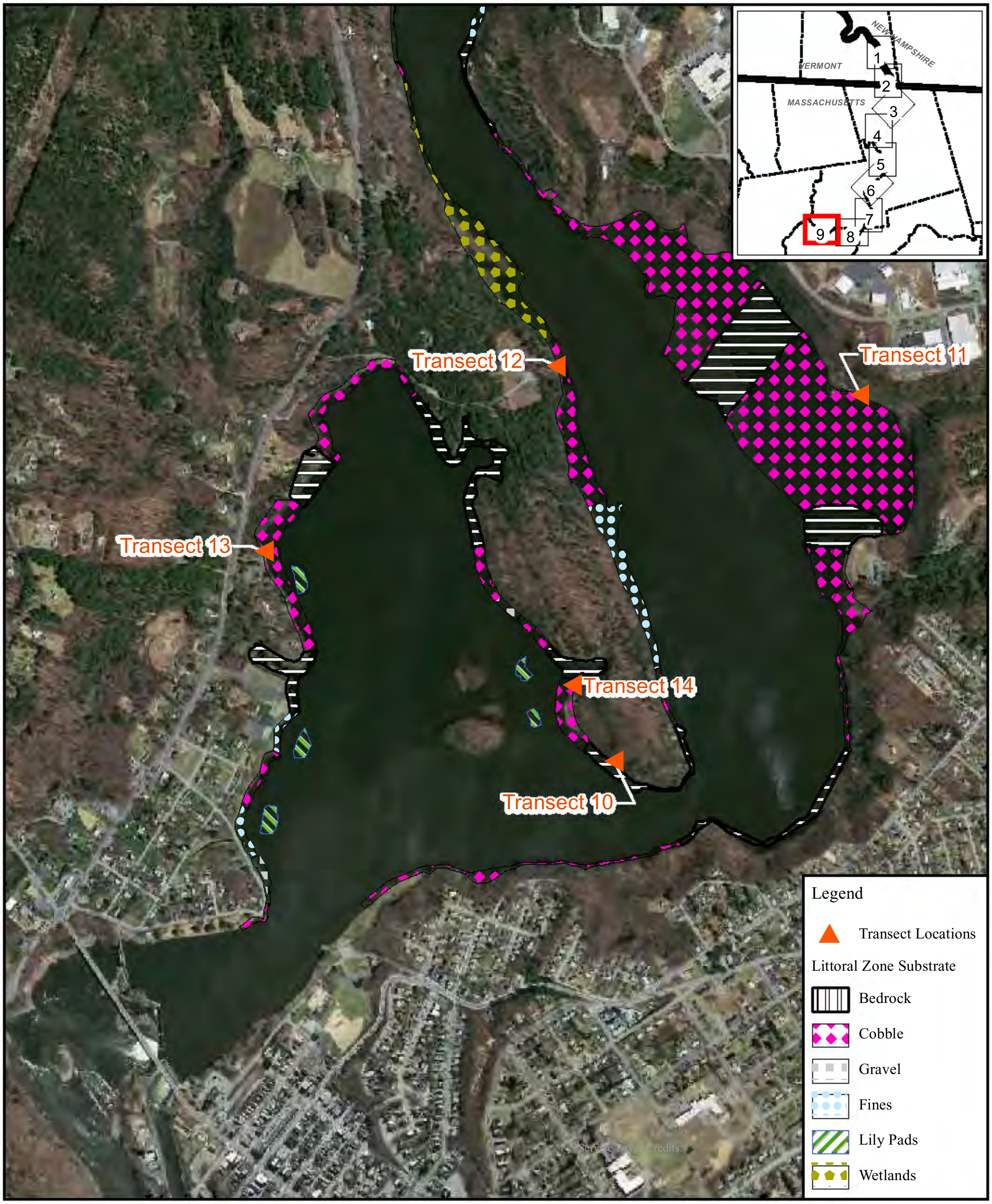

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Feet

Figure 3.3.3.1-2:
Littoral Habitat Mapping
Map 9

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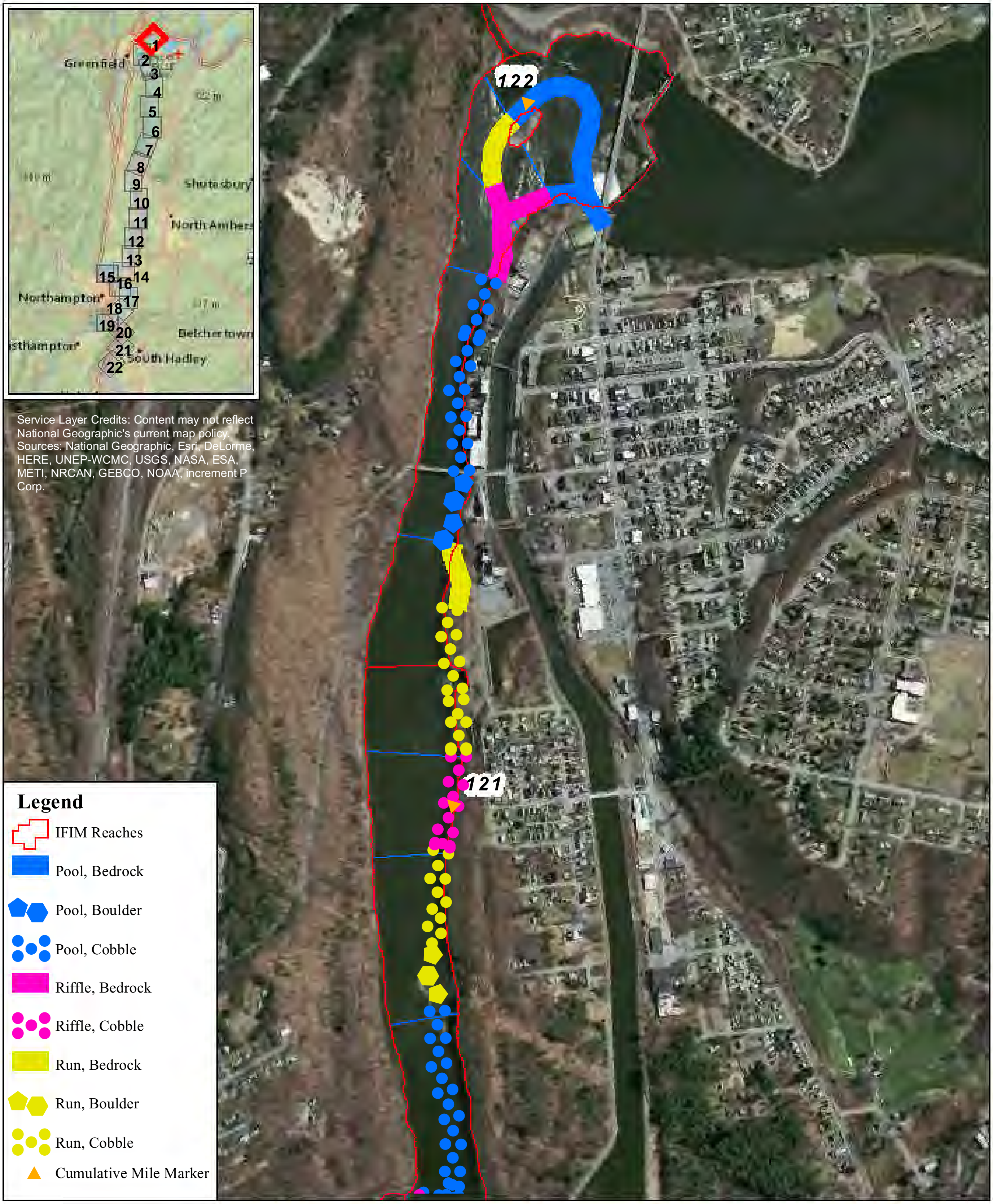

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 1

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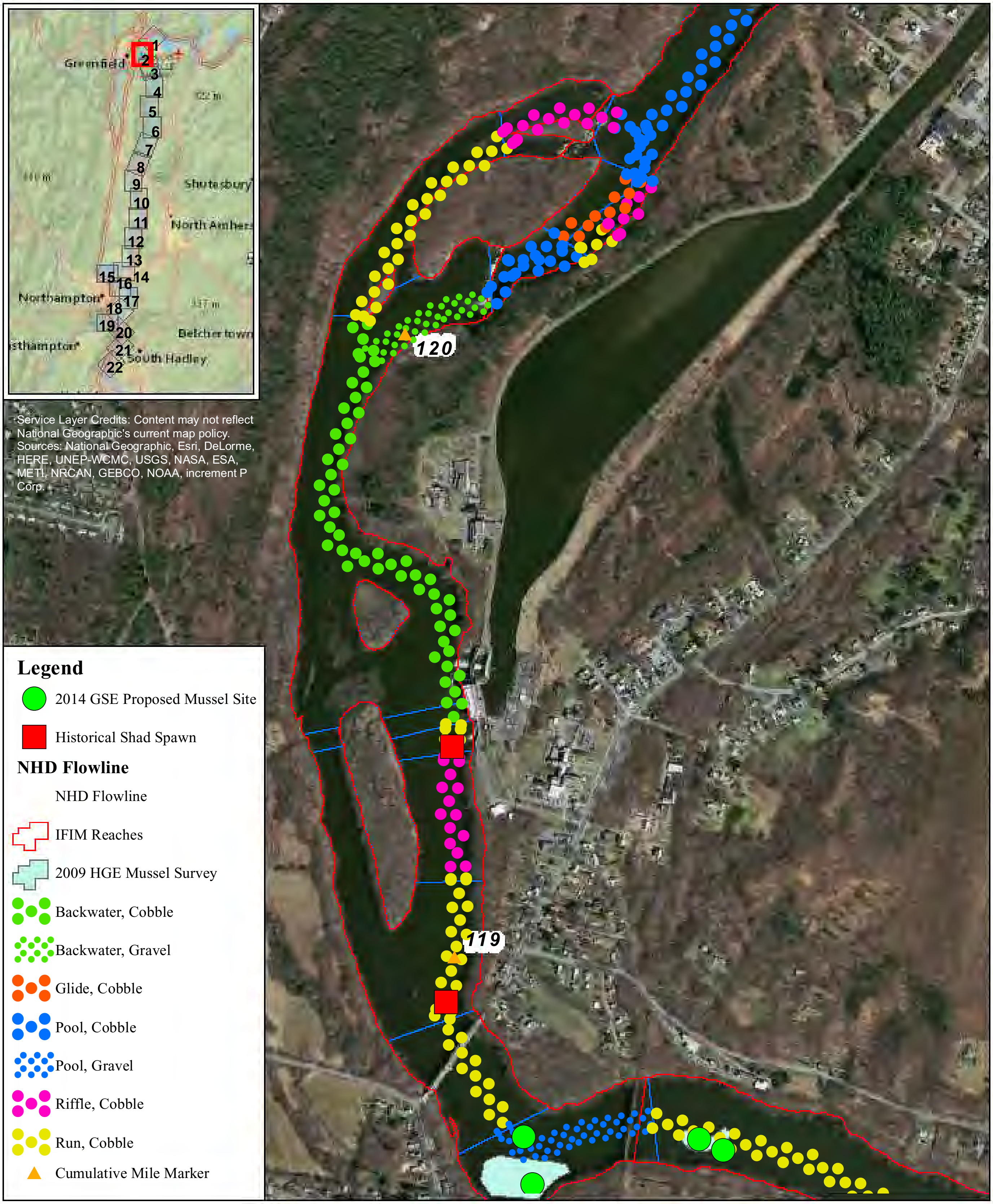

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 2

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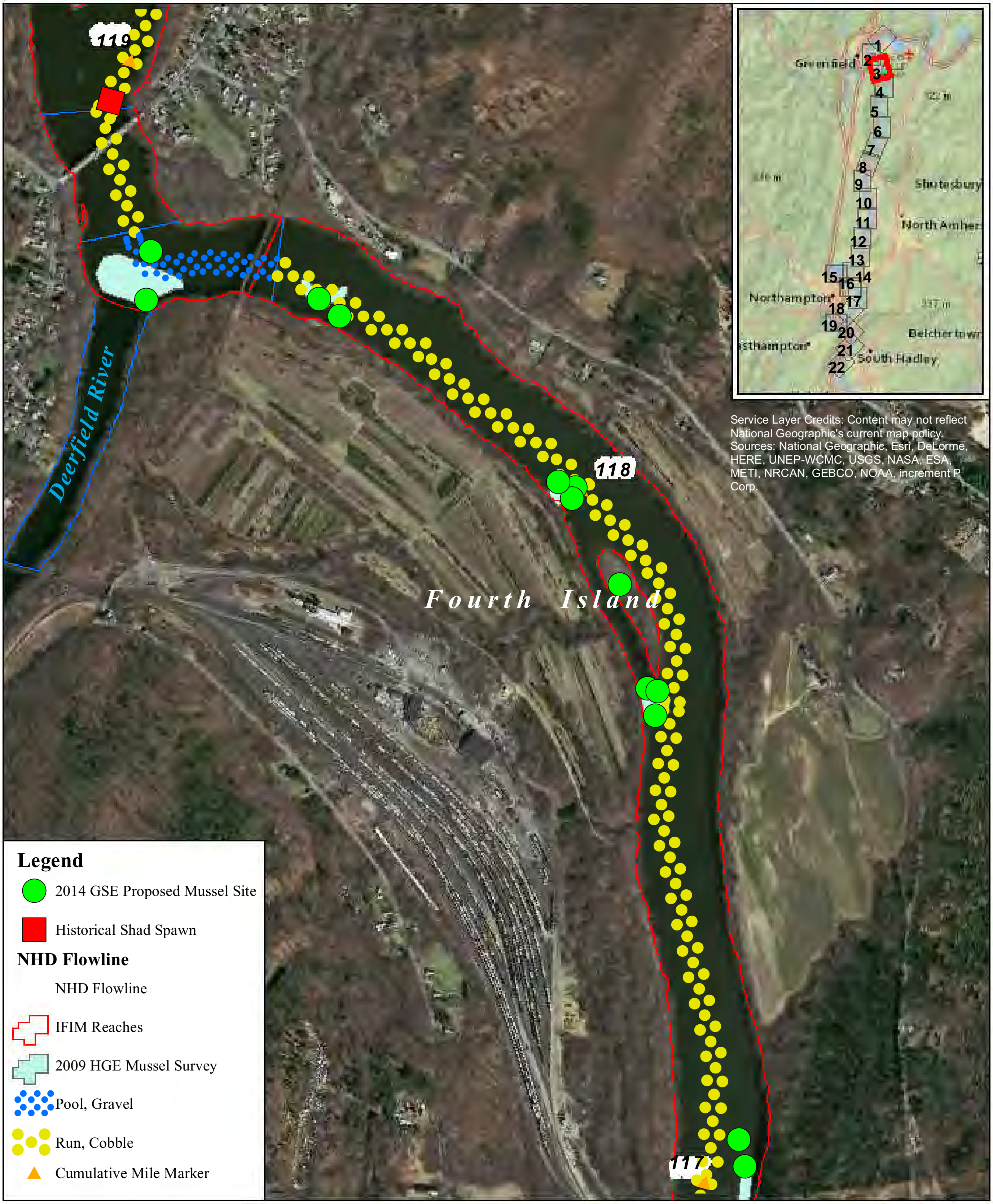

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 3

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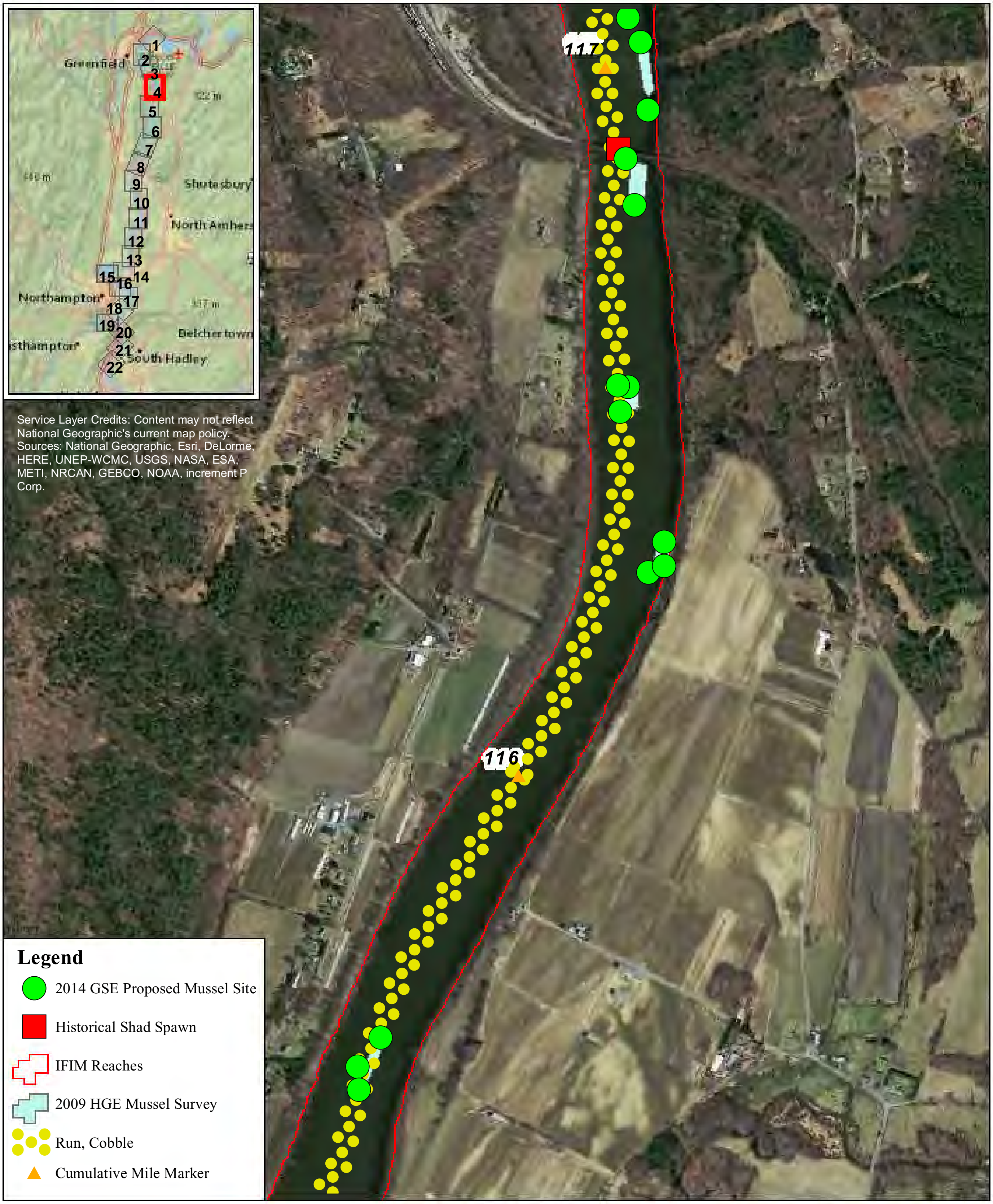

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Feet

Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 4

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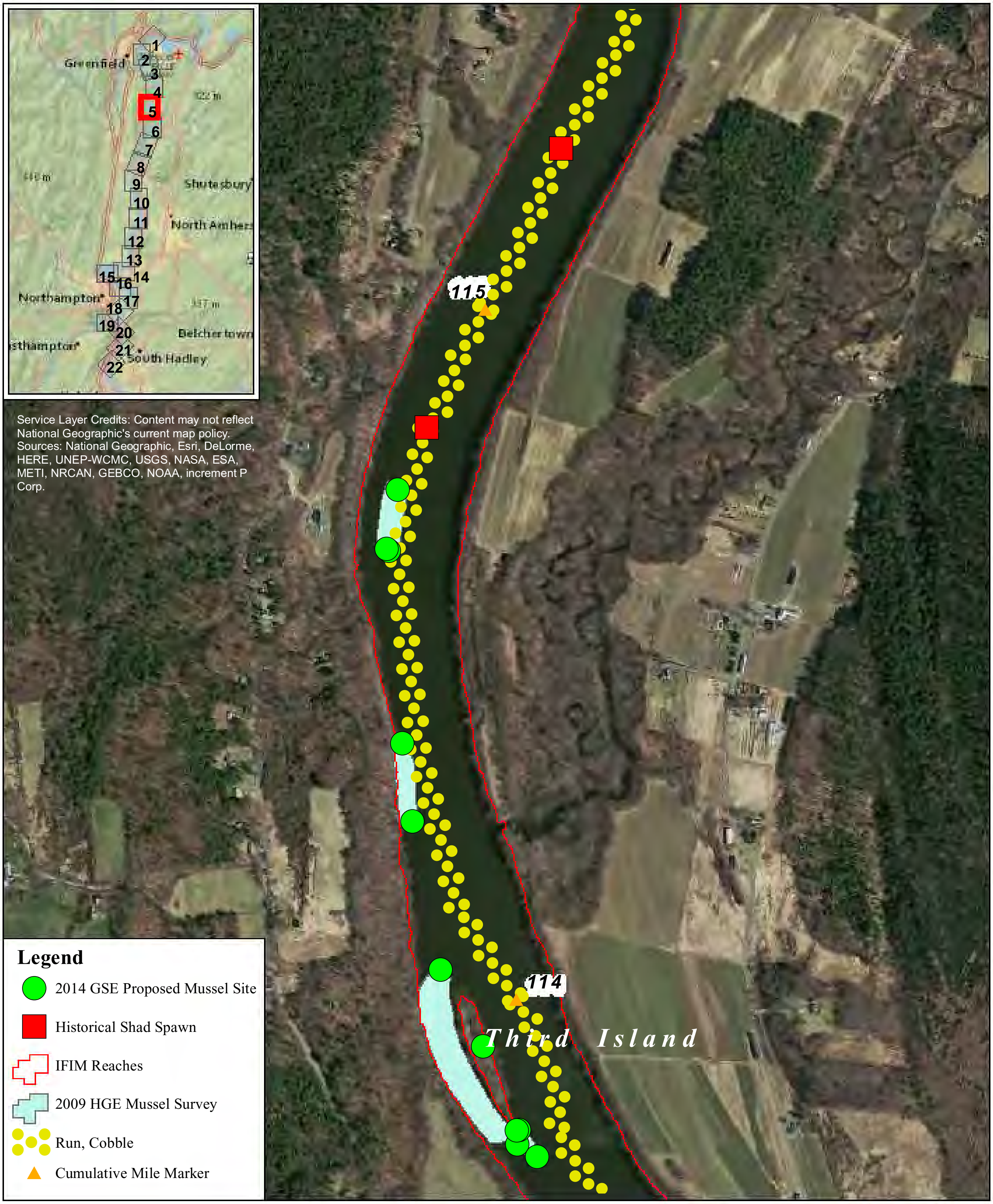

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 5

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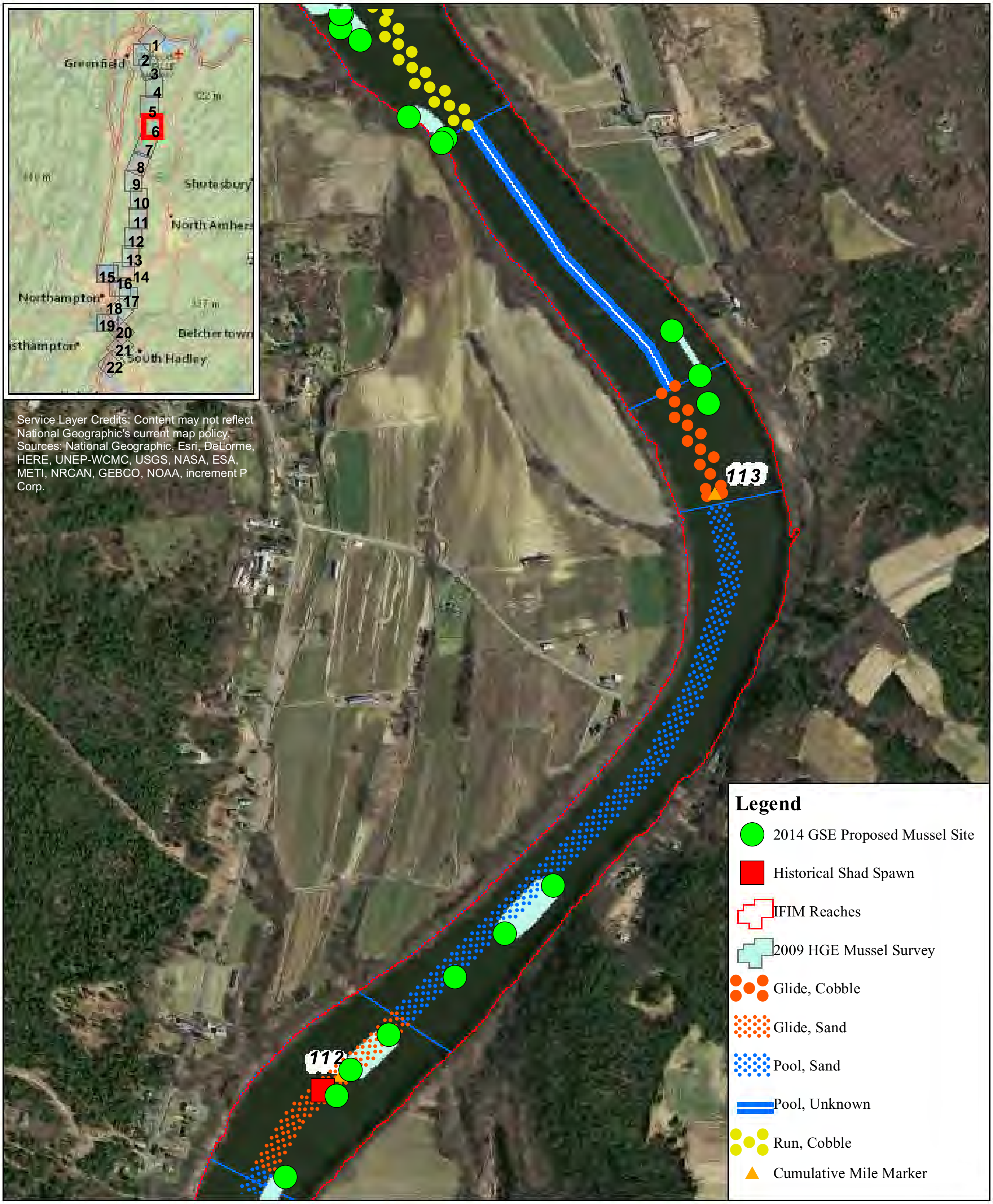

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 6

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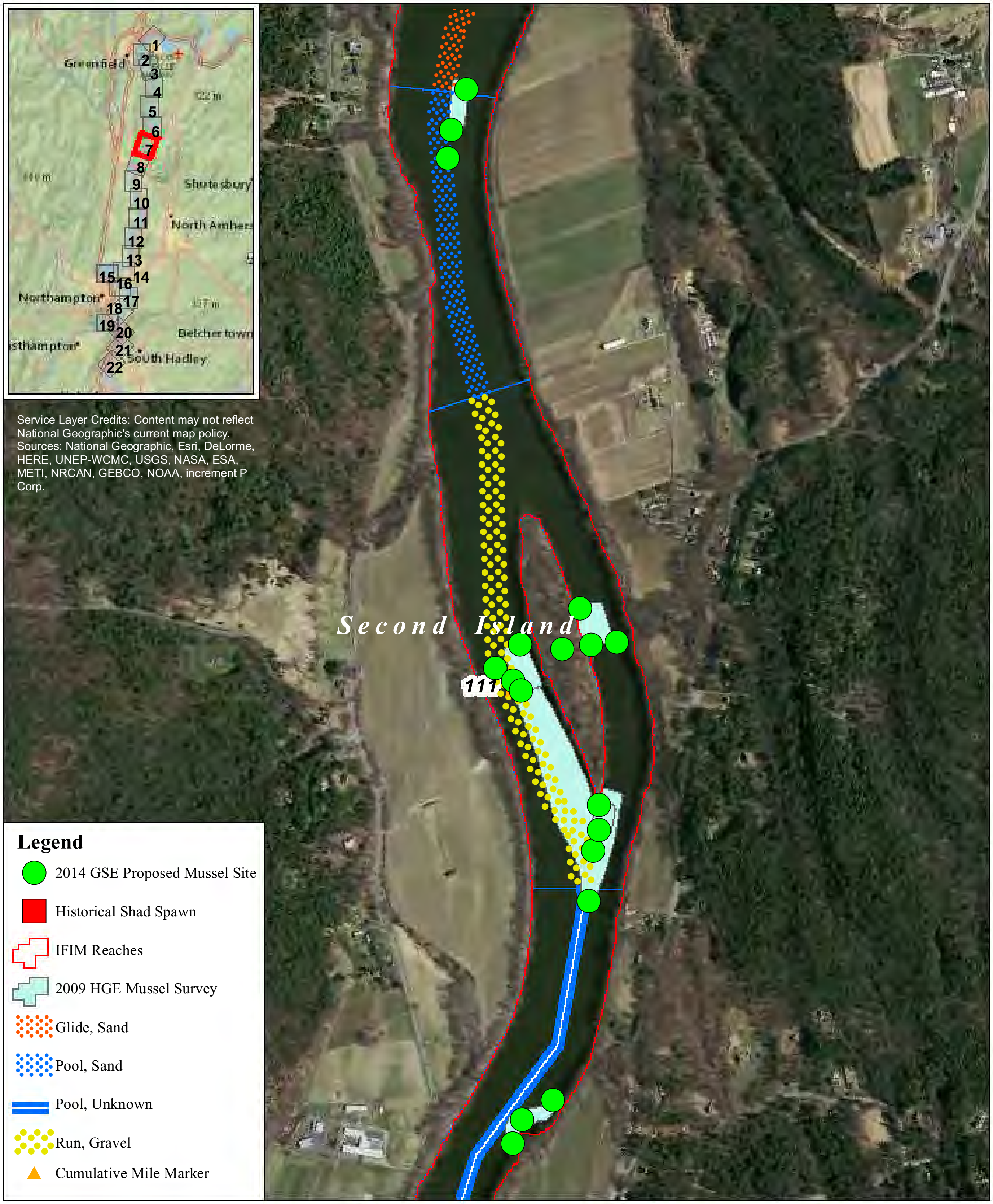

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 7

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0 500 1,000 2,000 Feet

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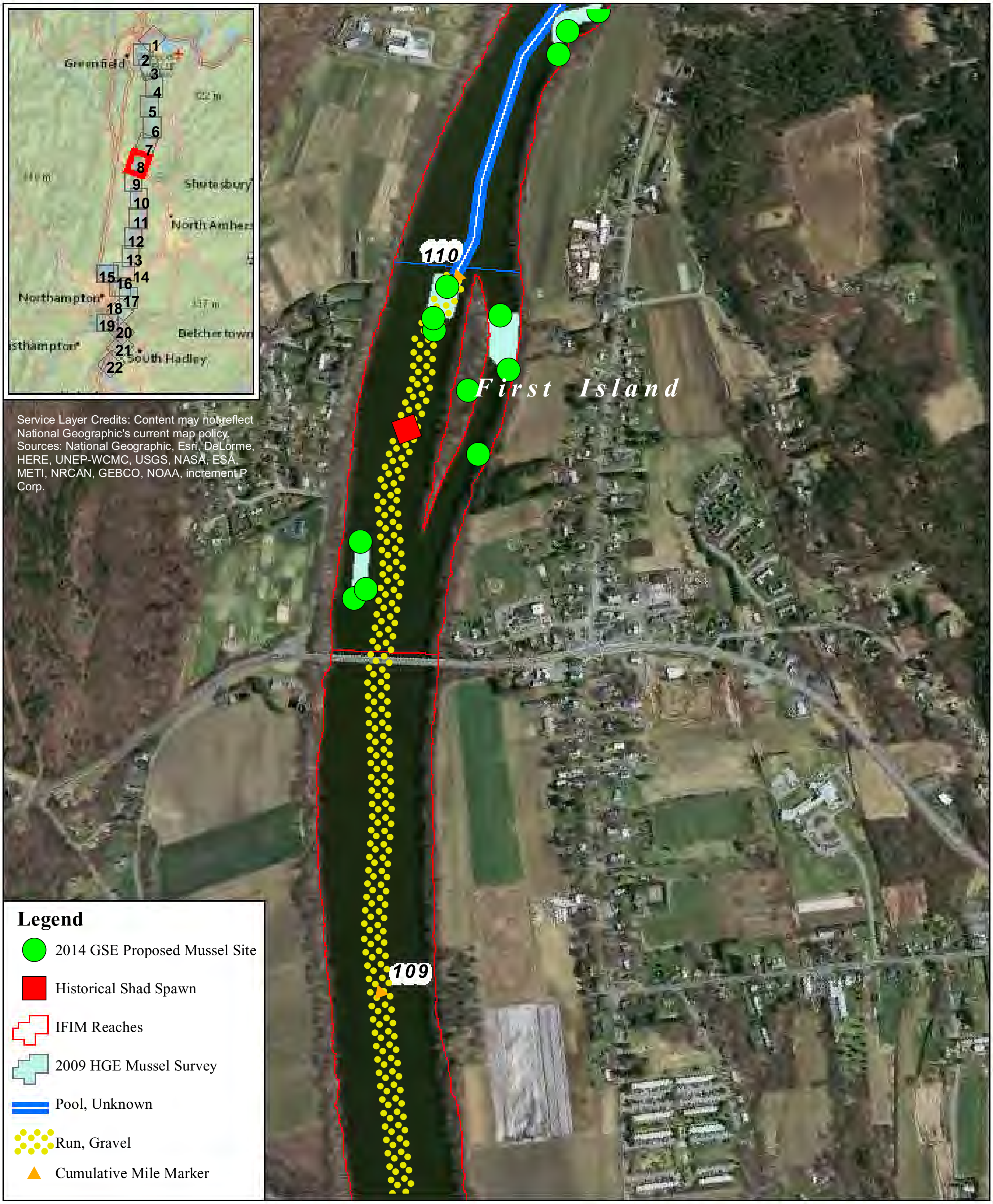

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 8

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 9

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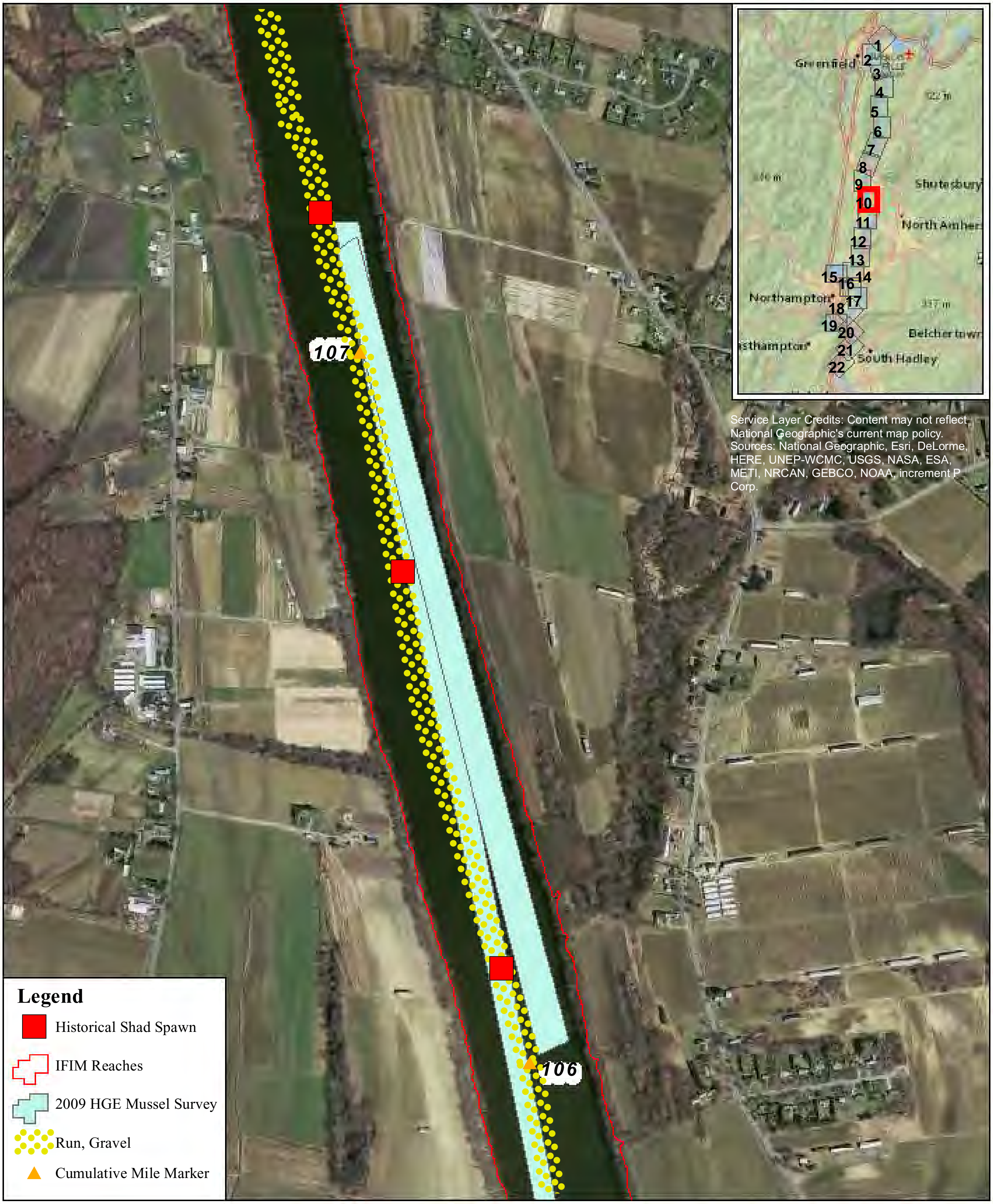

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 10

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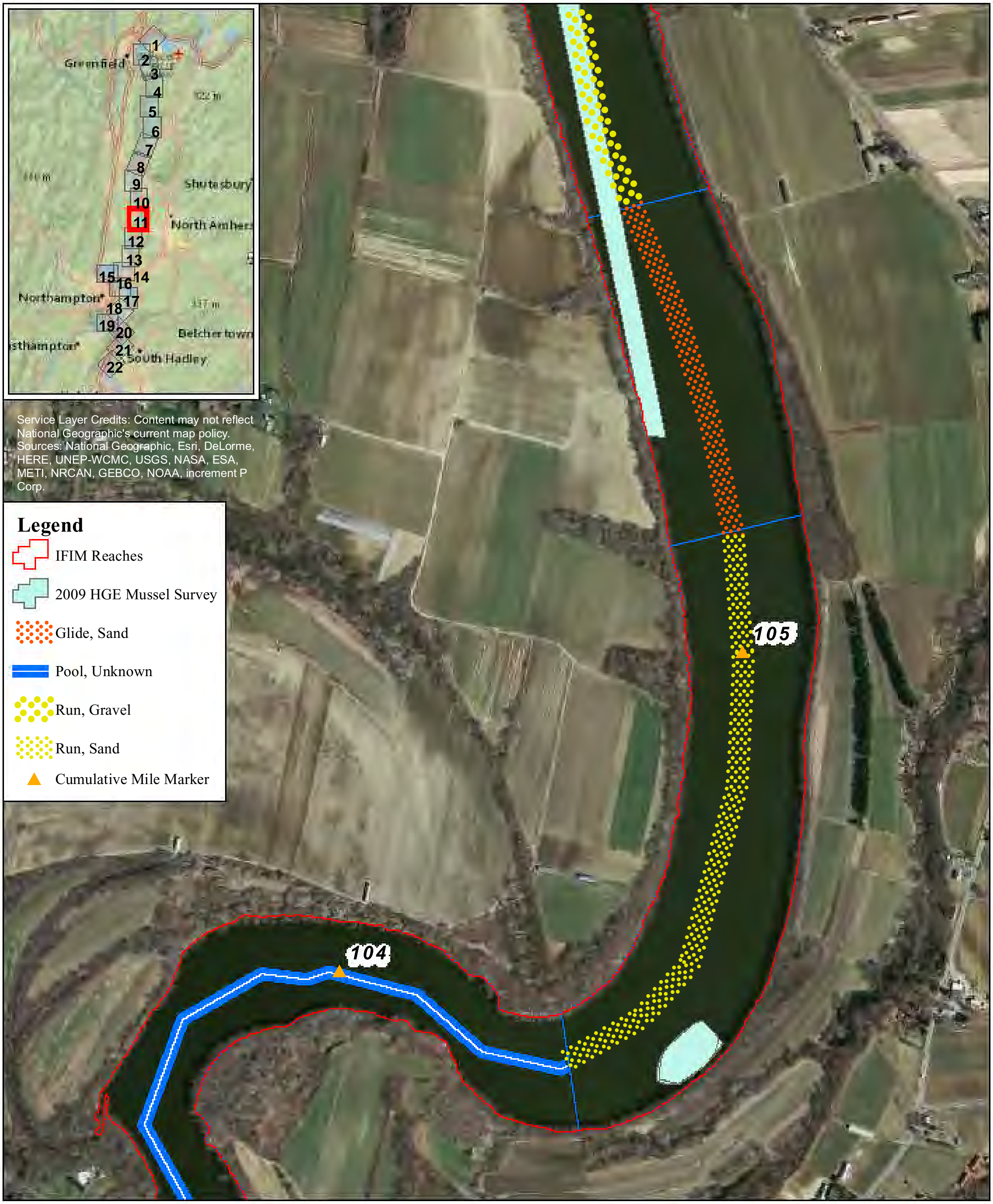

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0 500 1,000 2,000 Feet

Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 11

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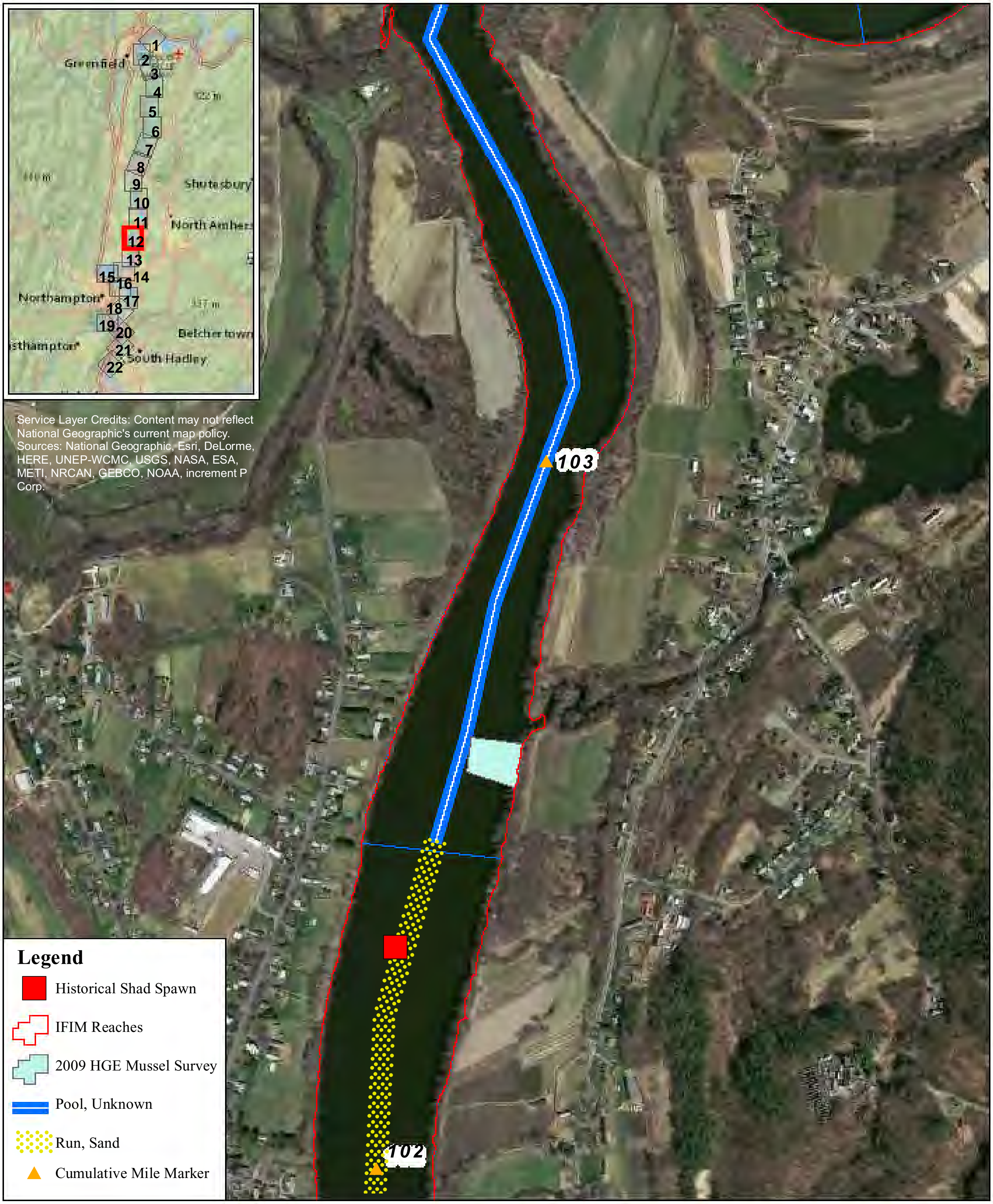

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0 500 1,000 2,000 Feet

Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 12

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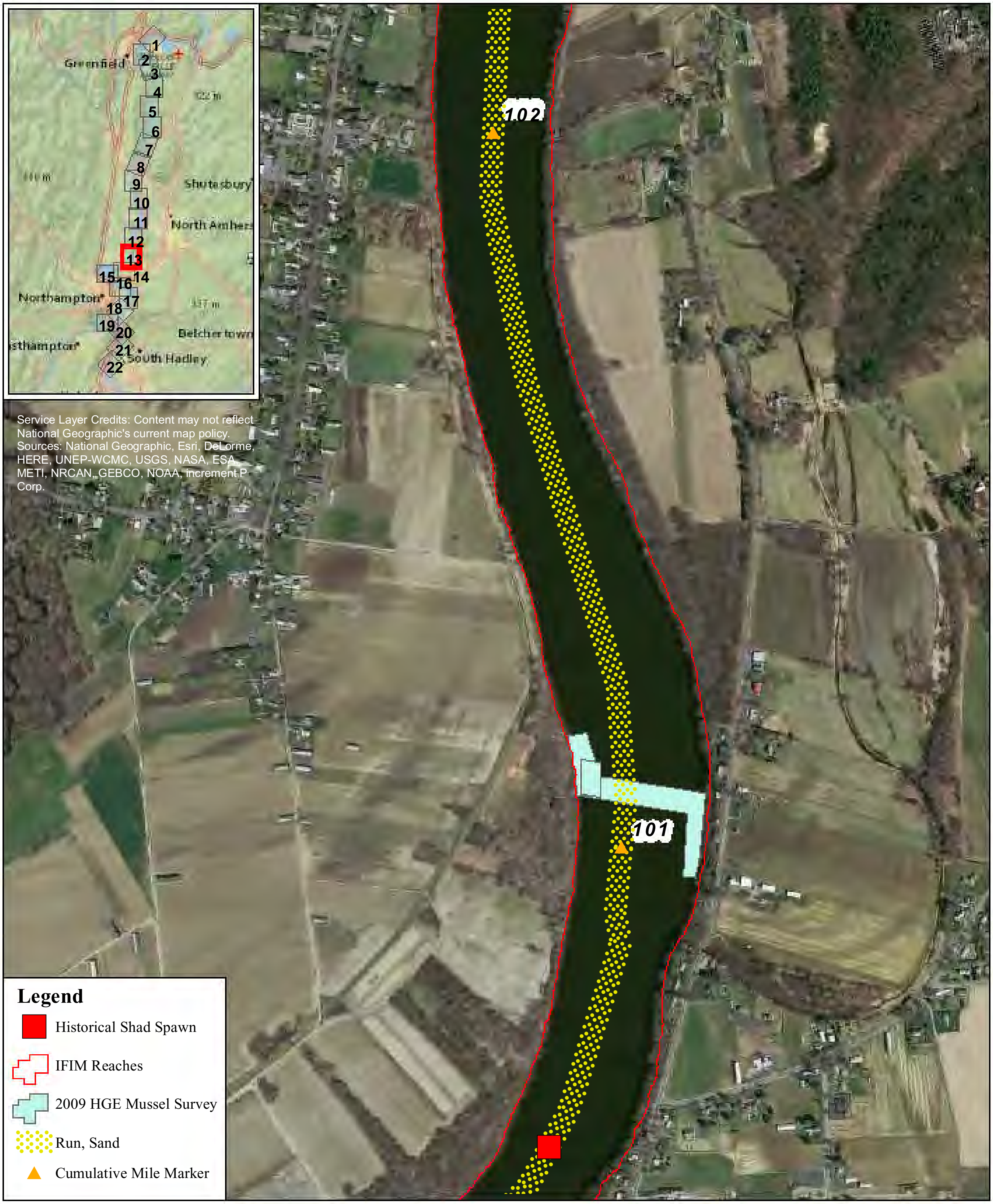

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 13

0 500 1,000 2,000 Feet

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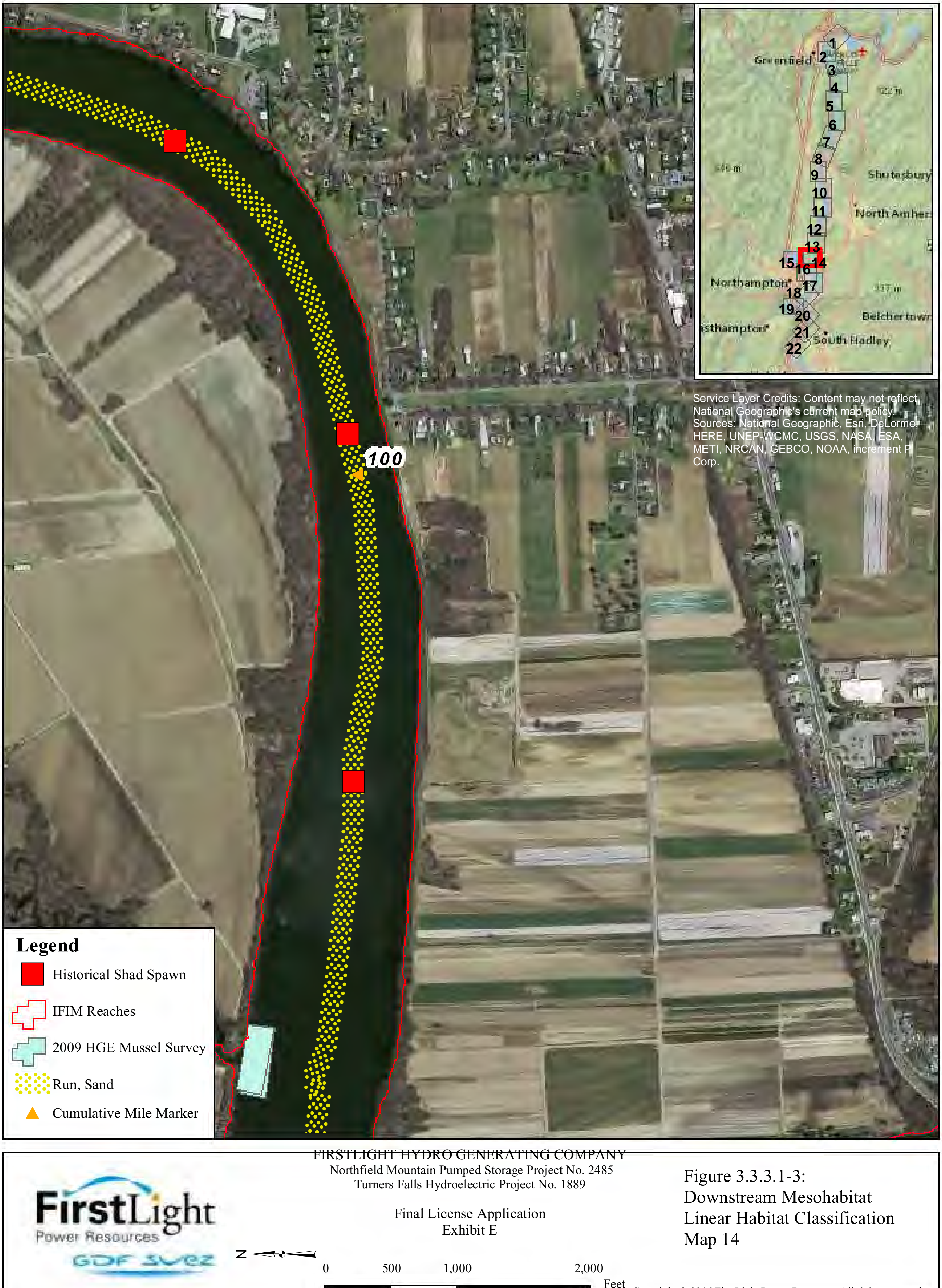

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 14

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 15

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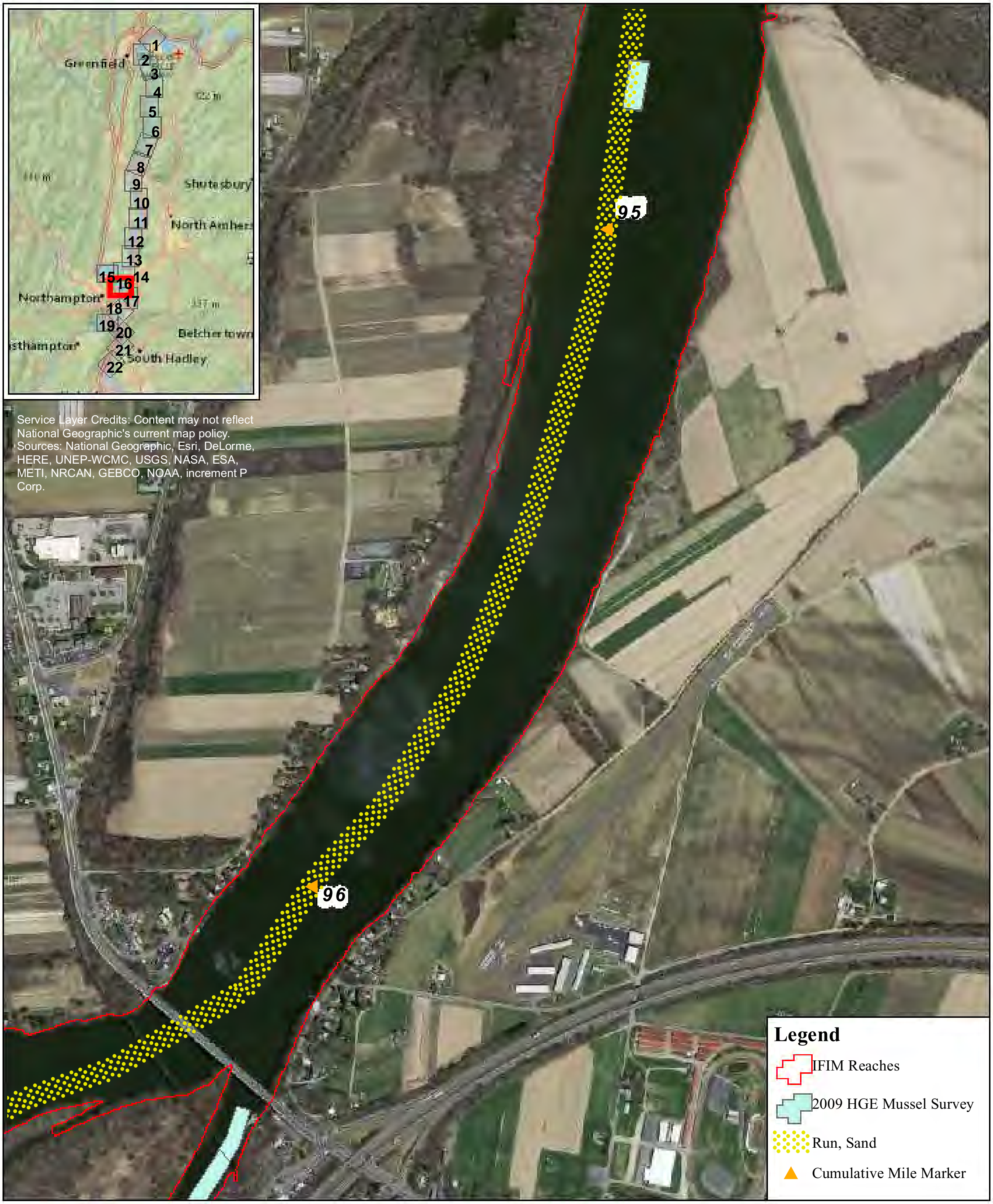

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 16

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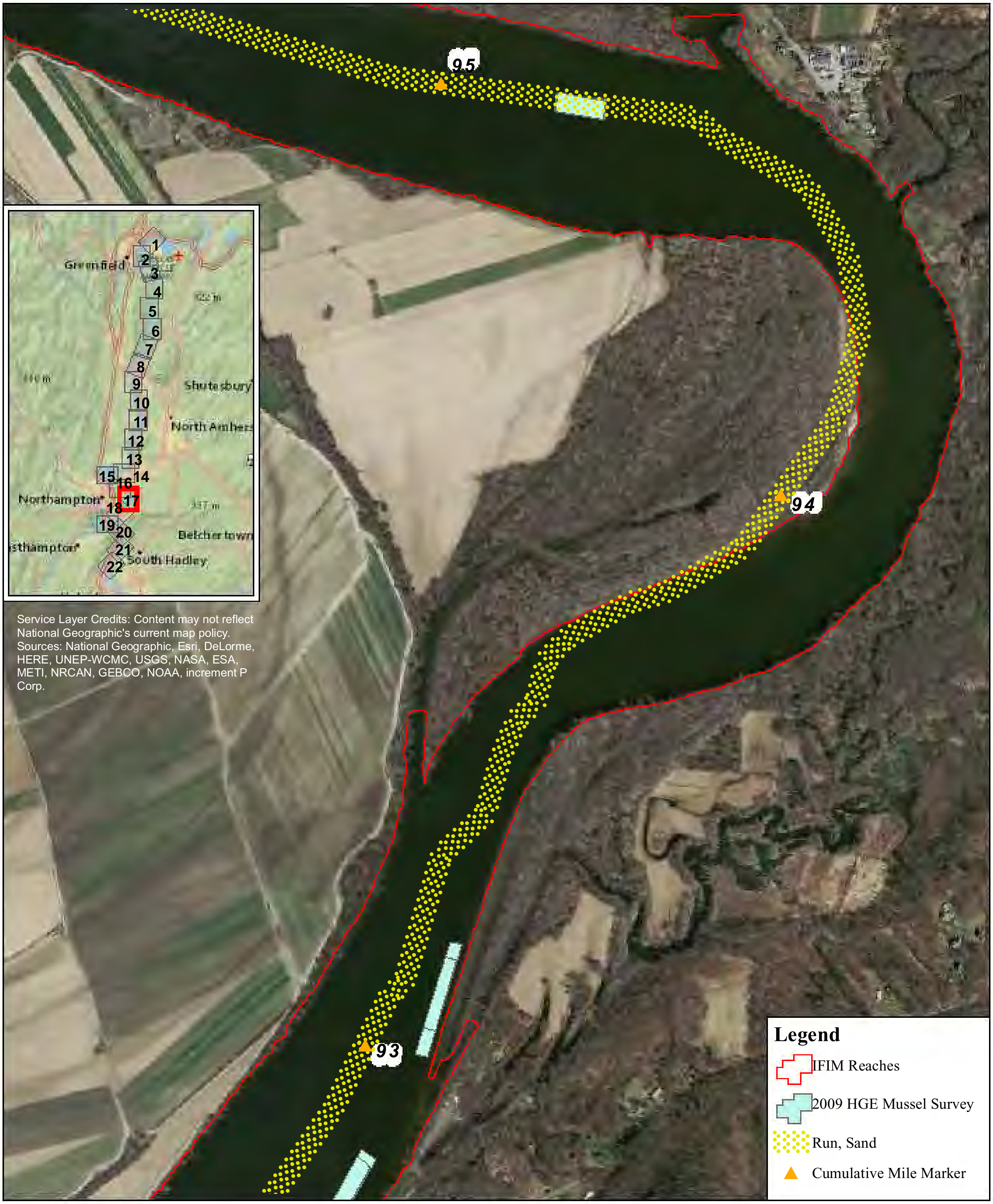

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 17

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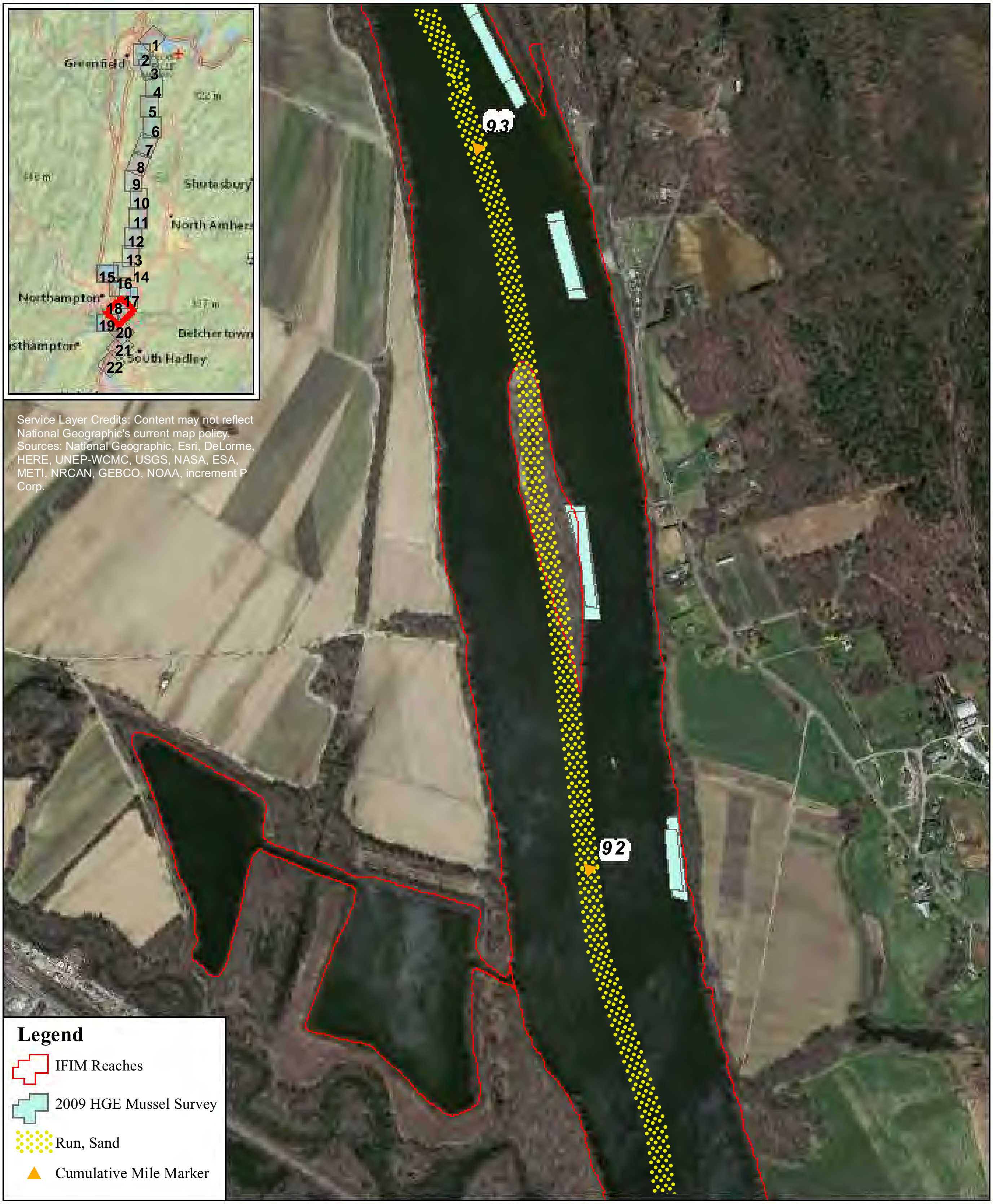

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 18

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 19

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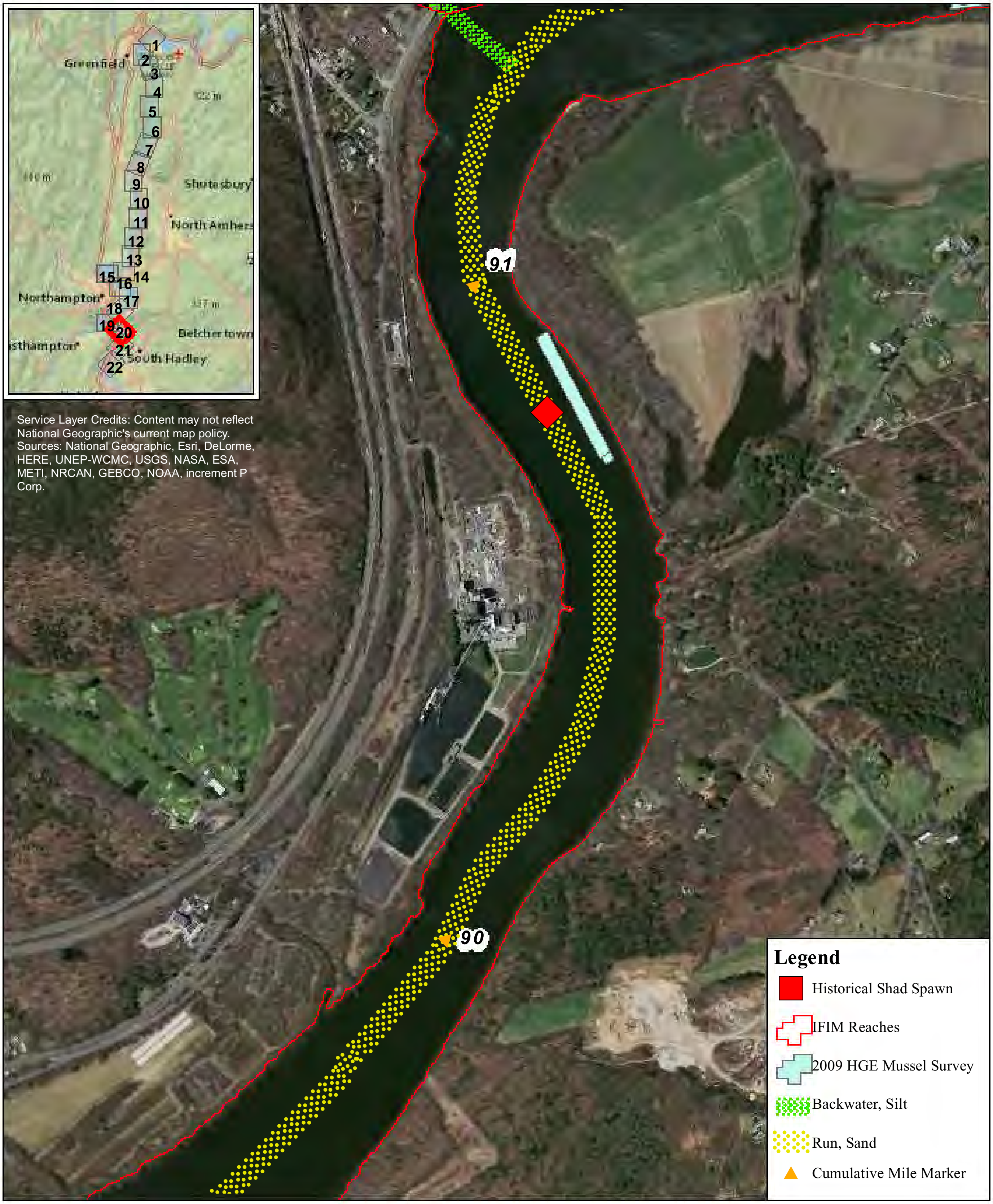

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N

0 500 1,000 2,000 Feet

Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 20

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 21

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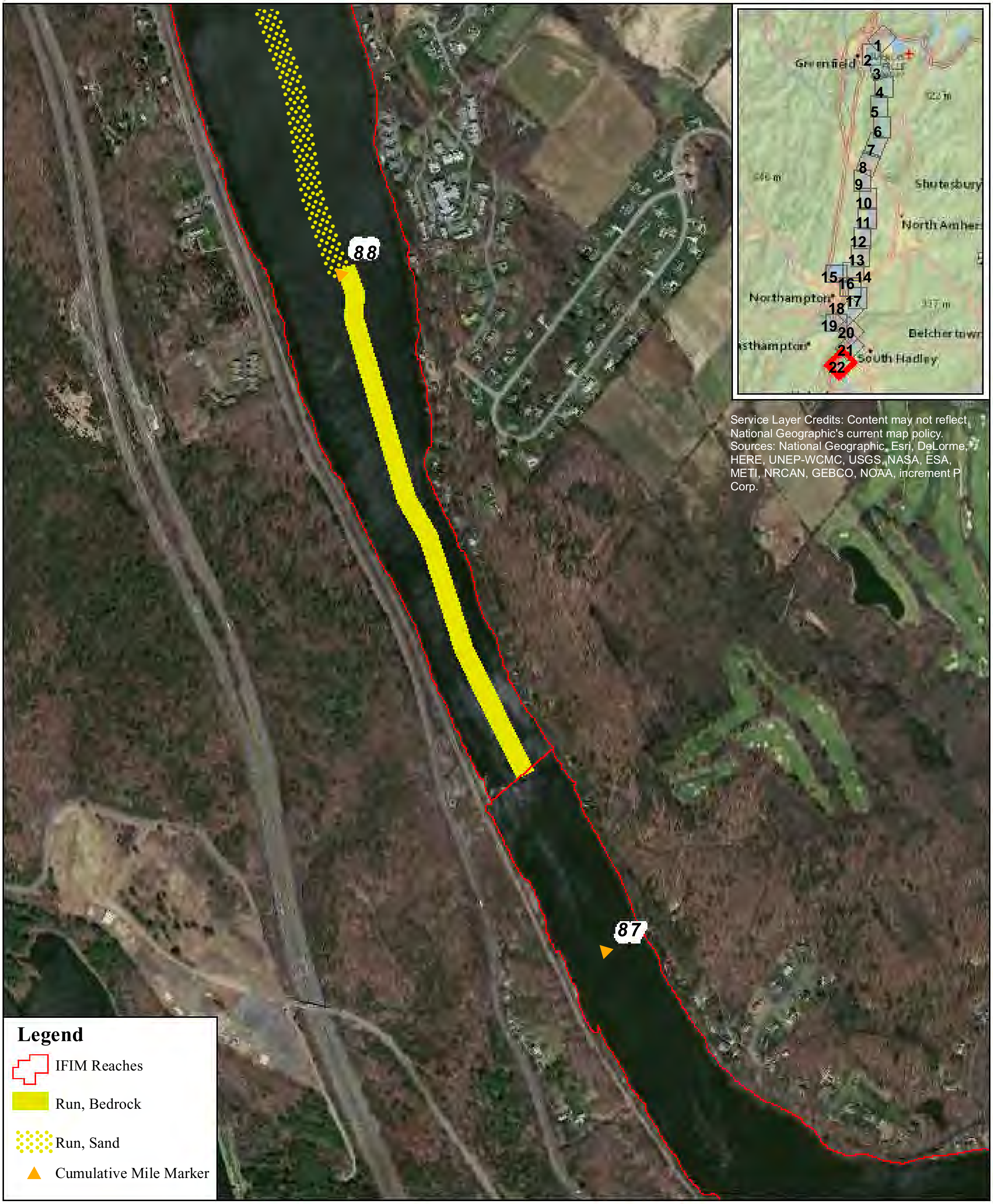

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Figure 3.3.3.1-3:
Downstream Mesohabitat
Linear Habitat Classification
Map 22

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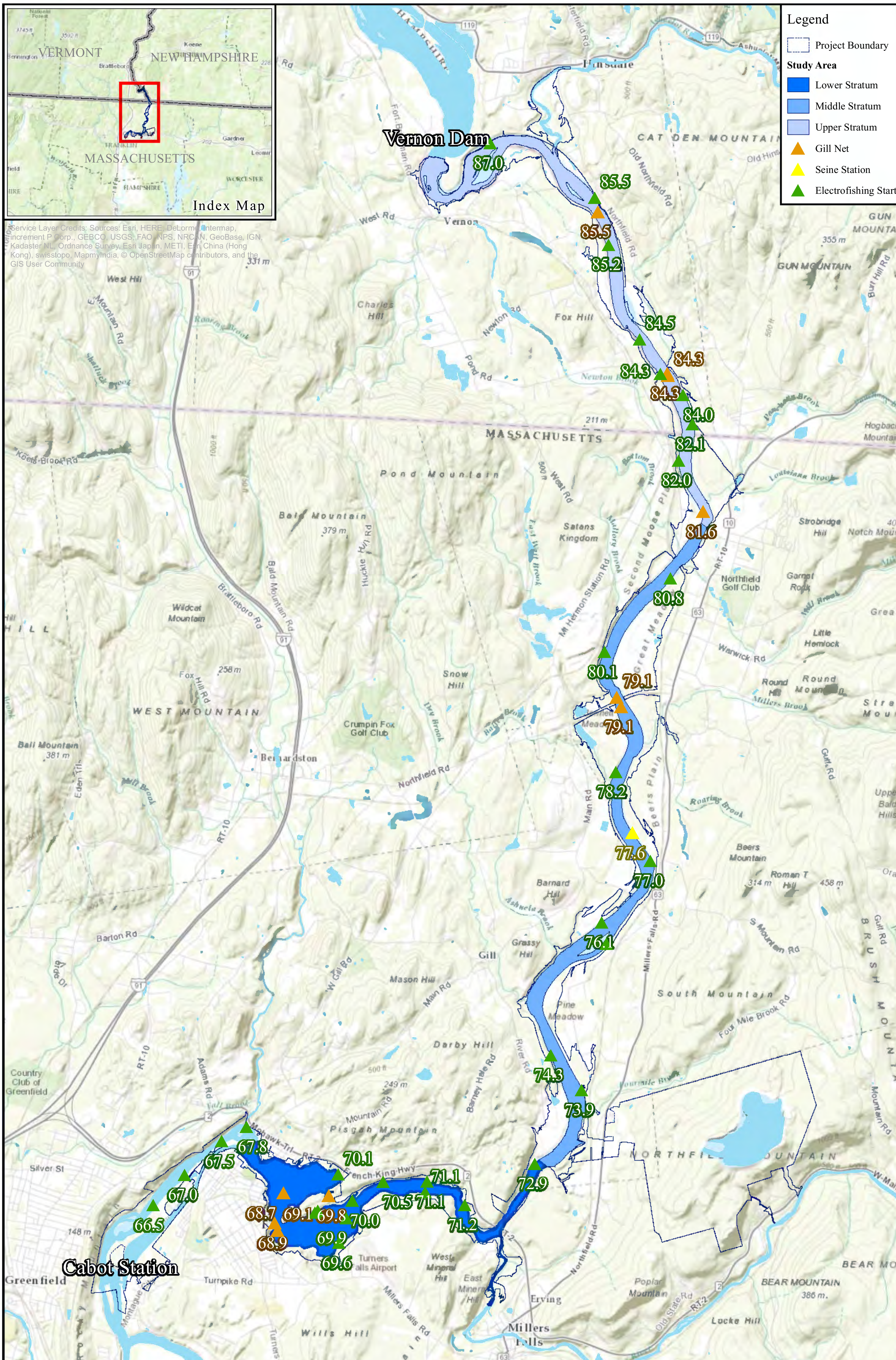

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0 0.5 1 2 Miles

Figure 3.3.3.1.2-1:
Turners Falls Project Fish Assemblage Study Area

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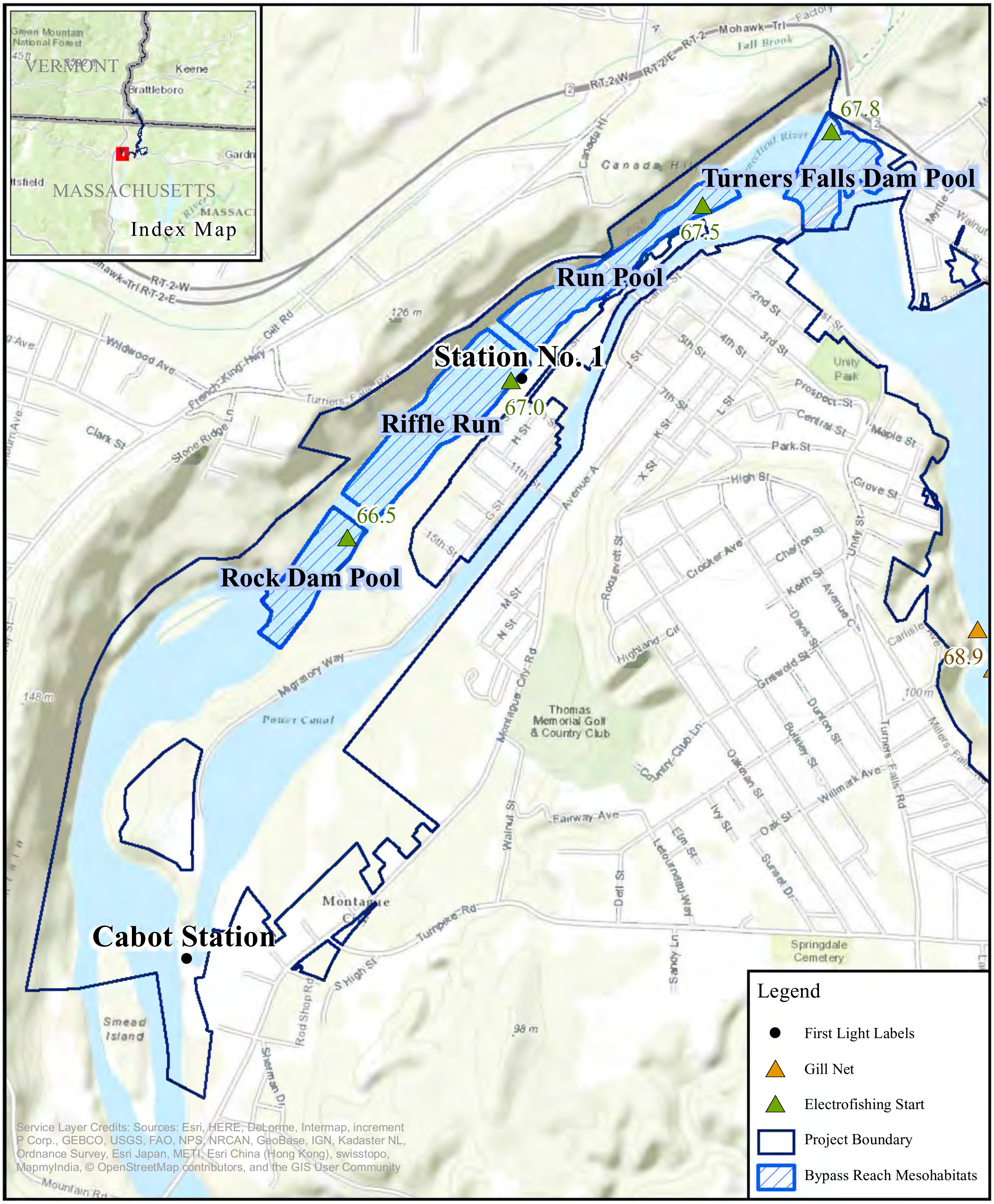

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Figure 3.3.3.1.2-2: Bypass Reach Fish Assemblage Study Area

0 0.125 0.25 0.5 Miles

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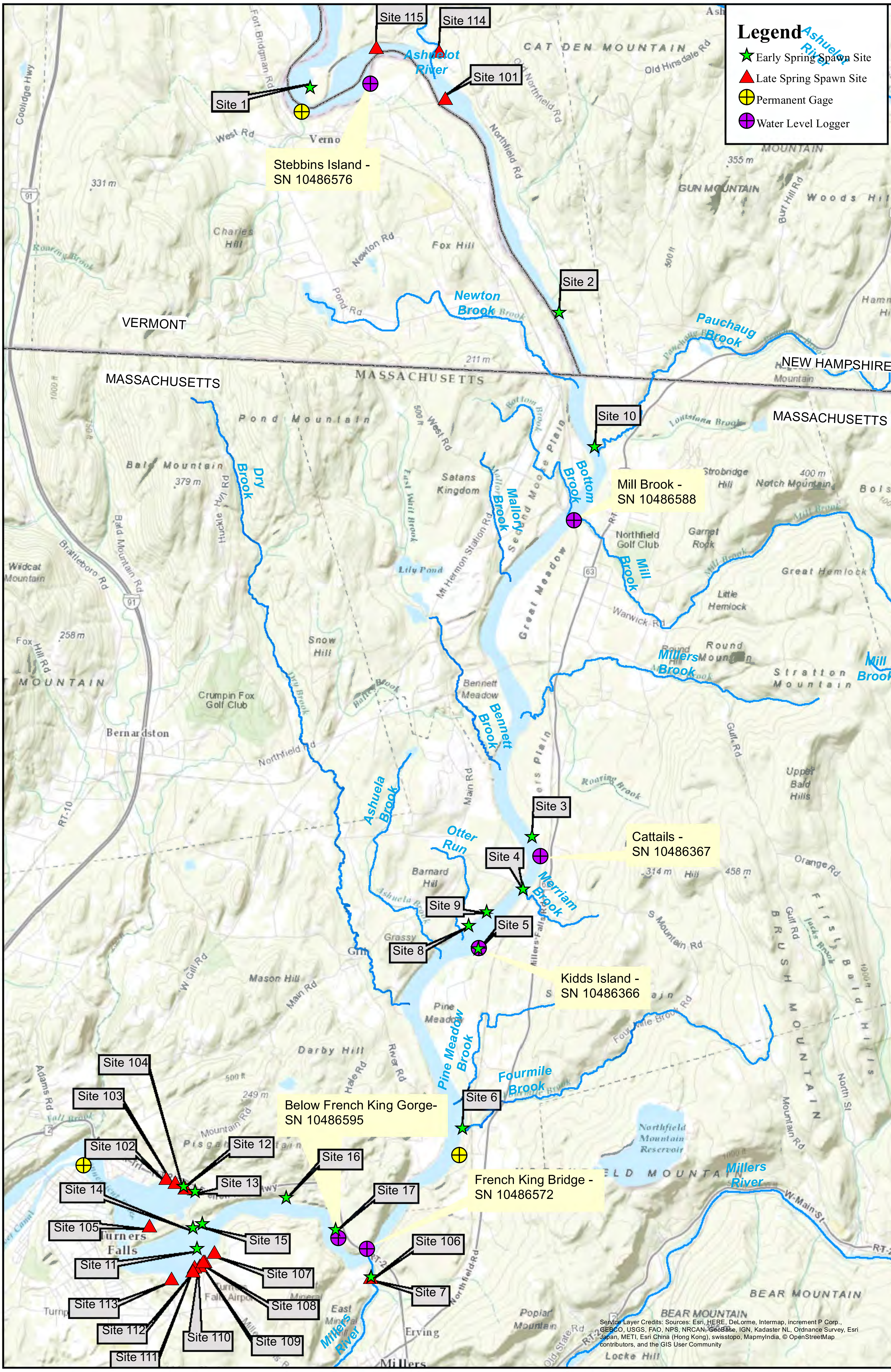

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0 0.5 1 2 Miles

Figure 3.3.3.1.2-3: Locations of Spawning Sites Identified During Early and Late Spring Littoral Zone Surveys

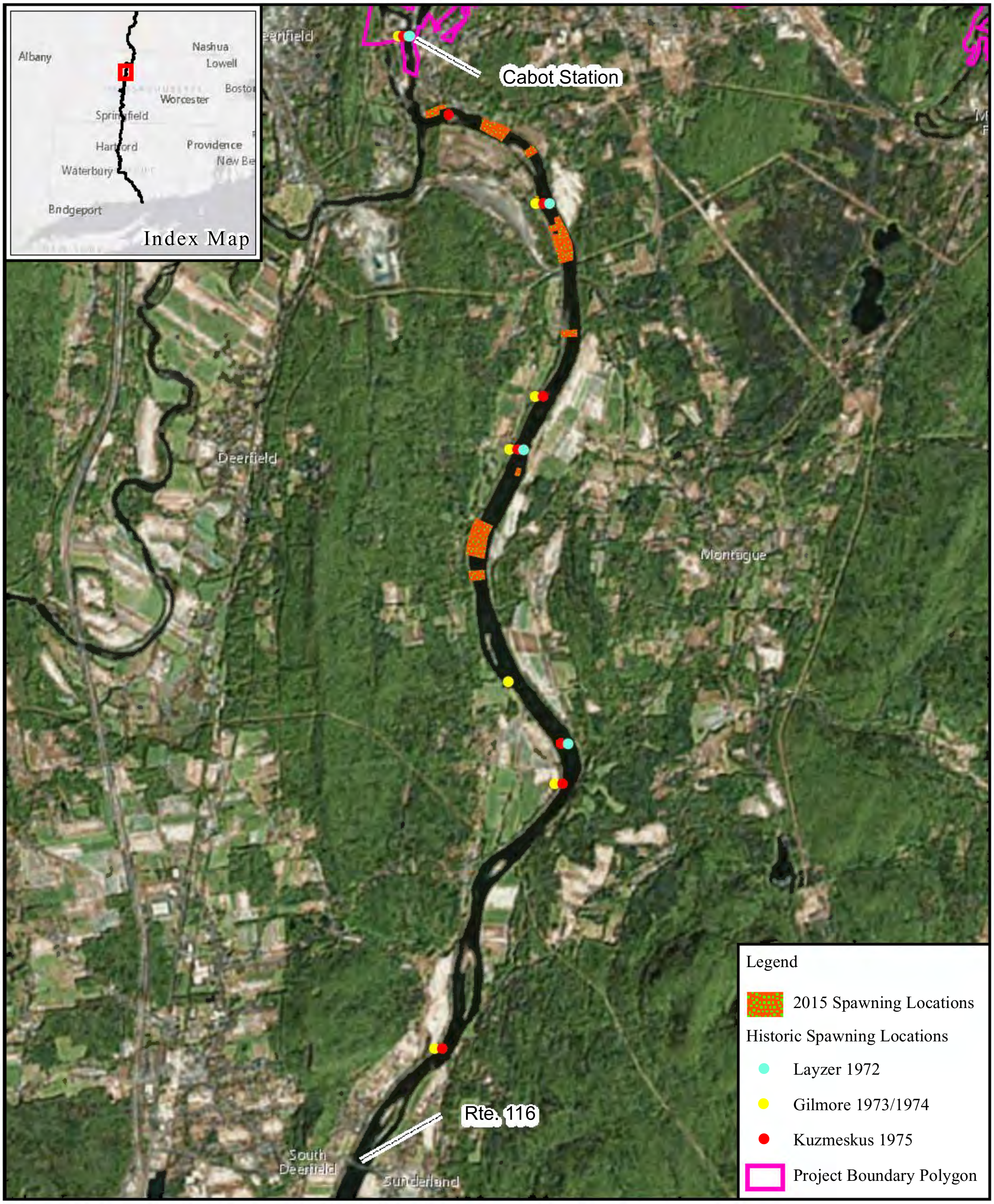

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Exhibit E

Figure 3.3.3.1.2-4
Locations of Observed Shad Spawning Areas between Cabot Station and Route 116 Bridge

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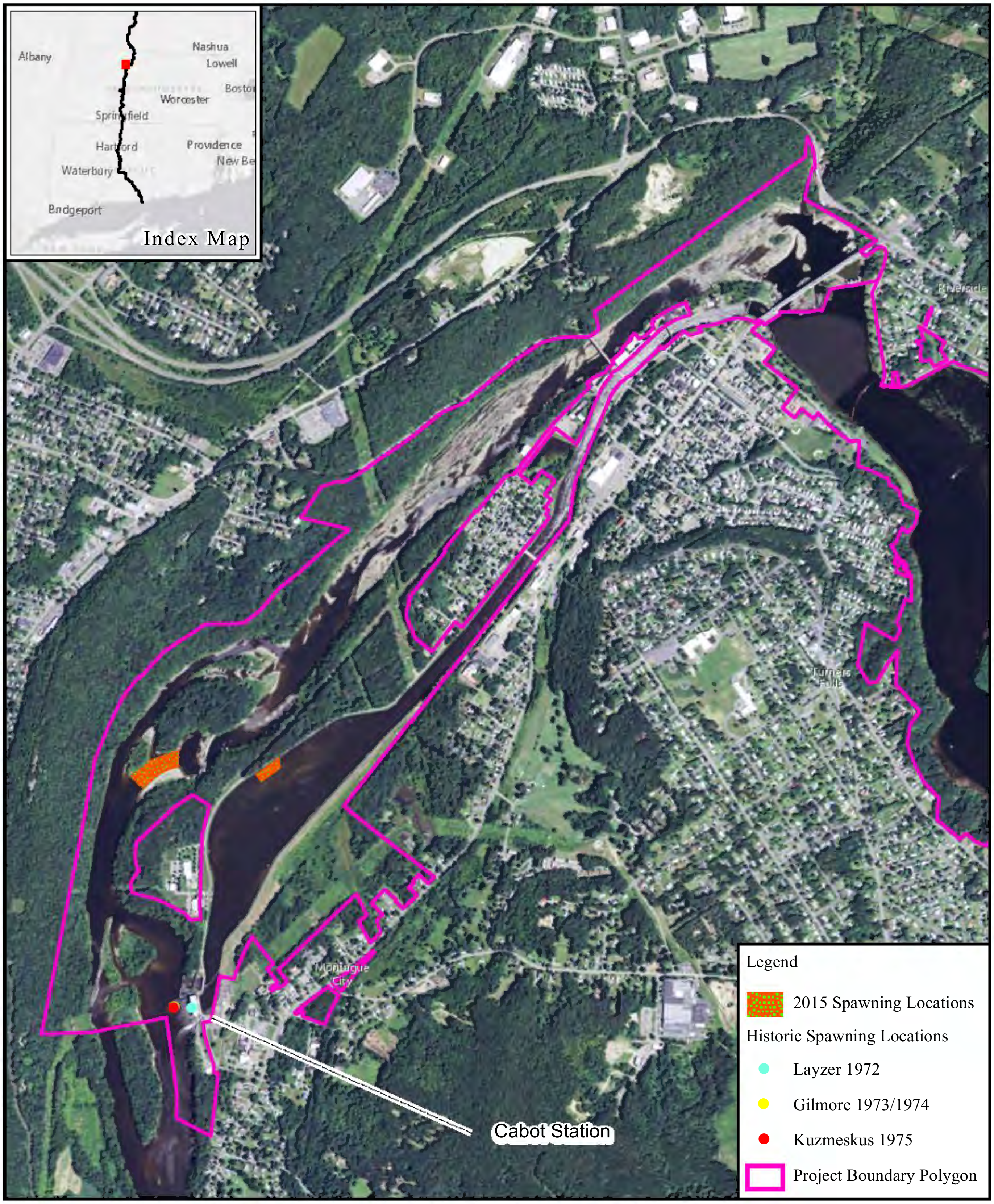

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Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

Figure 3.3.3.1.2-5: Locations of Observed Shad Spawning Areas in Bypass Reach and Lower Turners Falls Canal

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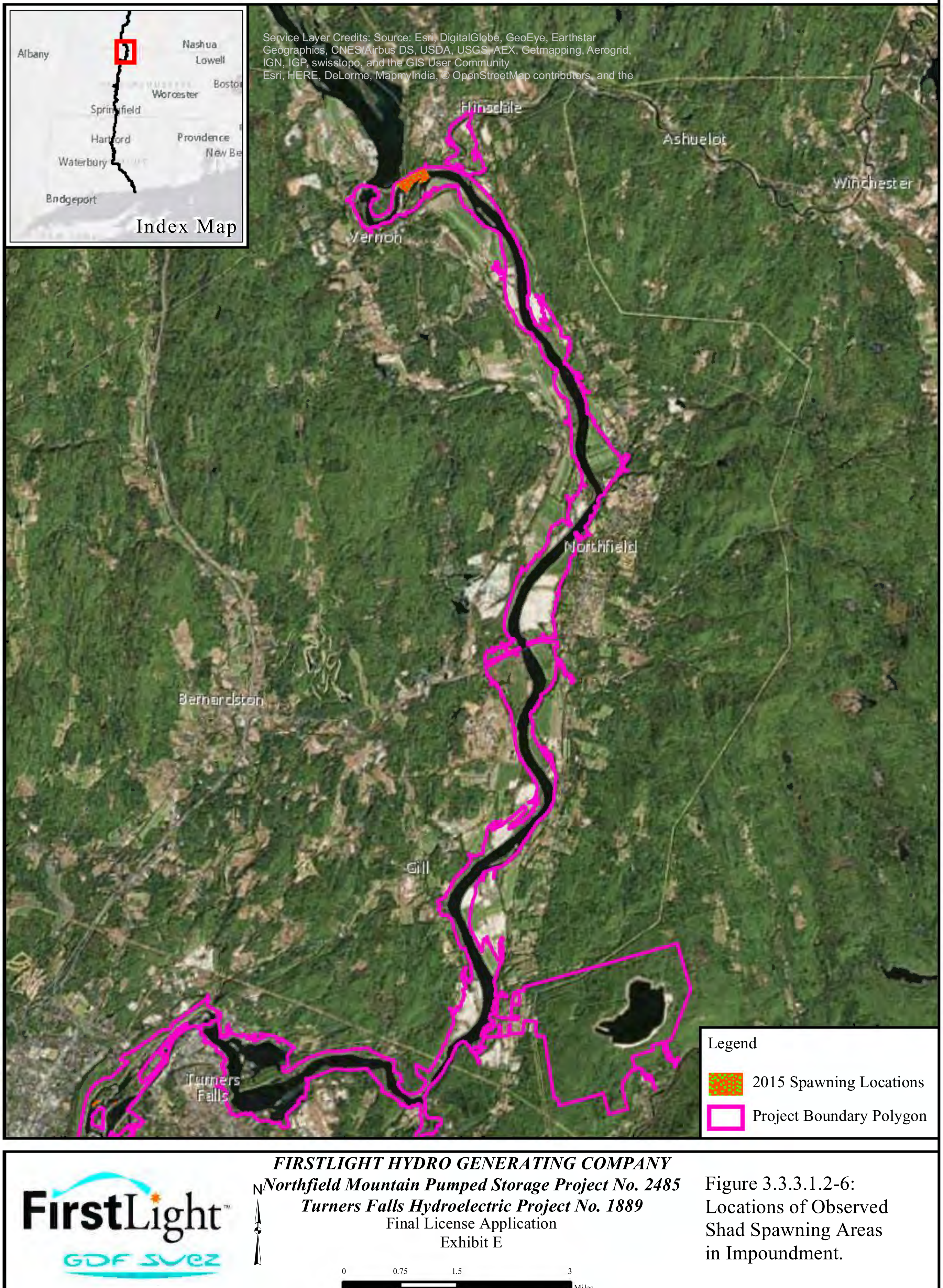

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889
Final License Application
Exhibit E

Figure 3.3.3.1.2-6: Locations of Observed Shad Spawning Areas in Impoundment.

Path: W:\gis\maps\Exhibit_E\figure_3_3_3_1_2-6.mxd

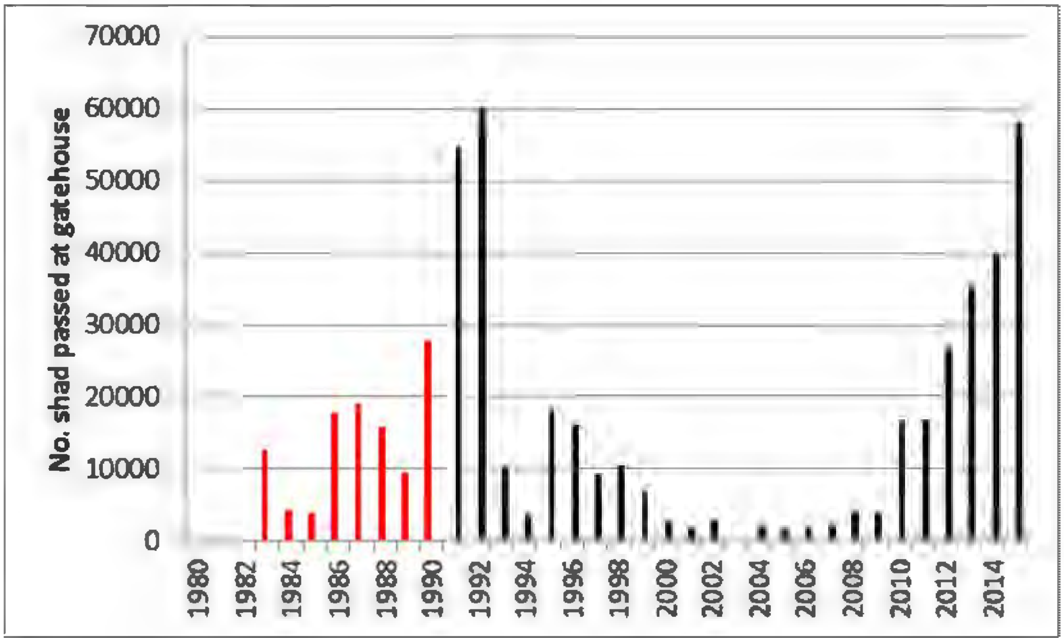


Figure 3.3.3.2.2-1: The number of American Shad observed passing through the Gatehouse Fishway at Turners Falls, 1980 through 2014

(Red bars include the first decade of upstream passage facility operation)

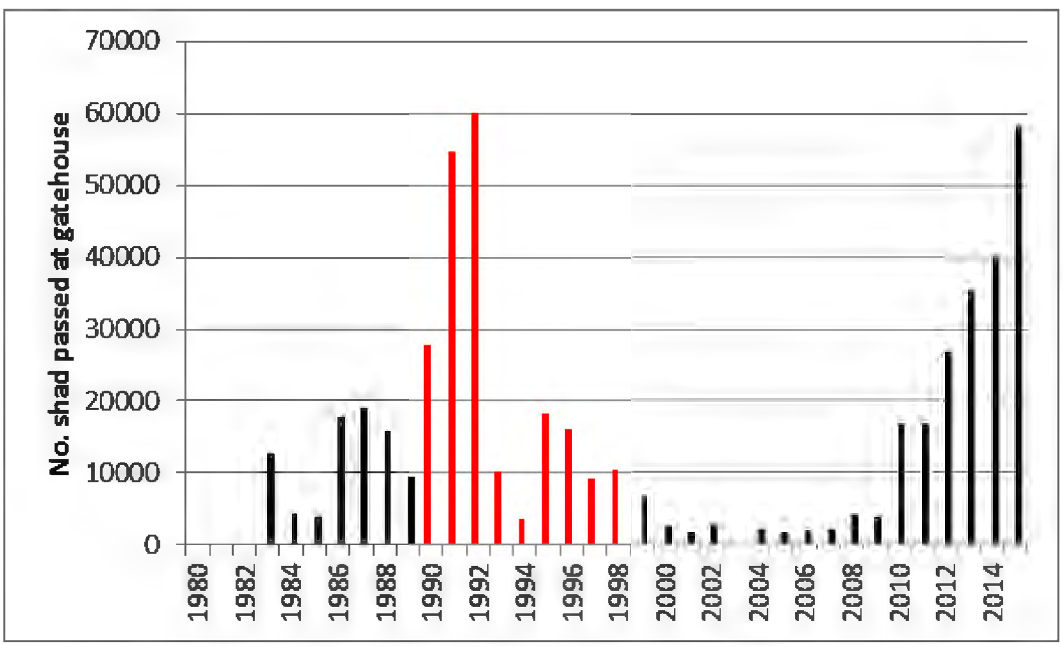


Figure 3.3.3.2.2-2: The number of American shad observed passing through the Gatehouse Fishway at Turners Falls, 1980 through 2014

(Red bars indicate years 1990-1998)

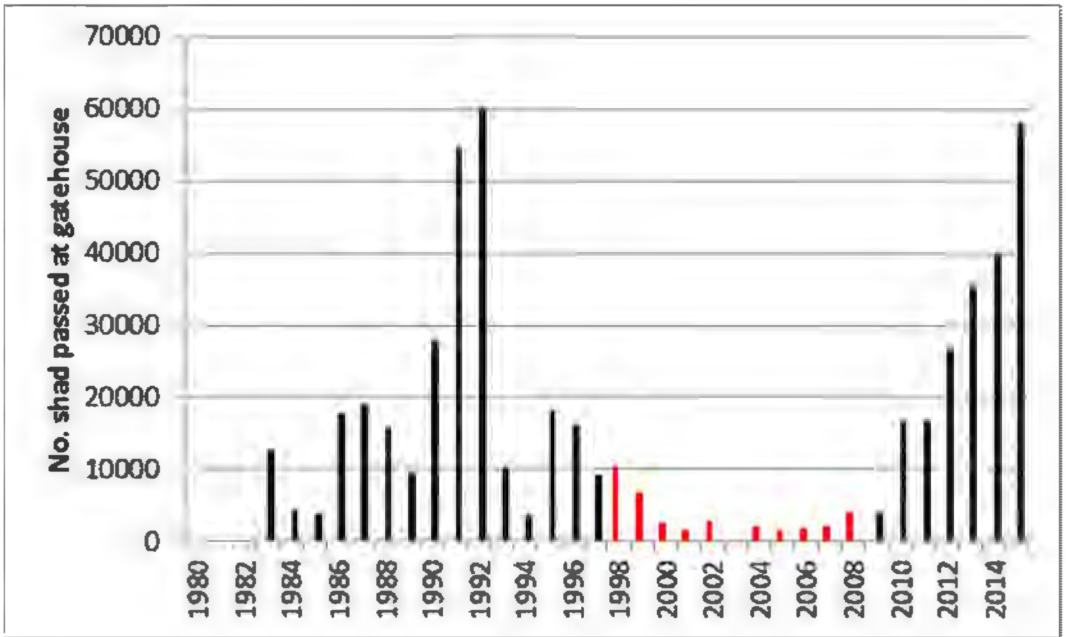


Figure 3.3.3.2.2-3: The number of American shad observed passing through the Gatehouse Fishway at Turners Falls, 1980 through 2014

(Red bars indicate years 1998-2008)

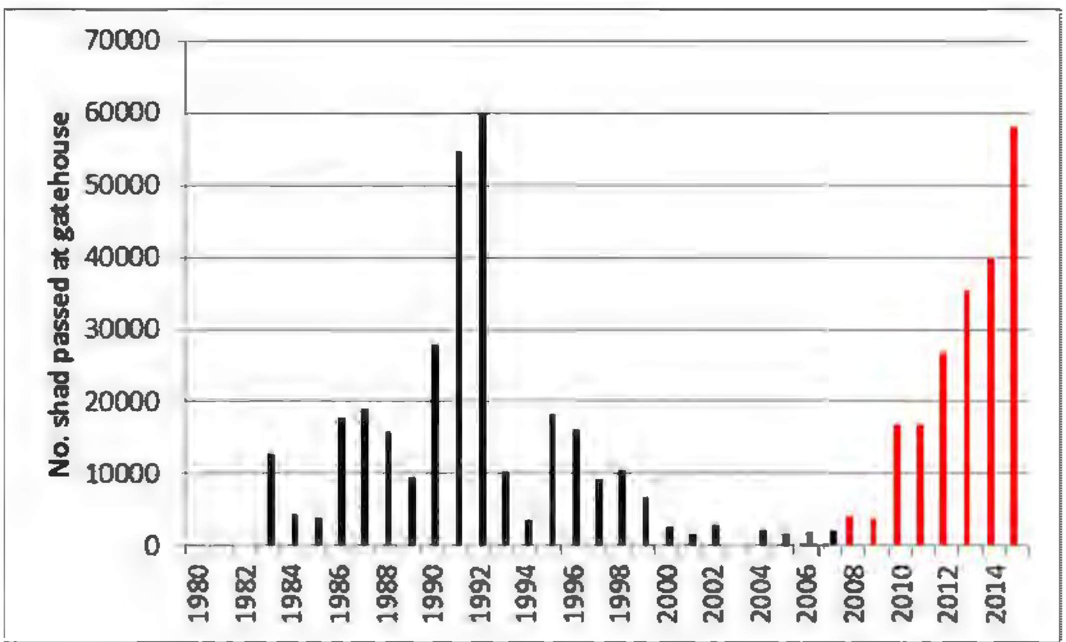


Figure 3.3.3.2.2-4: The number of American Shad observed passing through the Gatehouse Fishway at Turners Falls, 1980 through 2014

(Period of 2008-2015 indicated by red bars)

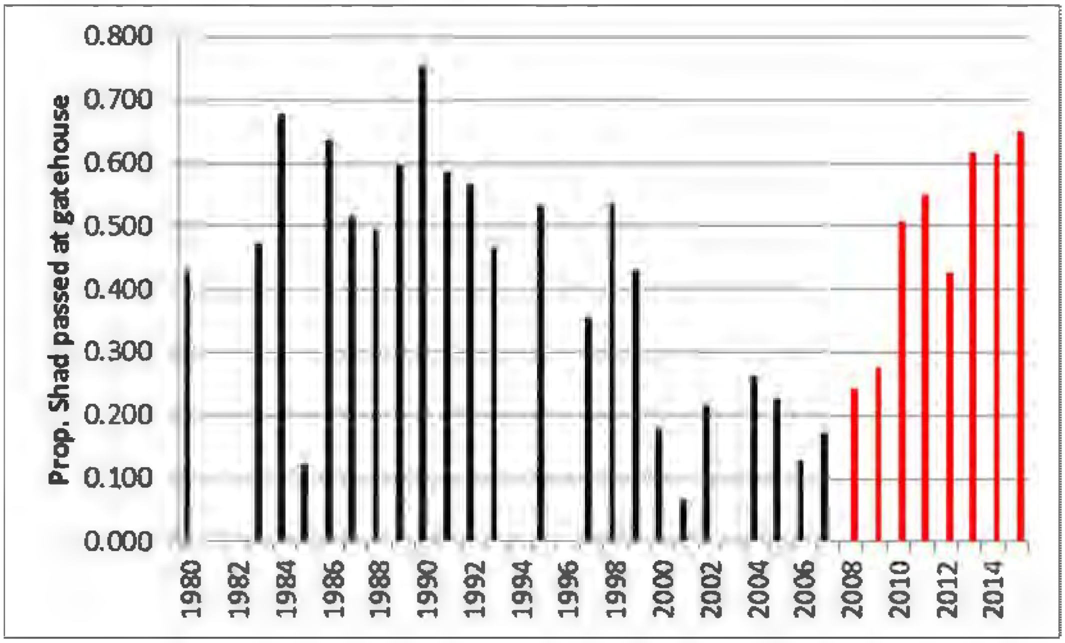


Figure 3.3.3.2.2-5: Proportion of American Shad passed at the Cabot and Spillway Fishways (combined) subsequently passed at the Gatehouse Fishway, 1980 through 2015

(Period of 2008-2015 indicated by red bars)

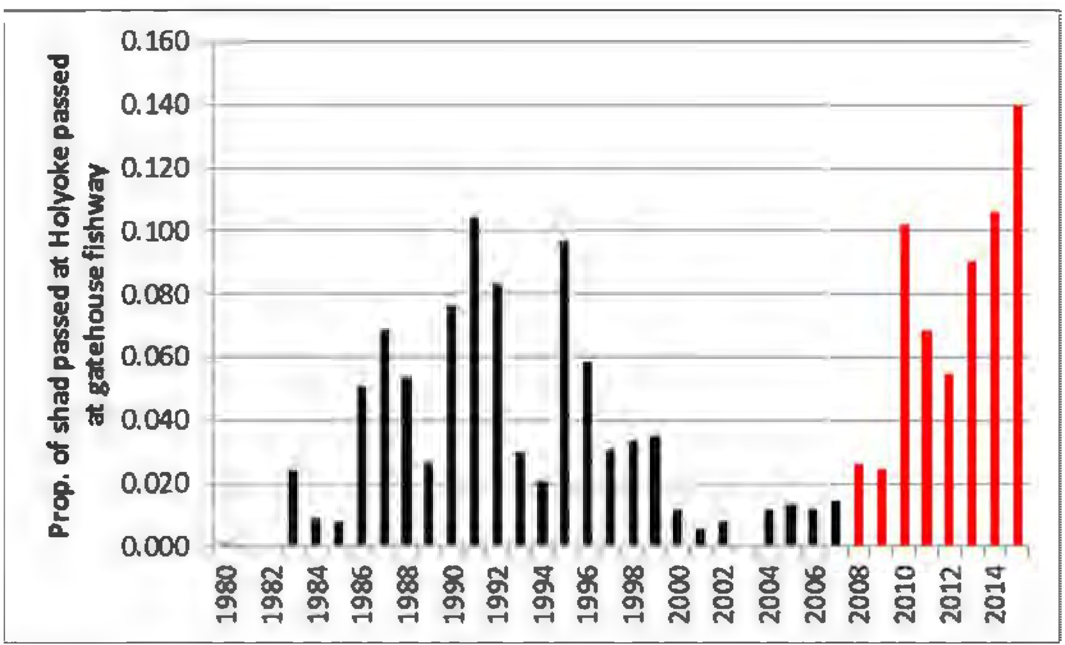


Figure 3.3.3.2.2-6: Proportion of American Shad passed at the Holyoke fish lift subsequently passed at the Turners Falls Gatehouse Fishway, 1980 through 2015

(Period of 2008-2015 indicated by red bars)

3.3.4 Terrestrial Resources

The Turners Falls Development and Northfield Mountain Pumped Storage Development provide habitat for a variety of wildlife and botanical species. An understanding of the terrestrial resources in the Project area provides information on the type and quantity of habitat potentially affected by Project operations. Biologists collected information on the distribution of invasive species, characterized habitats, and developed a plant census in 2014 and 2015 to determine if Project operations affect existing wildlife and botanical resources. As part of the relicensing process, three studies were conducted relative to terrestrial resources as follows:

- Study No. 3.4.1 Baseline Inventory of Terrestrial, Wildlife and Botanical Resources
- Study No. 3.4.2 Effects of Northfield Mountain Project-Related Land Management Practices and Recreation use on Terrestrial Habitats
- Study No. 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operation Impacts on Special-Status Species

A report for Study No. 3.4.2 was filed with FERC on September 14, 2015. Reports for Study Nos. 3.4.2 and 3.5.1 were filed with FERC on March 1, 2016.

3.3.4.1 Affected Environment

Background

The physiographic settings of the Project, with its relatively large tracts of undisturbed terrestrial habitats, provide a wide variety of habitats for terrestrial wildlife. There are a considerable number of parks and conservation lands in and around the Project area. Notable areas include (but are not limited to); Connecticut River Greenway State Park, Westwood Wildlife Sanctuary, Rocky Mt. Park, King Phillips Hill, Brush Mt. Conservation area, Pauchaug Brook area, Bennett Meadow area, Cabot Woods, and the Northfield State Forest. FirstLight also manages recreational resources at the Project as part of their FERC license and agreement with the State of Massachusetts. The Northfield Mountain Pumped Storage Development has many recreational features (e.g., a trail system with over 26 miles of trails, observation area, picnic areas) that are inherently attractive. Public recreation sites can affect wildlife behavior (both attracting and displacing) and impact botanical resources (e.g., trampling vegetation, causing erosion along trails, and spreading invasive species).

The study area for the Turners Falls Development and the Northfield Mountain Pumped Storage Development covers the following areas:

- Upland areas along the TFI including areas within the Project Boundary and areas up to 200 feet from shore where the Project Boundary is along the shoreline;
- Upland areas adjacent to the bypass reach, defined as extending from the Turners Falls Dam to the Cabot Station tailrace;
- The Connecticut River from the Cabot Station tailrace to the Route 116 Bridge in Sunderland; and
- Approximately 2,011 acres of land of Northfield Mountain, of which approximately 405-407 acres is the Upper Reservoir.

FERC Relicensing Studies

As noted above, FirstLight has conducted several studies to gather information necessary to understand the potential effects of land management practices and recreational use on wildlife and botanical resources within the Northfield Mountain Pumped Storage Development and the TFI study area. The goal of these studies is to characterize and describe the terrestrial wildlife and botanical resources that use representative upland habitats within and adjacent to the Project Boundary. Specific objectives are:

- Survey and inventory overall upland wildlife habitats;
- Note the occurrence of wildlife sighting during the course of the surveys;
- Survey and inventory vegetation communities and land use; and
- Survey and inventory the nature and extent of upland invasive, exotic vegetation species.

Wildlife

Mammals

Table 3.3.4.1-1 provides a list of the 35 mammal species that were directly and indirectly observed in the Project area during 2014 field surveys, as well as species that are likely to exist in the study area. The list of mammals likely to occur is inferred from available habitat types documented in the study area cross referenced with life history of mammals that are known to occur within the region as referenced by DeGraaf and Yamasaki (2001). The diverse vegetated communities within the study area provide a range of habitat niches for species typical of the highlands of central to western Massachusetts and the Connecticut River valley. The majority of the species are habitat generalists with a known tolerance for habitat modifications and adaptations.

Some of the furbearing animals that are known to inhabit the study area include beaver, red fox, gray fox, muskrat, Virginia opossum, and striped skunk. These wildlife species reside in many different habitat types such as woodland, wetland, scrub-shrub or early successional areas, and grassland areas. Use of these areas may shift during different life stages and/or times or year.

Reptiles and amphibians

Of the MADFW 45 inland native species of amphibians and reptiles that are known to occur in Massachusetts (Cardoza & Mirick, 2009), a total of 23 amphibians and reptiles were observed during 2014 field surveys or are likely to occur within the study area. Included are nine frogs and toads, four salamanders, three turtles, and seven snakes. These inland native species include terrestrial and semi-aquatic amphibians and reptiles. A list of reptiles and amphibians recorded or likely to occur in the study area is provided in Table 3.3.4.1-2.

Avian Species

The Connecticut River provides important habitat to a variety of bird species. During the spring and summer, many species (including those observed during this survey) breed and nest along the river. In spring and fall, the river is a major migratory flyway, and, generally, in the winter, it provides habitat for species of waterfowl that nest further north. Throughout the year the river is a source of food for foraging birds.

Sixty-four (64) species of birds were observed on or near the river (Table 3.3.4.1-3). Most species were found in the surrounding upland floodplain, rather than utilizing aquatic habitat. Species associated with the river include: Double-crested Cormorant, Canada Goose, Common Merganser, Mallard, Mute Swan, Wood Duck, Bank Swallow, Northern Rough-winged Swallow, Spotted Sandpiper, and Belted Kingfisher. Fifty-nine (59) species of birds were observed within the study area of Northfield Mountain (Table 3.3.4.1-3). The Northwest Slope had the greatest species richness, with 47 species, while the Northeast Slope had only 17 observed species. This is likely a reflection on the relative sizes of the various sections, rather than differing habitats. A few open habitat species occurred only in the mown areas and power line Right of Ways of the Northwest Slope, but the majority number of species were found in more than one slope section (e.g., Ovenbird).

Vegetative Communities

The region encompassing the study area is characterized by a diversity of terrestrial botanical resources that are influenced by geological features, soil type, hydrology, climate, and historic and current land use. Biologists documented 390 plant species within the study area in 2014 and 2015. An overall plant census list of all recorded plant species identified during the 2014 and 2015 field season is provided in Table 3.3.4.1-4. Field surveys were conducted in September 2015 to confirm vegetative communities. One plant community, the calcareous rock cliff community, was identified during survey work, but this habitat was not mapped as the aerial signature and habitat size did not allow for identification using available aerial imagery. Four disturbed or mostly unvegetated cover types; agricultural, development, bypass reach, and transmission right of way, were mapped, but these are not described by the Natural Heritage and Endangered Species Program (NHESP). Located in the Connecticut River valley, with adjacent high elevations of Northfield Mountain, the study area has characteristics of both Northeastern Highlands and Northeastern Coastal Zone ecoregions (Swain & Kersey, 2011).

The Connecticut River, during its course between Vernon Dam and Turners Falls Dam, regains the appearance of a river even though it is impounded. The wide and fertile plains on both sides of the Connecticut River are terminated by terraces rising to forest upland country to the east and west. Examples of geologic and geomorphic features influencing the area’s botanical communities include:

- the Connecticut River valley and remnant floodplains;
- the confluence of the Connecticut River and major tributaries (e.g., Millers River);
- bedrock and alluvial islands within the Connecticut River; and
- the high elevations of Northfield Mountain.

The primary upland plant communities (Table 3.3.4.1-5) include:

- Remnant / transitional flood plain forest
- Northern hardwoods-hemlock-white pine forest
- Successional northern hardwood forest
- Hemlock ravine
- White pine - oak forest
- Calcareous rock cliff (not mapped)
- Circumneutral rock cliff (not mapped),
- Oak - hickory forest (not mapped),
- Agricultural lands (not described by NHESP)
- High Energy Shore (not described by the NHESP)
- Development (not described by NHESP)
- Right of way (not described by NHESP)

Remnant/Transitional Floodplain Forests

Soils in this zone generally experience annual flooding and are either silt loams or very fine sandy loams, and soil mottling is generally preset within two feet of the soil surface. A surface organic layer is typically absent. Silver maple, sycamore, cottonwood, red maple, ash, American elm, and willow are the dominate tree species. A shrub layer is generally lacking; however, saplings of overstory trees are common. The herbaceous layer is typically an even mixture of wood-nettle, ostrich fern, sensitive fern and false nettle. Within the study area, these limited floodplain forests are the dominate forest type present along the main stem of the Connecticut River, islands, and its major tributaries (Figure 3.3.4.1-1).

Northern Hardwoods-Hemlock-White Pine Forest

Northern hardwoods - hemlock - white pine forest is the dominant vegetated community along the shoreline from Barton Cove upstream to the French King Bridge and on the northwestern and northeastern slopes of

Northfield Mountain. This forest type is associated with a closed canopy forest of a mixture of deciduous and evergreen trees, with sparse shrub and herbaceous layers (Figure 3.3.4.1-3). The forest is dominated by a mix of sugar maple, American beech, yellow birch, and red oak in variable proportions, with eastern hemlock and white pine intermingled throughout. American beech tend to dominate on drier location wetlands. Black cherry, white birch, red maple, and other early successional tree species are often scattered, with occurrences in the subcanopy with stripped maple, and sometimes ironwood. The shrub layer is usually open, with clumps of hobblebush, honeysuckle and Japanese barberry. The diverse but sparse herb layer includes Christmas fern, Canada mayflower, club mosses, asters, and false nettle.

Successional Northern Hardwoods

Successional northern hardwoods in the study area vary from forest communities with thick young sprouts and little diversity to mature, diversifying forests with undergrowth of more shade-tolerant trees. The canopy is seldom completely closed and undergrowth may be dense or open. Areas of successional forest are associated with past disturbance such as cutting or blow-down / storm damage. Aspen, white birch, black birch, red maple, and /or black cherry tend to be common throughout the community. The understory of more mature successional forests is comprised of young, more shade-tolerant trees (typically less than 10" at diameter at breast height). Shrubs and herbaceous species are variable, and includes species common to edge habitat and open areas such as sumac, goldenrod, Joe-pye weed and blackberry (Figure 3.3.4.1-2). Successional northern hardwood forests are found intermingled throughout the study area and are typical of transition areas and edge habitat around developed areas and agricultural lands.

Hemlock Ravine

Hemlock ravine communities are dominated by the dense overstory canopies of eastern hemlock trees. These cool moist habitats are located in topographic draws and drainage ways in the landscape. In the Project area, this heavily shaded habitat is characterized by little growth in the understory. The forest floor typically has little vegetation and is covered by needles, twigs, and small branches of hemlocks. Occasionally deciduous trees that grow along with hemlock occur at very low percentages and include; a mixture of oak species, (red, white and black), yellow birch, and red maple. Generally, the shrub layer is sparse, with occasional individuals of the canopy species and small patches of mountain laurel. Hemlock ravines communities attract wildlife that depend on mature dense evergreen forests and typically host a variety of songbirds that nest high in the canopy. Several hemlock forested areas and ravines are found along hillsides and lowlands at Barton Cove campgrounds and throughout the northern and southern slopes of Northfield Mountain (Figure 3.3.4.1-4)

White Pine- Oak Forest

The white-pine oak forests within the study area are limited. The forest has a partial closed canopy with sporadic understory shrub coverage. The overstory is dominated by white pine and red oak with the shrub layer dominated by red maple, low bush blue berry, and mountain laurel. Herbaceous vegetation varies, but includes bracken fern, Canada mayflower, and wintergreen. This habitat is ideal for generalist species such as gray squirrels, short-tailed shrews, voles, and chipmunks. Common birds within this habitat may include Red-eyed Vireo, Brown Creeper, Hermit Thrushes and Red Tailed Hawks. White pine – oak forests are found at lower elevations of the northwest and southern slope of Northfield Mountain (Figure 3.3.4.1-5).

Calcareous Rock Cliff Community

Rock Cliff Communities all occur on a more or less vertical bedrock cliff faces. They have extremely sparse scattered vascular plants on ledges and in crevices. Calcareous rock cliffs have vegetation that is more distinct and specific to the habitat. Purple cliff brake, maidenhair spleenwort, blunt-lobed cliff-fern, and columbine are characteristic of calcareous cliffs. Of these species, purple cliff brake and columbine were both seen within the Project area. Surrounding vegetation tends to be northern hardwood forest. This is a more uncommon community found throughout Massachusetts and is host to several unusual plants. A Calcareous Rock Cliff community exists on the western bank of the TFI extending upstream and downstream of the French King Bridge (Figure 3.3.4.1-6).

Circumneutral Rock Cliff Community

This community type is found along the summit and higher elevations of the southeastern slope of Northfield Mountain. Rose ledge and the Farley ledges are notable examples where sparse, scattered vascular plants are found in ledges and small crevices within vertical cliff faces. Lichens are occasionally dense on cliff faces. These communities can be variable in moisture, but generally consist of areas of significant rock outcroppings that are well shaded by trees of the surrounding forest. Species of dry open areas, including pale corydalis, bearberry, plantain-leaved pussytoes, columbine, marginal wood-fern little bluestem grass, ebony spleenwort, Rusty cliff-fern, and mosses. In the area, chestnut oak, scrub oak, and witch hazel are sporadically observed. These cliff areas can provide nesting habitats for Ravens. Few to no mammals, reptiles or amphibians would be expected on these steep slope faces (Figure 3.3.4.1-7).

Oak – Hickory Forest

This community consists of hardwood forests dominated by a mixture of oaks, with hickories mixed in at a lower density. The canopy is dominated by one or several oak species including red oak, white oak, and black oak. Mixed in are lower densities of one or several hickory species. Other trees include ash, birch, sassafras, and red maple. The subcanopy commonly includes ironwood, flowering dogwood, shadbush, chestnut, and witch-hazel. Low shrubs are common and often diverse; blueberries, dogwoods, and viburnums are characteristically present. The herbaceous layer is also richer than in many oak forests. Plants typical of the herbaceous layer include hepatica, goldenrod, tick-trefoil, wild sarsaparilla, and false Solomon's seal. This variable forest community is found at higher elevations on the Northfield Mountain range, most notably in a strip of deciduous forest between the northwestern slope and southeast slope, and adjacent to the upper elevations to Rose ledge (Figure 3.3.4.1-8).

Agricultural Lands

Land use along the corridor of the Connecticut River is primarily rural and agricultural. In the study area, approximately 25% of the land use is classified as agricultural/open field habitat. These lands are managed and go through several vegetative changes within a growing season. The edge habitat of agricultural lands can be vulnerable to the introduction of invasive species. Invasive species also favor these edges as a result of abundant sunlight which promotes favorable growing conditions. Most agricultural land within the study area is a mosaic of various croplands, with few lands used for active livestock pasture. There were relatively few instances where agricultural fields were cleared to the river's edge. Typically, there exists a narrow buffer of forested land which offers erosion protection along the shoreline (Figure 3.3.4.1-9).

High Energy Shore

High-energy riverbank communities are associated with steep gradient, fast-moving water, alluvial deposition and scour. These environments have limited plant growth and cover and were observed in the bypass reach and on the upstream ends of riverine islands – specifically, Sunderland Islands in Deerfield, MA. The upper reaches of some island communities transitioned into a band of invasive shrubs and vines, then transitioned further upland into floodplain and hardwood communities, previously described.

The bypass reach is approximately 2.7 miles long. Fall River, located near the head of the bypass channel, discharges into the bypass reach. Station No. 1 discharges into the bypass reach approximately 0.9 miles downstream of the Turners Falls Dam. The bypass is a unique habitat comprised of a mosaic of high energy shoreline and exposed bedrock. The eastern side of the bypass is occupied by historic industrial developments with numerous discharge locations that supported the historic industries that were built on the canal. The western side of the bypass is steeply sloping woodlands of Rocky Mountain Park. Rocky

Mountain Park is part of the Pocumtuck Ridge, and is the northernmost subrange of the Metacomet Ridge mountain range of southern New England known for its continuous high cliffs, scenic vistas, and microclimate ecosystems containing species common to the northern hardwoods ecosystem types. Hemlock crowd narrow ravines, blocking sunlight and creating damp, cool growing conditions with associated cool climate plant species. Talus slopes are especially rich in nutrients and support several calcium-loving plants uncommon in the region. The Massachusetts Audubon Society considers the Rocky Mountain section of Pocumtuck Ridge exceptionally rich in its diversity of bird species, and an especially important area for migratory, breeding, and wintering birds (Figure 3.3.4.1-10).

Development

Portions of the upland habitat within the study area are dominated by maintained spaces (i.e., residential, commercial, or transportation corridors) and sporadic shrub or overstory vegetation, such as solitary white pines or other species. The primary vegetation in these areas is comprised of shrub and herbaceous layer vegetation. Herbaceous vegetation is dominated by mowed areas of Kentucky bluegrass. Shrub layer vegetation may include glossy buckthorn, Russian olive, and several species of northern hardwood saplings.

Right-of-Way

This community was identified within the portion of the study area that is crossed by electric transmission right-of-ways. These areas are maintained by periodic vegetation management which limits the growth of large woody vegetation. The dominant communities are shrub and herbaceous communities. Shrub layer vegetation is dominated by white pine saplings, glossy buckthorn, red cedar, and meadowsweet. The herbaceous community is extensive and includes several weedy species such as chicory, mullein, and pearly everlasting. Additional herbaceous vegetation includes bracken fern, sensitive fern, Joe pye weed, and milkweed. Portions of these areas include gravel access roads (Figure 3.3.4.1-11).

Wetlands

Biologists led by a Professional Wetland Scientist field-verified NWI mapped wetlands within the Northfield Mountain Pumped Storage Development study area. These areas were not formally delineated, but the boundaries were refined to provide a better level of detail. Thirty (30) NWI mapped wetlands were field verified, and an additional 18 non-NWI mapped wetlands were also identified and mapped. Dominant wetland communities within the study area include:

- Hemlock swamp
- Red maple swamp
- Woodland vernal pool

Hemlock Swamp

Hemlock is a major or co-dominate canopy species in hemlock swamps within the study area. In some cases, hemlock forms dense stands, but more commonly hemlock is associated with a mixture of white pine, red maple and yellow birch. The understory tends to be sparse to moderately vegetated with highbush blueberry, winterberry, and mountain laurel. Ferns are common, especially cinnamon fern, along with a hummocky floor covered with sphagnum moss. Notable hemlock swamp habitat is found down gradient of the Farley ledges situated in a well -defined saddle in the landscape. These areas can provide year round habitat and breeding (i.e. vernal pools) for amphibian species (Figure 3.3.4.1-12).

Red Maple Swamp

Red maple is usually strongly dominate in the overstory of red maple swamps in the study area and can often provide up to 90% of the canopy cover. A variable mixture of subordinate tree species co-occurs with red maple, including yellow birch, black gum, white ash, white pine, elm, hemlock, pin oak, and swamp white oak. The shrub layer of red maple swamps is usually dense and well developed with greater than 50% cover, but it can be variable. Sweet pepperbush highbush blueberry, winterberry, spicebush, alder and viburnum species often dominant the shrub stratum. The herbaceous stratum can be variable, but ferns are unusually abundant. Cinnamon fern is common with other ferns including but not limited to; sensitive fern, royal fern and marsh fern. Gaminoides are common, mixed in with a variety of other herbaceous species commonly including; skunk cabbage, false hellebore, spotted touch-me-not, swamp dewberry, and marsh marigold (Figure 3.3.4.1-13).

In 2014 and 2015, NWI wetlands within the TFI study area were verified. If new wetlands (not occurring in the mapped NWI data) were located, the approximate boundaries were identified. Verified wetlands account for approximately 1,382 acres of wetland and include emergent, scrub-shrub, and forested wetland types. In addition, biologists identified an additional 55.7 acres of wetlands that were not captured in current NWI wetland mapping. In total, the TFI study area includes approximately 1,438 acres of wetland habitat with shrub dominated wetlands and freshwater ponds being most common. In general, the principle functions and services of wetlands within the study area are flood attenuation, wildlife habitat, shoreline stabilization, fish and shellfish habitat, visual quality, and recreation.

Palustrine Emergent Wetlands

Palustrine emergent wetlands within the study area occur, primarily, as fringe wetlands along the shoreline. The largest examples of these wetlands occur near Turners Falls Dam and the Barton Cove area. Large expanses of emergent and deep emergent marshes occur in these areas. Dominant species within these wetlands include American bulrush (*Schoenoplectus acutus*), sweet flag (*Acorus americanus*), soft-stem bulrush (*Schoenoplectus tabernaemontani*), arrowhead (*Sagittaria latifolia*), pickerelweed (*Pontederia cordata*), bur-reed (*Sparganium sp.*), and cattail (*Typha sp.*). Palustrine emergent wetlands within the study area provide several functions, primarily as wildlife habitat and also through sediment and toxicant retention (FirstLight, 2016a).

Palustrine Scrub-Shrub Wetlands

Palustrine scrub-shrub wetlands are the least abundant wetland type observed within the study area. Generally these wetland types occur in association with larger emergent or forested wetland complexes. The shrub wetlands occur along the fringes of emergent wetlands or intermixed in open canopy areas adjacent to or within forested communities. Dominant shrub vegetation within these wetlands includes alder (*Alnus incana*), button bush (*Cephalanthus occidentalis*), winterberry (*Ilex verticillata*), red-osier dogwood (*Cornus sericea*), elderberry (*Sambucus canadensis*), silky dogwood (*Cornus amomum*), high bush blueberry (*Vaccinium corymbosum*), and saplings of over story species. Herbaceous vegetation varies depending on light penetration, but may include sensitive fern (*Onoclea sensibilis*), horsetails (*Equisetum spp.*), jewelweed (*Impatiens sp.*), ostrich fern (*Matteuccia struthiopteris*), royal fern (*Osmunda regalis*), cinnamon fern (*Osmundastrum cinnamomeum*), and interrupted fern (*Osmunda claytonia*). Functionally these wetlands provide primarily wildlife habitat. Depending upon landscape position, these wetlands may also aid in flood storage, shoreline stabilization, and sediment retention (FirstLight, 2016a).

Palustrine Forested Wetlands

Palustrine forested wetlands within the study area are primarily forested floodplains. Excellent examples of these forested wetland systems are present near the Pauchaug boat launch. Dominant overstory species include silver maple (*Acer saccharinum)*, red maple (*Acer rubrum*), American basswood (*Tilia Americana*), American elm (*Ulmus americana*), willow, and cottonwood. The shrub layer in these systems is limited, but occasional alders and dogwoods occur. Herbaceous vegetation includes sensitive fern, ostrich fern, skunk cabbage (*Symplocarpus foetidus*), blue flag iris (*Iris versicolor*), clearweed (*Pilea pumila*), false nettle (*Boehmeria cylindrica*), and stinging nettle (*Urtica dioica*). Several islands within the study area also contain similar forested floodplains. In some cases, Japanese knotweed has invaded the understory of these systems. Forested wetland systems within the study area provide several important functions and services, most importantly flood storage, wildlife habitat, shoreline stabilization, and sediment retention (FirstLight, 2016).

Woodland Vernal Pool

Woodland vernal pools are typically small, shallow depressions that are isolated from other surface waters. They usually flood in spring and sometimes in fall, and generally hold water for a minimum of two months but are dry in summer. Because vernal pools are temporary bodies of water, they do not support fish populations. When dry, woodland vernal pools can be often be recognized by a layer of water-stained gray leaves covering the pool's basin and distinct waterline marks on the base of tree buttresses. These temporarily flooded areas provide important breeding habitat for amphibians. Due to prolonged standing water, woodland vernal pools often have sparse-to-little shrub and herbaceous vegetation within the pool basin. Red maple and hemlock, along with lesser quantities of various wetland tree species, are found in the canopy cover, similar to hemlock swamp and red maple swamp communities. Vernal pools are tracked as a separate community type because of the important habitat they provide for amphibians and invertebrates.

Biologists located and documented 13 woodland vernal pools in the Northfield Mountain study area (Figure 3.3.4.1-14) and one vernal pool along the TFI (Table 3.3.4.1-6). Commonly observed egg masses of obligate vernal pool indicator species included spotted salamanders and wood frogs. Wood frogs and four local species of mole salamanders have evolved breeding strategies intolerant of fish predation on their eggs and larvae; the lack of fish populations is essential to the breeding success of these species. Other amphibian species use vernal pools but they do not depend on them including American toads, green frogs, and red-spotted newts. It should be noted that green frogs and red-spotted newts feed on obligate vernal pool species eggs and larval and can have negative effects on other amphibian population dynamics. Vernal pools also support a diverse invertebrate fauna, including obligate indicator species like fairy shrimp which complete their entire life cycle in vernal pools (Burne, 2001).

Invasive Species

Biologists identified 25 invasive plants in the Northfield Mountain and Turners Falls study area including; MIPAG listed non-native invasive plants, one MIPAG watch list species (coltsfoot), one USDA Forestry Service early detection species (Spotted knapweed), and, for consistency with other studies, European alder (see Table 3.3.4.1-7). Locations of invasive species within the study area observed during 2014 field reconnaissance surveys are shown in Figure 3.3.4.1-15. This figure illustrates the relative abundance and distribution of invasive plants along the TFI using estimated cover classes of <5%, 6-25%, 26-50%, > 50%. The following five (5) exotic and invasive plant species were found to be common within the study area during the 2014 field surveys:

- Oriental Bittersweet - found throughout the study area, particularly ubiquitous along the edge of the river where there is abundant sunlight. Highest concentrations were noted in the TFI north of Pauchaug Brook where the TFI transitions to a more dynamic riverine environment. In the upper reaches of the TFI, Oriental bittersweet can be found covering at least 50% of the trees and shrubs along the shoreline.
- Japanese Knotweed - typically confined to discrete patches along the immediate shoreline and, in some instances, in small stands along the edge habitat of previously disturbed areas.
- Multiflora Rose - scattered throughout the study area, particularly along edges of field habitat and along shoreline/transition areas that abut agricultural lands.
- Japanese Barberry - throughout the study area, a common forest understory shrub that forms monoculture thickets. Particularly found in low lying lands and on upland islands within the river.

- Black Swallowwort – found throughout study area, particularly on the banks of the river and the TFI.

3.3.4.2 Environmental Effects

The occurrence and distribution of wildlife and botanical resources in the study area are generally unrelated to the Turners Falls Development and Northfield Mountain Pumped Storage Development and/or Project operations. There is no evidence of any on-going adverse effects on upland wildlife and botanical resources. The majority of invasive species found at the Project are upland species that occur outside the range of water level fluctuations that occur as part of day-to-day Project operations. However, fluctuating water levels from Project operations may cause disturbances allowing the establishment of invasives such as common reed and Japanese knotweed. Recreational activities at the Turners Falls Development and Northfield Mountain Pumped Storage Development do not appear to cause extensive harm on wildlife, but may include temporary displacement of some species. In some cases, wildlife which utilizes the shoreline may be temporarily impacted as water levels rise and fall, but generally these species are able to move freely. Wildlife and botanical resources within the study area may be impacted by vegetation management and maintenance of development lands around the TFI, the Northfield Mountain Upper Reservoir, Power Canal and the maintenance of development-related access ways. As such, there is some potential for ground disturbing activities (i.e., land clearing construction activities) which may result in the spread or propagation of invasive species as well as degradation of existing habitat. In addition, recreational facilities (i.e., boat launches) may allow for the movement or introduction of invasive vegetation (both terrestrial and aquatic). However, such effects would be minimized through vegetation management planning.

3.3.4.3 Cumulative Effects

Operation and maintenance of the Northfield Mountain Pumped Storage Development and Turners Falls Development may, to a limited degree, have a cumulative effect on the spread of invasive species. Commercial, residential and agricultural development within and adjacent to the Project boundaries potentially introduce invasive species to terrestrial habitat within the Project boundaries. Other potential vectors for invasive species include a transmission line right-of-way maintained by Eversource in the western portion of the Northfield Mountain study area, the Northfield Mountain trail system, which includes over 25 miles of trail, and recreational activities (e.g. boating) within the TFI that could disturb the shoreline or bring in aquatic invasives from other locations.

3.3.4.4 Proposed Environmental Measures

No environmental measures are proposed at this time.

3.3.4.5 Unavoidable Adverse Impacts

Vegetation management activities including mowing, are necessary in areas around the Northfield Mountain Upper Reservoir which are maintained for safety and surveillance as part of the development's Dam Safety Surveillance and Monitoring Program. Vegetation management also occurs for maintenance associated with the Power Canal. Vegetation management activities associated with the developments represent a minor, unavoidable adverse impact to terrestrial resources, but are necessary for public safety and the integrity of Project facilities.

Table 3.3.4.1-1: List of Mammals Observed or Likely to Occur in Study Area

Common Name	Scientific Name
Beaver*	*Castor canadensis*
Black bear**	*Ursus americanus*
Bobcat	*Felix rufus*
Coyote**	*Canis latrans*
Deer mouse	*Peromyscus maniculatus*
Eastern chipmunk*	*Tamias striatus*
Eastern mole	*Scalopus aquaticus*
Fisher	*Martes pennanti*
Gray fox	*Urocyon cinereoargenteus*
Gray squirrel*	*Sciurus carolinensis*
Hairy-tailed mole	*Parascalops breweri*
Hoary bat	*Lasiurus cinereus*
House mouse	*Mus musculus*
Long-tailed shrew	*Sorex dispar*
Masked shrew	*Sorex cinereus*
Meadow jumping mouse	*Zapus hudsonius*
Meadow vole	*Microtus pennsylvanicus*
Muskrat*	*Ondatra zibethicus*
New England cottontail	*Sylvilagus transitionalis*
Northern short-tailed shrew	*Blarina brevicauda*
Norway rat	*Rattus norvegicus*
Porcupine**	*Erethizon dorsatum*
Raccoon*	*Procyon lotor*
Red bat	*Lasiurus borealis*
Red fox**	*Vulpes*
Red squirrel*	*Tamiasciurus hudsonicus*
Silver-haired bat	*Lasionycteris noctivagans*
Star-nosed mole	*Condylura cristata*
Striped skunk	*Mephitis*
Virginia oppossum*	*Didelphis virginiana*
White-footed mouse	*Peromyscus leucopus*
White-tailed deer*	*Odocoileus virginianus*
Woodchuck	*Marmota monax*
Woodland jumping mouse	*Napaeozapus insignis*
Woodland vole	*Microtus pinetorum*

* Denotes Direct Observation

**Denotes Indirect Observation

Table 3.3.4.1-2: List of Reptiles and Amphibians Observed or Likely to Occur in Study Area

Common Name	Scientific Name
Frogs & Toads	
American bullfrog*	*Lithobates catesbeiana*
American toad*	*Anaxyrus americanus*
Fowler's toad	*Bufo fowleri*
Gray treefrog	*Hyla versicolor*
Green frog*	*Lithobates clamitans*
Northern leopard frog	*Lithobates pipiens*
Pickerel frog*	*Lithobates palustris*
Spring peeper*	*Pseudacris crucifer*
Wood frog*	*Lithobates sylvatica*
Salamanders	
Eastern-red-backed salamander*	*Plethodon cinereus*
Northern dusky salamander*	*Desmognathus fuscus*
Red-spotted newt*	*Notophthalmus viridescens*
Spotted salamander*	*Ambystoma maculatum*
Snakes	
Common ribbon snake	*Thamnophis sauritus*
Eastern garter snake*	*Thamnophis sirtalis*
Eastern ratsnake	*Pantherophis alleghaniensis*
Northern black racer	*Coluber constrictor*
Northern red-bellied snake	*Storeria occipitomaculata*
Northern ring-necked snake	*Diadophis punctatus edwardsii*
Northern watersnake*	*Nerodia sipedon*
Turtles	
Painted turtle*	*Chrysemys picta*
Snapping turtle*	*Chelydra serpentina*
Spotted turtle*	*Clemmys guttata*

*Denotes direct observation

Table 3.3.4.1-3: Avian Species Found in the Study Area

Common Name	Scientific Name	TF[1]	Northfield Mountain					
			Total area	NW Slope	NE Slope	SE Slope	SW Slope	Reservoir
American Crow	*Corvus brachyrhynchos*	X	X	X		X		X
American Goldfinch	*Carduelis tristis*	X	X	X		X		
American Redstart	*Setophaga ruticilla*	X	X	X		X		
American Robin	*Turdus migratorius*	X	X	X		X		X
Bald Eagle	*Haliaeetus leucocephalus*	X	X					X
Baltimore Oriole	*Icterus galbula*	X						
Bank Swallow	*Riparia riparia*	X	X					X
Barn Swallow	*Hirundo rustica*	X						
Belted Kingfisher	*Megaceryle alcyon*	X						
Black and White Warbler	*Mniotilta varia*	X	X	X	X	X	X	
Black-billed Cuckoo	*Coccyzus erythropthalmus*	X	X	X				
Blackburnian Warbler	*Setophaga fusca*		X	X	X	X		
Blacked-capped Chickadee	*Poecile atricapillus*	X	X	X		X	X	
Black-throated Blue Warbler	*Setophaga caerulescens*		X	X	X	X	X	
Black-throated Green Warbler	*Setophaga virens*	X	X	X	X	X	X	
Blue Jay	*Cyanocitta cristata*	X	X	X	X	X	X	
Blue-headed Vireo	*Vireo solitarius*		X	X		X	X	
Blue-winged Warbler	*Vermivora cyanoptera*	X						
Broad-winged Hawk	*Buteo platypterus*	X						
Brown Creeper	*Certhia americana*		X	X		X		
Brown-headed Cowbird	*Molothrus ater*	X						
Canada Goose	*Branta canadensis*	X						
Cedar Waxwing	*Bombycilla cedrorum*	X	X	X	X		X	X
Chestnut-sided Warbler	*Setophaga pensylvanica*	X	X	X				

Common Name	Scientific Name	TF[1]	Northfield Mountain					
			Total area	NW Slope	NE Slope	SE Slope	SW Slope	Reservoir
Chimney Swift	*Chaetura pelagica*	X						
Chipping Sparrow	*Spizella passerina*		X	X		X	X	X
Common Grackle	*Quiscalus quiscula*	X						
Common Merganser	*Mergus merganser*	X						
Common Raven	*Corvus corax*	X	X			X		
Common Yellowthroat	*Geothlypis trichas*	X	X	X				X
Coopers Hawk	*Accipiter cooperii*	X						
Double-crested Cormorant	*Phalacrocorax auritus*	X						
Downy Woodpecker	*Picoides pubescens*	X	X	X				
Easten Wood-Pewee	*Contopus virens*		X	X	X	X	X	
Eastern Bluebird	*Sialia sialis*		X					X
Eastern Kingbird	*Tyrannus tyrannus*	X						
Eastern Phoebe	*Sayornis phoebe*	X	X	X	X	X	X	
Eastern Towhee	*Pipilo erythrophthalmus*		X	X				
European Starling	*Sturnus vulgaris*		X	X				
Field Sparrow	*Spizella pusilla*		X					X
Gray Catbird	*Dumetella carolinensis*	X	X	X				
Great Blue Heron	*Ardea herodias*	X						
Great Crested Flycatcher	*Myiarchus crinitus*	X	X	X		X	X	
Greater Yellowlegs	*Tringa melanoleuca*	X						
Green Heron	*Butorides virescens*	X						
Hairy Woodpecker	*Leuconotopicus villosus*		X	X		X	X	
Hermit Thrush	*Catharus guttatus*		X	X		X	X	
Indigo Bunting	*Passerina cyanea*	X	X	X	X	X		X

Common Name	Scientific Name	TF[1]	Northfield Mountain					
			Total area	NW Slope	NE Slope	SE Slope	SW Slope	Reservoir
Killdeer	*Charadrius vociferus*	X	X					X
Least Flycatcher	*Empidonax minimus*	X						
Louisiana Waterthrush	*Parkesia motacilla*	X						
Mallard	*Anas platyrhynchos*	X						
Mute Swan	*Cygnus olor*	X						
Northern Cardinal	*Cardinalis cardinalis*	X	X	X				
Northern Mockingbird	*Mimus polyglottos*		X	X				
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	X						
Nothern Flicker	*Colaptes auratus*		X				X	X
Orchard Oriole	*Icterus spurius*	X						
Osprey	*Pandion haliaetus*	X						
Oven Bird	*Seiurus aurocapilla*		X	X	X	X	X	
Peregrine Falcon	*Falco peregrinus*		X			X		
Pileated Woodpecker	*Hylatomus pileatus*	X	X	X	X	X	X	
Pine Warbler	*Setophaga pinus*		X	X		X	X	
Prairie Warbler	*Setophaga discolor*		X	X				
Red-breasted Nuthatch	*Sitta canadensis*		X	X		X		
Red-eyed Vireo	*Vireo olivaceus*	X	X	X	X	X	X	X
Red-tailed Hawk	*Buteo jamaicensis*	X	X		X	X		
Red-winged Blackbird	*Agelaius phoeniceus*	X						
Rock Pigeon	*Columba livia*	X						
Rose-breasted Grosbeak	*Pheucticus ludovicianus*		X	X		X		
Ruby-throated Hummingbird	*Archilochus colubris*		X	X			X	
Scarlet Tanager	*Piranga olivacea*	X	X	X	X	X	X	
Song Sparrow	*Melospiza melodia*	X	X	X				X

Common Name	Scientific Name	TF[1]	Northfield Mountain					
			Total area	NW Slope	NE Slope	SE Slope	SW Slope	Reservoir
Spotted Sandpiper	*Actitis macularius*	X	X					X
Tree Swallow	*Tachycineta bicolor*	X	X					X
Tufted Titmouse	*Baeolophus bicolor*	X	X	X		X	X	
Turkey Vulture	*Cathartes aura*	X	X	X				X
Veery	*Catharus fuscescens*	X	X	X	X	X	X	
Warbling Vireo	*Vireo gilvus*	X						
White-breasted Nuthatch	*Sitta carolinensis*	X	X	X	X	X	X	
Wild Turkey	*Meleagris gallopavo*		X	X		X	X	X
Winter Wren	*Troglodytes hiemalis*		X	X		X		
Wood Duck	*Aix sponsa*	X						
Wood Thrush	*Hylocichla mustelina*	X	X	X	X	X	X	
Yellow Warbler	*Setophaga petechia*	X						
Yellow-bellied Sapsucker	*Sphyrapicus varius*	X	X			X	X	
Yellow-billed Cuckoo	*Coccyzus americanus*	X						
Yellow-throated Vireo	*Vireo flavifrons*		X	X				
Total Number Observed		**64**	**59**	**47**	**17**	**36**	**26**	**18**

[1]TF= Turners Falls Development (Includes the shoreline of TFI, the Bypass Reach, and below Cabot Station to the Route 116 Bridge in Sunderland)

Table 3.3.4.1-4: Botanical Species Found in the Study Area

Common Name	Scientific Name	NFM[1]	TF[2]
alternate-leaved dogwood	*Swida alternifolia*		X
American basswood	*Tilia americana*		X
American beech	*Fagus grandifolia*	X	X
American chestnut	*Castanea dentata*	X	
American elm	*Ulmus americana*		X
American hazelnut	*Corylus americana*	X	
American hornbeam	*Carpinus caroliniana*	X	X
American pokeweed	*Phytolacca americana*	X	
American speedwell	*Veronica americana*		X
American witch-hazel	*Hamamelis virginiana*	X	X
anise-scented goldenrod	*Solidago odora*		X
arrow arum	*Peltandra virginica*		X
arrow-leaved tearthumb	*Persicaria sagittata*		X
arrowwood	*Viburnum dentatum*		X
Asian bush honeysuckle	*Lonicera sp.*	X	
Asiatic dayflower	*Commelina communis*		X
asparagus	*Asparagus officinalis*		X
autumn olive	*Elaeagnus umbellata***	X	X
balsam fir	*Abies balsamea*	X	
barberpole sedge	*Scirpus microcarpus*	X	
bearberry	*Arctostaphylos uva-ursi*	X	
bedstraw	*Gallium spp.*		X
bee balm	*Monarda didyma*		X
big bluestem	*Andropogon gerardii*		X
big-star sedge	*Carex rosea*		X
bigtooth aspen	*Populus grandidentata*	X	
bird's-foot trefoil	*Lotus corniculatus*	X	
bittersweet nightshade	*Solanum dulcamara*	X	X
black cherry	*Prunus serotina*		X
black chokeberry	*Aronia melanocarpa*		X
black elderberry	*Sambucus nigra*		X
black gum	*Nyssa sylvatica*		X
black locust	*Robinia pseudoacacia***		X
black oak	*Quercus velutina*	X	X
black swallow-wort	*Cynanchum louiseae***		X
black-eyed Susan	*Rudbeckia hirta*	X	X
bladder campion	*Silene sp.*	X	
bladder sedge	*Carex intumescens*	X	
bloodroot	*Sanguinaria canadensis*		X
blue flag iris	*Iris versicolor*	X	X
blue vervain	*Verbena hastata*		X
blue-eyed grass	*Sisyrinchium angustifolium*	X	
bluejoint grass	*Calamagrostis canadensis*		X
blue-stemmed goldenrod	*Solidago caesia*		X
bluets	*Houstonia sp.*		X
blunt spikerush	*Elocharis obtusa*		X
blunt-lobed cliff-fern	*Woodsia obtusa*		X
boneset	*Eupatorium perfoliatum*	X	X
box elder	*Acer negundo*	X	
bracken fern	*Pteridium aquilinum*	X	X

Common Name	Scientific Name	NFM[1]	TF[2]
broad-leaved cattail	*Typha latifolia*		X
broad-leaved dock	*Rumex obtusifolius*		X
broom sedge	*Carex scoparia*	X	
burning bush	*Euonymus alatus***	X	X
burred	*Sparganium americanum*		X
bush honeysuckle	*Diervilla lonicera*	X	X
butter-and-eggs	*Linaria vulgaris*	X	X
buttonbush	*Cephalanthus occidentalis*		X
calico aster	*Symphyotrichum lateriflorum*		X
Canada mayflower	*Maianthemum canadense*	X	X
Canada rush	*Juncus canadensis*		X
Canada St. John's wort	*Hypericum canadense*	X	
Canada thistle	*Cirsium arvense*		X
Canada yew	*Taxus canadensis*		X
cardinal flower	*Lobelia cardinalis*		X
carrion flower	*Smilax herbacea*		X
chestnut oak	*Quercus montana*	X	
chickweed	*Stellaria media*		X
chokecherry	*Prunus virginiana*	X	
christmas fern	*Polystichum acrostichoides*	X	X
cinnamon fern	*Osmundastrum cinnamomeum*	X	X
clasping dogbane	*Apocynun cannabinum*		X
clearweed	*Pilea pumila*		X
club moss	*Huperzia sp.*	X	
coltsfoot	*Tussilago farfara****	X	X
common blackberry	*Rubus allegheniensis*		X
common buckthorn	*Rhamnus cathartica***		X
common burdock	*Arctium minus*	X	X
common chicory	*Cichorium intybus*	X	X
common cinquefoil	*Potentilla simplex*	X	X
common cocklebur	*Xanthium strumarium* var. *glabratum*		X
common cow-wheat	*Melampyrum pratense*	X	
common dewberry	*Rubus flagellaris*	X	X
common evening primrose	*Oenothera biennis*		X
common greenbrier	*Smilax rotundifolia*		X
common jewelweed	*Impatiens capensis*	X	X
common milkweed	*Asclepias syriaca*	X	X
common mugwort	*Artemisia vulgaris***		X
common mullein	*Verbascum thapsus*	X	X
common plantain	*Plantago major*	X	
common ragweed	*Ambrosia artemisiifolia*	X	X
common reed	*Phragmites australis***	X	X
common shadbush	*Amelanchier arborea*		X
common spikerush	*Elocharis palustris*		X
common threesquare	*Schoenoplectus pungens*		X
common water plantain	*Alisma subcordatum*		X
common woodsorrell	*Oxalis montata*		X
cow vetch	*Vicia cracca*	X	X
creeping jenny	*Lysimachia nummularia***		X
creeping spearwort	*Ranunculus repens*		X
curled dock	*Rumex crispus*	X	
dandelion	*Taraxacum officinale*		X

Common Name	Scientific Name	NFM[1]	TF[2]
daylily	*Hemerocallis sp.*	X	
deer berry	*Vaccinium stanimeum*		X
deer-tongue grass	*Dichanthelium clandestinum*	X	X
deptford pink	*Dianthus armeria*	X	
devil's begger-ticks	*Bidens frondosa*	X	X
Dewey's sedge	*Carex deweyana*		X
downy rattlesnake plantain	*Goodyera pubescens*	X	X
early lowbush blueberry	*Vaccinium vacillans*	X	
early saxifrage	*Micranthes virginiensis*		X
eastern cottonwood	*Populus deltoides*	X	X
eastern hemlock	*Tsuga canadensis*	X	X
eastern serviceberry	*Amelanchier canadensis*	X	X
eastern teaberry	*Gaultheria procumbens*	X	X
eastern white pine	*Pinus strobus*	X	X
ebony spleenwort	*Asplenium platyneuron*	X	X
enchanter's nightshade	*Cerastium fontanum*	X	X
European alder	*Alnus glutinosa*	X	
false baby's breath	*Galium mollugo*		X
false dragonhead	*Physostegia virginiana*		X
false hellebore	*Veratrum viride*	X	X
false indigo	*Amorpha fruticosa*		
false nettle	*Boehmeria cylindrica*		X
false Solomon's seal	*Maianthemum racemosum*	X	X
field penny-cress	*Thlaspi arvense*	X	
field pepperweed	*Lepidium campestre*	X	
flattened oatgrass	*Danthonia compressa*		X
flat-top goldentop	*Euthamia graminifolia*	X	
flat-top white aster	*Doellingeria umbellata*		X
fleabane	*Erigeron spp.*	X	X
flowering dogwood	*Benthamidia florida*		X
foam flower	*Tiarella cordifolia*	X	X
forget-me-not	*Myosotis scorpioides*		X
fox grape	*Vitis labrusca*		X
fringe loosestrife	*Lysimachia ciliata*		X
fringed sedge	*Carex crinita*	X	
garlic mustard	*Alliaria petiolata***		X
gaywings	*Polygala paucifolia*		X
giant goldenrod	*Solidago gigantica*		X
glossy buckthorn	*Frangula alnus***	X	X
golden alexanders	*Zizua ayrea*		X
golden ragwort	*Packera aurea*		X
goldenrod	*Solidago spp.*	X	X
goldthread	*Coptis trifolia*	X	X
grass-leaf flat-topped goldenrod	*Euthamia graminifolia*		X
grass of Parnassus	*Parnassia glauca*		X
gray birch	*Betula populifolia*	X	
gray goldenrod	*Solidago nemoralis*		X
great blue lobelia	*Lobelia siphilitica**		X
great Solomon's seal	*Polygonatum biflorum*		X
green ash	*Fraxinus pennsylvanica*	X	X
green bulrush	*Scirpus atrovirens*	X	
gill over the ground	*Glechoma hederacea*	X	X

Common Name	Scientific Name	NFM[1]	TF[2]
groundnut	*Apios americana*		X
ground pine	*Lycopodium obscurum*	X	X
hair-cap moss	*Polytrichum juniperinum*		X
hairy bush clover	*Lespedeza hirta*	X	
hairy Solomon's seal	*Polygonatum pubescens*		X
harebell	*Campanula rotundifolia*		X
hawkweed	*Hieracium caespitosum*	X	
hawthorn	*Crataegus sp.*		X
hay-scented fern	*Dennstaedtia punctilobula*	X	
heart-leaved aster	*Symphyotrichum cordifolium*		X
hepatica	*Hepatica nobilis*	X	
highbush blueberry	*Vaccinium corymbosum*	X	X
hobblebush	*Viburnum lantanoides*	X	X
hog peanut	*Amphicarpaea bracteata*	X	X
hop hornbeam	*Ostrya virginiana*		X
hop trefoil	*Trifolium campestre*	X	
Indian cucumber	*Medeola virginiana*	X	X
Indian grass	*Sorghastrum nutans*		X
Indian pipe	*Monotropa uniflora*	X	X
Indian tobacco	*Lobelia inflata*		X
intermediate spike-sedge	*Eleocharis intermedia**		X
interrupted fern	*Osmunda claytoniana*	X	X
Jack in the pulpit	*Arisaema triphyllum*		X
Japanese barberry	*Berberis thunbergii***	X	X
Japanese honeysuckle	*Lonicera japonica***		X
Japanese knotweed	*Fallopia japonica***	X	X
Japanese privet	*Ligustrum obtusifolium***		X
Japanese stiltgrass	*Microstegium vimineum****		X
Jerusalum artichoke	*Helianthus tuberosus*		X
joe-pye weed	*Eutrochium purpureum*	X	X
jump seed	*Persicaria virginiana*		X
leafy spurge	*Euphorbia esula***		X
lesser celandine	*Ranunculus ficaria***		X
lily-of-the-valley	*Convallaria majalis*		X
little bluestem grass	*Schizachyrium scoparium*	X	X
lowbush blueberry	*Vaccinium angustifolium*	X	X
mad dog skullcap	*Scutellaria lateriflora*		X
maiden-hair fern	*Adiantum pedatum*		X
maidenhair spleenwort	*Asplenium trichomanes*		X
mannagrass	*Glyceria sp.*	X	
marginal wood-fern	*Dryopteris marginalis*	X	
marsh fern	*Thelypteris palustris*	X	X
marsh horsetail	*Equisetum palustre*	X	
marsh marigold	*Caltha palustris*	X	X
marsh speedwell	*Veronica scutellata*		X
marshpepper knotweed	*Persicaria hydropiper*		X
mayapple	*Podophyllum peltatum*		X
mint	*Mentha arvensis*		X
monkey flower	*Mimulis ringens*		X
morning glory	*Ipomoea purpurea*		X
Morrow's honeysuckle	*Lonicera morrowii***		X
mountain alder	*Alnus viridis* ssp. *crispa**		X

Common Name	Scientific Name	NFM[1]	TF[2]
mountain laurel	*Kalmia latifolia*	X	X
mouse-ear-chickweed	*Cerastium fontanum*		X
multiflora rose	*Rosa multiflora***	X	X
naked-flowered tick trefoil	*Hylodesmum nudiflorum*		X
nannyberry	*Viburnum lentago*		X
narrowleaf cattail	*Typha angustifolia*	X	
New England aster	*Symphyotrichum novae-angliae*		X
New England sedge	*Carex novae-angliae*		X
New York aster	*Symphyotrichum novi-belgii*		X
New York fern	*Parathelypteris noveboracensis*	X	
nodding smartweed	*Persicaria lapathifolia*		X
northern bayberry	*Morella pensylvanica*		X
northern bugleweed	*Lycopus uniflorus*	X	X
northern catalpa	*Catalpa speciosa*		X
northern red oak	*Quercus rubra*	X	X
Norway maple	*Acer platanoides***		X
Norwegian cinquefoil	*Potentilla norvgica*		X
Olney's three-square bulrush	*Schoenoplectus americanus*	X	
orangegrass	*Hypericum gentianoides*	X	
Oriental bittersweet	*Celastrus orbiculatus***	X	X
ostrich fern	*Matteuccia struthiopteris*	X	X
ovate spikerush	*Eleocharis ovata*		X
oxeye daisy	*Leucanthemum vulgare*	X	
pale corydalis	*Corydalis sempervirens*	X	
panicled aster	*Symphyotrichum lanceolatum*		X
partridge berry	*Mitchella repens*	X	X
path rush	*Juncus tenuis*		X
pearly everlasting	*Anaphalis margaritacea*		X
pickerelweed	*Pontederia cordata*		X
pin cushion moss	*Leucobryum albidum*		X
pin oak	*Quercus palustris*	X	
pinkweed	*Persicaria pensylvanica*		X
pippsissewa	*Chimaphila umbellata*		X
pale dogwood	*Swida amomum* var. *schueltzeana*		X
plantain-leaved pussytoes	*Antennaria plantaginifolia*	X	
plantain-leaved sedge	*Carex plantaginea*		X
poison ivy	*Toxicodendron radicans*	X	X
prickly lettuce	*Lactuca serriola*		X
princess pine	*Dendrolycopodium obscurum*		X
purple chokeberry	*Aronia x floribunda*		X
purple cliff brake	*Pellaea atropurpurea*		X
purple leaved willow herb	*Epilobium ciliatum*		X
purple loosestrife	*Lythrum salicaria***	X	X
purple osier willow	*Salix purpurea*[±]		X
purple-flowering raspberry	*Rubus odoratus*		X
quaking aspen	*Populus tremuloides*	X	
Queen Anne's lace	*Daucus carota*	X	X
quillwort	*Isotes spp.*		X
rabbit-foot clover	*Trifolium arvense*		X
red cedar	*Juniperus virginiana*	X	
red chokeberry	*Aronia arbutifolia*		X
red clover	*Trifolium pratense*	X	X

Common Name	Scientific Name	NFM[1]	TF[2]
red fescue	*Festuca rubra*		X
red maple	*Acer rubrum*	X	X
red mullberry	*Morus alba*		X
red pine	*Pinus resinosa*		X
red trillium	*Trillium erectum*	X	
red-osier dogwood	*Swida sericea*		X
reed canary grass	*Phalaris arundinacea***		X
Rhododendron	*Rhododendron sp.*	X	
rice cutgrass	*Leersia oryzoides*		X
river bank grape	*Vitis riparia*	X	X
rock polypody	*Polypodium virginianum*	X	X
rough bedstraw	*Galium asprellum*	X	
rough-fruited cinquefoil	*Potentilla novegica*	X	
rough-leaved goldenrod	*Solidago patula*		X
round-leaved dogwood	*Swida rugosa*		X
rough-stemmed goldenrod	*Solidago rugosa*		X
round-lobed hepatica	*Anemone americana*		X
royal fern	*Osmunda regalis*	X	X
Russian olive	*Elaeagnus angustifolia*		X
Rusty cliff-fern	*Woodsia ilvensis*	X	
sandbar cherry	*Prunus pumila var. depressa**		X
sandbar willow	*Salix exigua**		X
sassafras	*Sassafras albidum*	X	X
saxifrage	*Micranthes sp.*		X
scouring rush	*Equisetum hyemale*	X	
scrub oak	*Quercus ilicifolia*	X	X
seedbox	*Ludwigia alternifolia*		X
self-heal	*Prunella vulgaris*	X	X
sensitive fern	*Onoclea sensibilis*	X	X
shagbark hickory	*Carya ovata*	X	
shallow sedge	*Carex lurida*	X	
shaved sedge	*Carex tonsa*		X
sheep laurel	*Kalmia angustifolia*	X	
silky dogwood	*Swida amomum*	X	X
silver maple	*Acer saccharinum*		X
silver rod	*Solidago bicolor*		X
silver vein	*Parthenocissus henryana*		X
skunk cabbage	*Symplocarpus foetidus*		X
slender gerardia	*Agalinis tenuifolia*		X
slender rattlesnake root	*Nabalus altissimus*		X
smartweed	*Persicaria sp.*	X	X
smooth alder	*Alnus serrulata*		X
smooth sumac	*Rhus glabra*	X	
soft rush	*Juncus effusus*	X	X
soft-stem bulrush	*Schoenoplectus tabernaemontani*		X
speckled alder	*Alnus incana*	X	X
sphagnum	*Sphagnum sp.*	X	
spinulose woodfern	*Dryopteris carthusiana*	X	
spotted joe-pyeweed	*Eutrochium maculatum*		X
spotted knapweed	*Centaurea maculosa****	X	
spreading dogbane	*Aposynum androsaemifolium*	X	X
squashberry	*Viburnum edule*	X	

Common Name	Scientific Name	NFM[1]	TF[2]
St. John's wort	*Hypericum perforatum*		X
staghorn sumac	*Rhus hirta*	X	X
starflower	*Lysimachia borealis*	X	X
steeplebush	*Spiraea tomentosa*	X	X
stiff aster	*Lonactis linariifolia*		X
stinging nettle	*Urtica dioica*		X
striped maple	*Acer pensylvanicum*	X	X
striped wintergreen	*Chimaphila maculata*	X	X
sugar maple	*Acer saccharum*		X
swamp azalea	*Rhodoendron viscosum*		X
swamp candles	*Lysimachia terrestris*		X
swamp dewberry	*Rubus hispidus*	X	X
swamp honeysuckle	*Lonicera oblongifolia*	X	
swamp rose	*Rosa palustris*	X	
swamp white oak	*Quercus bicolor*	X	
sweet fern	*Comptonia peregrina*	X	X
sweet flag	*Acorus calamus*	X	X
sweetgale	*Myrica gale*		X
switchgrass	*Panicum vigatum*		X
sycamore	*Platanus occidentalis*		X
tall blue lettuce	*Lactuca biennis*		X
tall meadow rue	*Thalictrum puescens*		X
Tartarian honeysuckle	*Lonicera tatarica****		X
three-leaved blackberry	*Rubus parvifolius*		X
three seed mercury	*Acalypha rhomboidea*		X
three-way sedge	*Dulichium arundinaceum*		X
tick-trefoil	*Desmondium glutinosum*	X	
tiger lily	*Lilium lancifolium*		
tower mustard	*Arabis glabra*	X	
Tradescant's aster	*Symphyotrichum tradescantii*		X
trident maple	*Acer rubrum* var. *trilobum*	X	
trillium	*Trillium sp.*	X	
turtle head	*Chelone glabra*		X
tussock sedge	*Carex stricta*		X
twig sedge	*Cladium mariscoides*		X
twisted stalk	*Streptopus amplexifolis*	X	
thyme-leaved speedwell	*Veronica serpyllifolia*		X
upland white aster	*Oligoneuron album**		X
violet	*Viola sp.*	X	X
viper's bugloss	*Echium vulgare*	X	
Virginia creeper	*Parthenocissus quinquefolia*	X	X
virgin's bower	*Clematis virginiana*	X	X
water hemlock	*Cicuta maculata*		X
water horehound	*Lycopus americanus*	X	X
water horsetail	*Equisetum fluviatile*		X
water parsnip	*Sium suave*	X	X
water pennywort	*Hydrocotyle sp.*	X	
water purslane	*Ludwigia palustris*		X
water-chestnut	*Trapa natans*		X
watercress	*Nasturtium officinale*		X
white ash	*Fraxinus americana*		X
white avens	*Geum canadense*		X

Common Name	Scientific Name	NFM[1]	TF[2]
white birch	*Betula papyrifera*	X	X
white clover	*Trifolium repens*	X	
white meadowsweet	*Spiraea alba var. latifolia*	X	X
white oak	*Quercus alba*	X	
white ricegrass	*Leersia virginica*		X
white snakeroot	*Ageratina altissima*		X
white sweet clover	*Melilotus albus*	X	X
white vervain	*Verbena urticifolia*		X
white wood aster	*Eurybia divaricata*		X
whorled loosestrife	*Lysimachia quadrifolia*	X	X
whorled wood aster	*Oclemena acuminata*		X
wild columbine	*Aquilegia canadinsis*	X	X
wild madder	*Rubia peregrina*	X	
wild oats	*Avena fatua*		X
wild oats	*Uvularia sessilifolia*		X
wild raisin	*Viburnum nudum*		X
wild sarsaparilla	*Aralia nudicaulis*	X	X
wild strawberry	*Fragaria virginiana*	X	
winterberry	*Ilex verticillata*	X	X
wood nettle	*Laportea canadensis*		X
woodfern	*Dryopteris sp.*		X
woolgrass	*Scirpus cyperinus*		X
yarrow	*Achillea millefolium*	X	X
yellow birch	*Betula alleghaniensis*	X	X
yellow iris	*Iris pseudacorus***	X	
yellow nutsedge	*Cyperus esculentus*		X
yellow woodsorrell	*Oxalis stricta*	X	

[1]NFM= Northfield Mountain Pumped Storage Development Area
[2]TF= Turners Falls Development Study Area (Includes the shoreline of TFI, the Bypass Reach, and below Cabot Station to the Route 116 Bridge in Sunderland)
* Denotes RTE
**Denotes Invasive according to MIPAG
***Denotes Likely Invasive according to MIPAG
± Denotes Non-native species of interest

Table 3.3.4.1-5: Mapped Habitats, Dominant Vegetation, and Percent Occurrence within the Study Area

Habitat Type	Dominant Overstory	Dominant Shrub	Dominant Herbaceous[1]	NFM[1]		TF[1]	
				Acres	% of Area	Acres	% of Area
Transitional Floodplain Forest	Silver maple (51-75%), sycamore (10-15%), cottonwood (10-15%), red maple (10-15%), ash (5-10%), American elm (5-10%), and willow (5-10%)	Silver maple (trace), sycamore (trace), cottonwood (trace), red maple (trace), ash (trace), American elm (trace), and willow (trace)	wood-nettle (5-10%), ostrich fern (6-25%), sensitive fern (5-10%) and false nettle (5-10%)	0	0	547.9	7.8
Northern hardwoods-hemlock-white pine forest	hemlock (75-100%), yellow birch (10-15%), American beech (5-10%)	hemlock (trace), hobblebush (trace), striped maple (trace)	sarsaparilla (trace), Canada mayflower (trace), wood fern (trace)	127.8	6.4	1,107.9	15.7
Successional Northern Hardwood Forest	red maple, American beech, white birch, quaking aspen (51-75%)	striped maple (6-25%) witch hazel (6-25%)	sarsaparilla (6-25%), twisted stalk (6-25%), starflower (6-25%)	666.8	33.2	2.9	.05
Hemlock Ravine	eastern hemlock (76-100%)	mountain laurel (6-25%)	starflower (trace), wintergreen (trace)	621.5	30.9	0	0
White Pine - Oak Forest	white pine (75-100%), red oak (6-25%), overcup oak (6-25%)	red maple (25%), low bush blueberry (10%), white oak (10%)	Canada mayflower (6-25%), partridge berry (6-25%)	70.1	3.5	0	0
Agricultural Lands	N/A	N/A	N/A	0	0	1,624.7	23.0

Habitat Type	Dominant Overstory	Dominant Shrub	Dominant Herbaceous[1]	NFM[1]		TF[1]	
				Acres	% of Area	Acres	% of Area
High Energy Shore	N/A	silky dogwood (trace), sandbar willow (trace), sandbar cherry (trace)	Beggartick (6-25%), dogbane (6-25%)	0	0	5.17	.07
Development	white pine (trace)	N/A	Kentucky bluegrass (76-100%)	284.8	14.2	317.3	4.5
Right of Way	N/A	white pine (6-25%), glossy buckthorn (6-25%)	goldenrod spp. (6-25%), interrupted fern (6-25%), sweetfern (6-25%), bracken fern (6-25%), mullein (6-25%)	14.3	0.7	4.8	.07
Wetlands	See section X	See section X	See section X	N/A	N/A	342.2	4.8
Water	N/A	N/A	N/A	225.5	11.1	3,112.4	44.1
Total				**2010.8**	**100**	**7,065.2**	**100**

[1]NFM=Northfield Mountain, TF=Turners Falls (Includes the shoreline of Turners Falls Impoundment, the Bypass Reach, and below Cabot Station to the Route 116 Bridge in Sunderland

Table 3.3.4.1-6: Vernal Pool Field Notes

Pool ID	Egg Masses		Pool Dimensions (Feet)	Water Depth (Feet)	Comments
	Spotted Salamander	Wood Frog			
VP-1	0	0	80x30	1.0	Only VP found in TF project area.
VP-2	0	0	200x50	3.0	Spotted salamander (Ambystoma maculatum) spermatophores man-made rock-quarry
VP-3	>66	40	45x72	1.5	
VP-4	25	0	120x30	2.0	
VP-5	50	25	100x40	1.0	
VP-6	32	0	100x45	1.0	
VP-7	25	0	125x75	2.0	
VP-8	18	6	75x40	2.0	
VP-9	12	2	20x20	2.0	
VP-10	12	0	-	3.0	
VP-11	52	18	45x25	2.0	
VP-12	15	>30	-	-	red spotted newts (Notophthalmus viridescens) feeding on egg masses
VP-13	25	>500	250x50	4.0	red spotted newts (Notophthalmus viridescens) feeding on egg masses
VP-14	5	6	120x45	2	

Table 3.3.4.1-7: Invasive Species found in the Study Area

Common Name	Scientific Name	Lifeform Type	NFM	TF	Notes
autumn olive	*Elaeagnus umbellata*	Shrub	X	X	Grows in full sun, berries spread by birds, aggressive in open areas
black locust	*Robinia pseudoacacia*	Tree		X	Occurs in uplands, grows full sun to full shade, aggressive in areas with sandy soils
black swallow-wort	*Cynanchum louiseae*	Perennial vine		X	Grows in full sun to partial shade, forms dense stands, deadly to Monarch butterfly larvae
burning bush	*Euonymus alatus*	Shrub	X	X	Capable of germinating in full sun to full shade. Escapes from cultivation and can form dense thickets and dominate the understory
coltsfoot	*Tussilago farfara**	Perennial herb	X		Occurs in lowland and upland woods, grows in full sun to full shade, spreads vegetatively and by seed, forms dense stands
common buckthorn	*Rhamnus cathartica*	Shrub-tree		X	Occurs in uplands and wetlands, grows in full sun to full shade.
common reed	*Phragmities australis*	Perennial grass	X	X	Grows in uplands and wetlands, full sun to full shade, forms dense stands, flourishes in disturbed areas
creeping jenny	*Lysimachia nummularia*	Perennial herb		X	Occurs in uplands and wetlands, grows in full sun to full shade, forms dense mats
European alder	*Alnus glutinosa****	Shrub	X		Rapidly growing shrub that establishes monspecific stands displacing natives
garlic mustard	*Alliaria petiolatea*	Biennial Herb		X	Widespread, grows full sun to full shade, spreads by seed, especially in wooded areas
glossy buckthorn	*Frangula alnus*	Shrub-tree	X		Occurs in uplands and wetlands, grows in full sun to full shade, forms thickets
Japanese barberry	*Berberis thunbergii*	Shrub	X	X	Wooded uplands and wetlands, grows in full sun to full shade, spread by birds, forms dense stands
Japanese honeysuckle	*Lonicera japonica*	Perennial vine	X	X	Widespread, grows full sun to full shade, climbs vegetation, seeds dispersed by birds

Common Name	Scientific Name	Lifeform Type	NFM	TF	Notes
Japanese knotweed	*Fallopia japonica*	Perennial Herb-subshrub	X	X	Widespread, grows in full sun to full shade, spreads vegetatively and by seed, forms dense thickets
leafy spurge	*Euphorbia esula*	Perennial herb		X	Aggressive, grows in full sun, occurs in grasslands
lesser celandine	*Ranunculus ficaria*	Perennial herb		X	Occurs in lowland and upland woods, grows in full sun to full shade, spreads vegetatively and by seed, forms dense stands
multiflora rose	*Rosa multiflora*	Shrub	X	X	Widespread, grows in full sun to full shade, forms thorny thickets, dispersed by birds.
Morrow's honeysuckle	*Lonicera morrowii*	Shrub		X	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Norway maple	*Acer platanoides*	Tree		X	Common in woodlands with colluvial soils, grows full sun to full shade dispersed by water, wind and vehicles
Oriental bittersweet	*Celastrus orbiculatus*	Perennial vine	X	X	Grows in full sun to partial shade, berries spread by birds and humans
purple loosestrife	*Lythrum salicaria*	Perennial herb	X	X	Occurs in uplands and wetlands, grows in full sun to partial shade, high seed production, overtakes wetlands
reed canary grass	*Phalaris arundinacea*	Perennial grass		X	Occurs in uplands and wetlands, grows full sun to partial shade, can form large colonies, common in agricultural settings
spotted knapweed	*Centaurea maculosa**	Perennial herb	X	X	Occurs in full sun, spreads rapidly in artificial corridors, agricultural fields, and margins.
yellow iris	*Iris pseudacorus*	Perennial herb	X		Occurs in wetland habitat, grows in full sun to partial shade, out-competes native plant communities.

NFM=Northfield Mountain, TF=Turners Falls (Includes the shoreline of Turners Falls Impoundment, the Bypass Reach, and below Cabot Station to the Route 116 Bridge in Sunderland)
** Denotes Likely Invasive according to MIPAG*
**** Not on MIPAG list, but noted for consistency with other studies*

Figure 3.3.4.1-1: Example of Remnant Floodplain Forest Along Shoreline Downstream of Cabot

Figure 3.3.4.1-2: Example of Successional Northern Hardwoods

Figure 3.3.4.1-3: Example of Northern Hardwoods-Hemlock-White Pine Forest on Northwest Slope of Northfield Mountain

Figure 3.3.4.1-4: Example of Hemlock Ravine Community

Figure 3.3.4.1-5: View Through the Interior of the White Pine-Oak Forest

Figure 3.3.4.1-6: Calcareous Cliff Habitat

Figure 3.3.4.1-7: Circumneutral Rock Cliff Community- Farley Ledges (formed from granitic gneiss)

Figure 3.3.4.1-8: Example of Oak - Hickory Forest

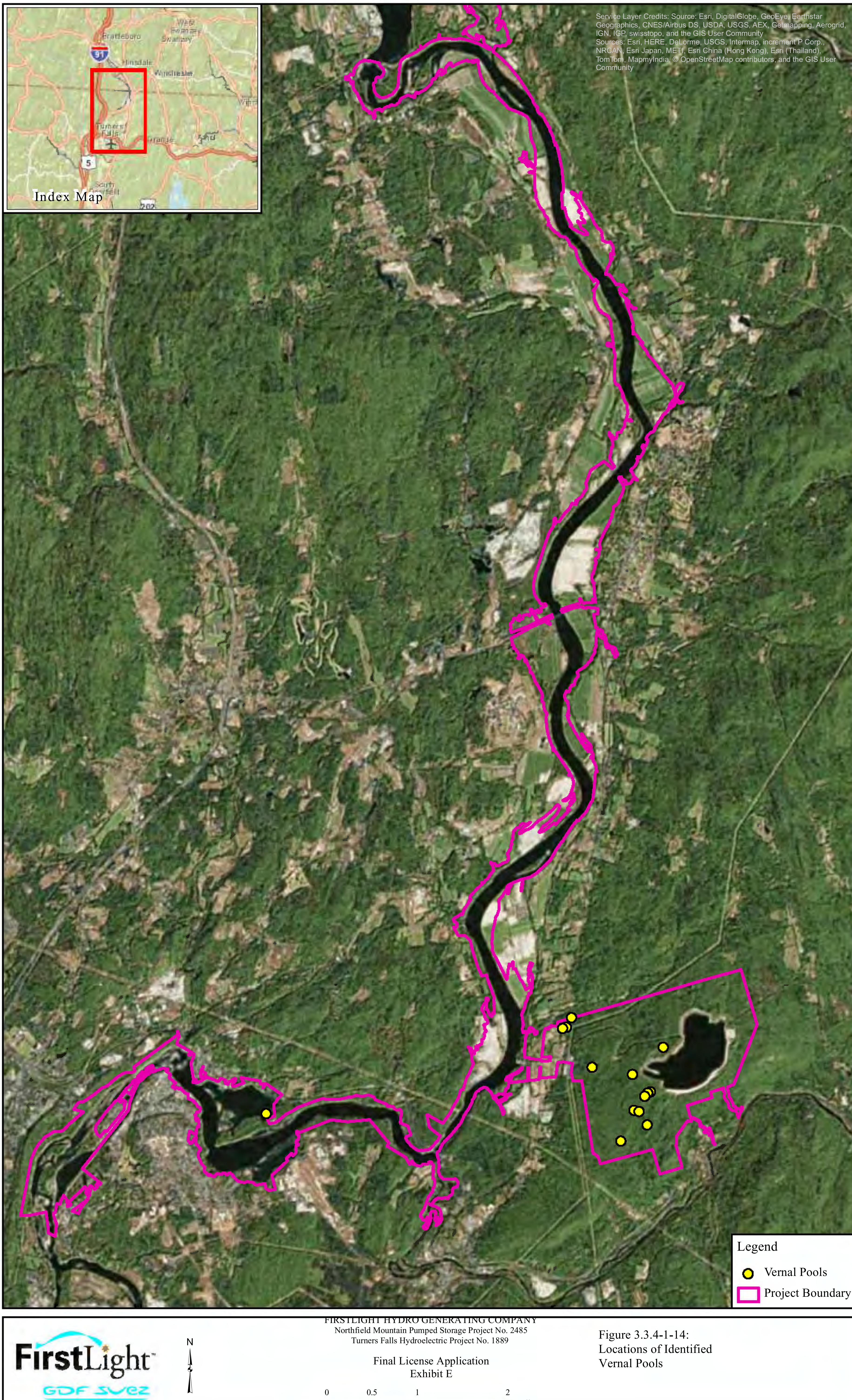
Figure 3.3.4.1-9: Example of Agricultural Land in the Study Area

Figure 3.3.4.1-10: Typical Habitat of Bypass During Low-Flow in Late Summer

Figure 3.3.4.1-11: Representative View of the Right-of-Way Community.

Figure 3.3.4.1-12: Example of Hemlock Swamp Near the Base of the Farley Ledges

Figure 3.3.4.1-13: Example of Red Maple Swamp on Southeast Slope of Northfield Mountain



FirstLight GDF SUEZ

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

Final License Application
Exhibit E

Figure 3.3.4-1-14:
Locations of Identified
Vernal Pools

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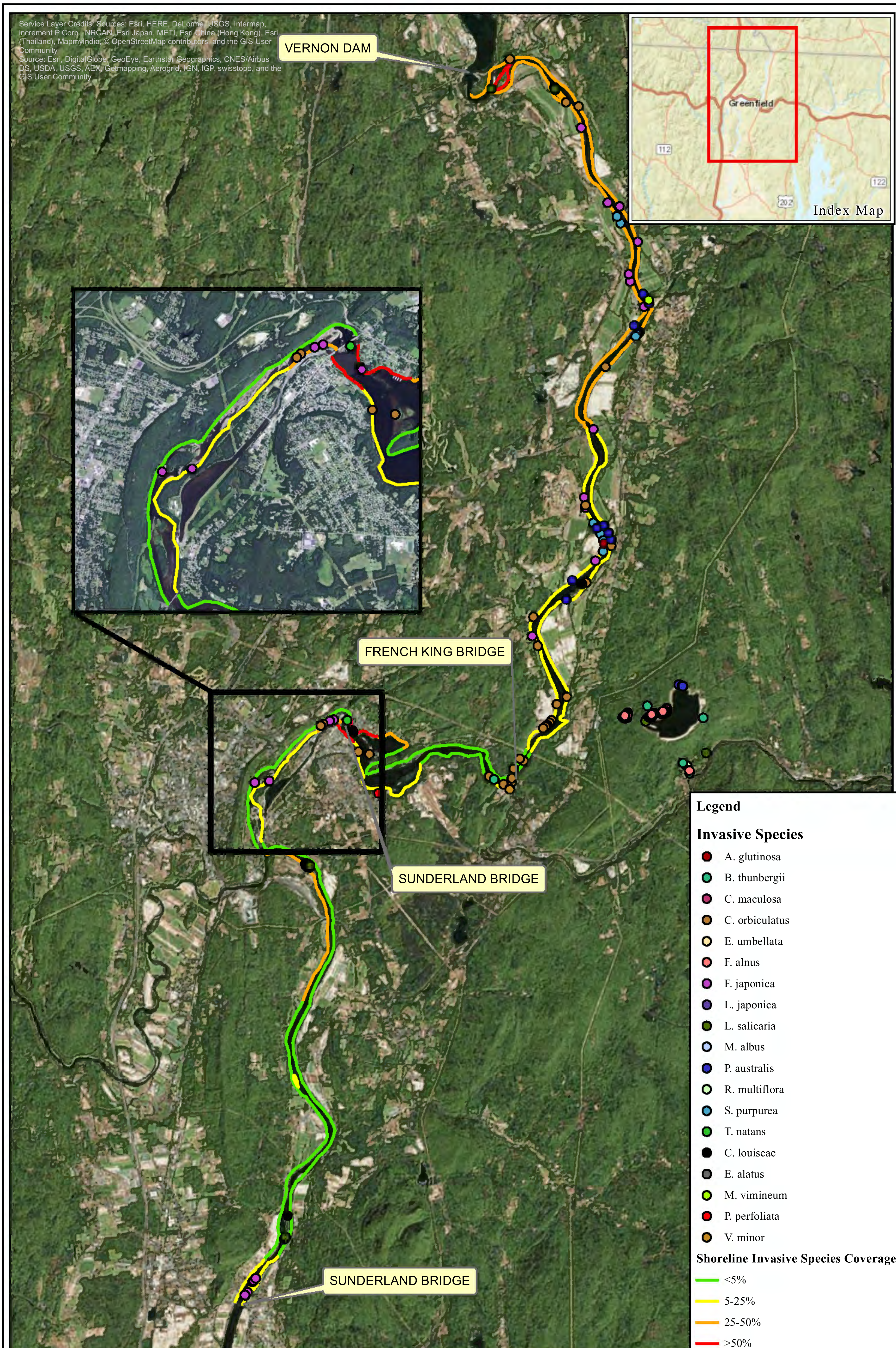

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Figure 3.3.4.1-15:
Locations of Identified
Invasive Plants in 2014

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3.3.5 *Threatened and Endangered Species*

In 2011, the following Federal and state agencies were contacted regarding the potential presence of rare, threatened, and endangered (RTE) species and critical habitats within the Turners Falls Development and Northfield Mountain Pumped Storage Development boundaries:

- USFWS
- NMFS
- NHESP
- Vermont Fish and Wildlife Department (VTFWD)
- New Hampshire Fish and Game Department (NHFGD)

NHESP provided a list of state-listed species known or likely to occur in the vicinity of the Turners Falls Development and Northfield Mountain Pumped Storage Development area in a letter dated October 27, 2011. Following the submittal of the Draft Modified Study Plan (No. 3.5.1 *Baseline Inventory of Wetland, Riparian, and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operation Impact on Special Status Species*) to the NHESP in December of 2013, comments were received and incorporated in to the RSP (FirstLight, 2013). The RSP, which included surveys for identified special concern species at the Turners Falls Development and Northfield Mountain Pumped Storage Development, was completed throughout 2014 and 2015.

FERC Relicensing Studies

FirstLight has conducted several studies to gather information necessary to understand the potential effects of land management practices and recreational use on protected resources within the Northfield Mountain Pumped Storage Development and the Turners Falls Development study area. The goal of these studies is to characterize and describe both the extent of protected resources within the Project as well as potential effects. Study objectives included:

- Survey and inventory identified protected and sensitive species;
- Note the occurrence of additional sensitive species during the course of the surveys;
- Complete fine scale data collection related to the elevation of specific species (i.e., vascular plants and tiger beetles) to identify potential impacts related to water level fluctuations.

3.3.5.1 Affected Environment

Background

Protected species within the Project area include vascular plants, vertebrate animals, and invertebrate animals.

At a November 1, 2013 meeting, NHESP provided FirstLight with a list of 10 sensitive plant species of concern (target plants) known to occur or have historical records of occurrence within or near the vicinity of the Project between Vernon Dam and the Route 116 Bridge in Sunderland. NHESP targeted these state-listed plant species as having the highest likelihood of experiencing potential effects due to Project operations - specifically related to inundation (including depth, timing and duration).

Pursuant to the NHESP Data Release Agreement (NHESP File #11-30121) dated November 13, 2013, NHESP provided FirstLight with a list of specific locations where the above listed sensitive plant species have been observed or where NHESP has historical records of occurrences. For some locations NHESP has spatial data they have provided to FirstLight to better focus survey efforts. Pursuant to the data release agreement, FirstLight is not permitted to disclose the specific location of the plant specimens in publicly available documents.

Vascular Plants

Submerged Aquatic Vegetation

During the summer of 2014, the TFI was surveyed for submergent aquatic vegetation (SAV). The intent was to describe dominant species as well as estimate the coverage within mapped patches of SAV. In most cases, very dense stands were dominated by exotic species, primarily variable leaf and Eurasian milfoil (*Myriophyllum heterophyllum* and *Myriophyllum spicatum*).

Several exotic and invasive aquatic species are currently found within the study area including variable leaf milfoil, Eurasian milfoil, curly-leaf pondweed (*Potamogeton crispus*), fanwort (*Cabomba caroliniana*), and water chestnut (*Eleocharis dulcis*). In total, 41 of the mapped 107 SAV beds had some level of infestation by exotic species, which accounts for 38% of the SAV beds. The majority of the exotic species occur immediately upstream of the Turners Falls Dam with fewer occurrences upstream of the French King Bridge. In general, exotic species upstream of the French King Bridge are not as widespread and occur at lower densities. No exotic SAV was identified in mapped SAV beds below the bypass reach. Beds of SAV vegetation, outside of the areas near Barton Cove, generally occur as narrow bands located parallel to the TFI shoreline. In some cases, shallow shoals within the TFI, often associated within islands, support large beds of SAV. Native species include wild celery (*Vallisneria americana*), various pondweeds (*Potamogeton spp*.), muskgrasses (*Chara ssp*.), and coontail (*Ceratophyllum demersum*). Downstream of the Turners Falls Dam species are dominated by wild celery and pondweeds. Wild celery occurs throughout the majority of the identified SAV beds within the entire study area. Table 3.3.5.1-1 includes SAV species identified during the survey work.

The greatest area of SAV beds are dense (295.6 acres), with the largest being beds located near Barton Cove and the Turners Falls Dam. Medium density beds account for 132.2 acres and sparse density beds account for 62.3 acres. No SAV beds were mapped within the bypass reach, and the Montague to Sunderland Bridge reach contained only medium and sparse beds of SAV (FirstLight, 2016).

Protected Species

Field surveys completed in 2014 and 2015, and based on coordination with the NHESP, identified eight of the ten plant species identified by the NHESP within the TFI, bypass reach, and downstream section to the Sunderland Bridge (Table 3.3.5.1-2). One additional species, great blue lobelia, was also identified. The bypass reach, which is dominated by exposed bedrock was the preferred location for all species identified during the survey work. Habitat within the bypass reach, which includes ledges, exposed bedrock, cobbles, and occasional sandy areas, is ideal for the majority of the species. In most cases mapped polygons includes dense populations ranging from a few to several thousand individuals. The bypass reach was the only location where great blue lobelia was identified (FirstLight, 2016). A location overview for all mapped species in shown in Figure 3.3.5.1-1.

A topographic survey was completed in 2015 to examine elevation preferences for occupied suitable habitat in relation to current water level fluctuations. In addition, suitable, unoccupied habitat was also surveyed. A total of 15 transects were surveyed for topographic elevation and species density. Transects were established within occupied and unoccupied habitat from Vernon Dam to Sunderland Bridge. During the survey, the lower limit of the transect was placed at or slightly below the WSEL at the time of the survey; in all cases the lower limit was below any observable terrestrial vegetation. The location of the survey transects are shown in figures included in Study Report No. 3.5.1 (FirstLight, 2016). All elevations in Section 3.3.5 are presented using the National Geodetic Vertical Datum of 1929 (NGVD29). Water surfaces for varying flows in the TFI and below the Turners Falls Dam to Sunderland Bridge were obtained from Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot* (FirstLight, 2016b).

Mountain Alder

The mountain alder is a shrub which may reach approximately 12 feet in height, similar to other alders. It has toothed leaves generally with 6-9 main veins. The range of the mountain alder extends from Canada south to northern New England, and in Massachusetts the species is primarily found on exposed ledges, boulders, and cobble bars. Often these habitats coincide with high energy rivers. The primary threat to this species is from disturbance of habitat as well as competition from exotic species such as Japanese knotweed. Within the Project area, mountain alder is primarily found within the bypass reach, a typical example of the habitat present in the bypass reach is shown in Figure 3.3.5.1-2. Eight polygons of mountain alder (Figure 3.3.5.1-1) were mapped within the bypass reach in 2014, these polygons included approximately 73 individuals. Two remaining populations of the species were mapped at the northern extent of the TFI, just below Vernon Dam. These populations were surveyed in 2015 to examine preferred elevations as well as to determine population density. In general, habitat for mountain alder in the upper TFI populations is similar to the bypass reach and consisted of exposed ledges, large cobbles, and bedrock. Associated species included speckled alder, smooth alder, dogbane, and scrub oak. Within the study area, mountain alder is primarily found within the bypass reach and just downstream of Vernon Dam (Transect 10 in the report for Study No. 3.5.1 is located just downstream of Vernon Dam). At Transect 10 mountain alder was identified growing at an elevation between 197.7 and 197.0 feet. Density for the population at Transect 10 was calculated as 0.007 individuals/ft^2 with one individual identified in a single plot. In addition, two plants were identified on a rocky outcrop near the transmission line upstream from Stebbins Island and were surveyed at elevation 191.4 feet and 191.7 feet. The minimum elevation observed for mountain alder at Transect 10 is 193.4 feet. Based on hydraulic modeling, all mountain alders identified on Transect 10 occur above the April median WSEL; the lowest mountain alder (193.4 feet) is 4.2 feet above the April median WSEL (189.2 feet) (FirstLight, 2016).

Intermediate Spike Sedge

The intermediate spike sedge is a small densely tufted annual herb with very wiry stems. The primary aid to identification of this species is to examine the achene, which is hard and nut-like. The achene for the intermediate spike sedge matures in mid to late summer and is three-sided with a narrow tubercle. Habitat for the intermediate spike sedge includes marshes and freshwater mudflats, or areas with muddy substrates. Potential threats to this species are unknown, and based on habitat preference the species is generally found in the proximity of freshwater (i.e., streams, rivers, and ponds). The NHESP has noted that regular water level fluctuations may benefit the species as it maintains the exposed muddy habitat preferred by the species (NHESP, 2009). The species was only identified in one location, the Pauchaug Boat Launch, in the Project area during survey work completed in 2014 and 2015 (Figure 3.3.5.1-1). Identification in the field was completed by NHESP approved botanist Steve Johnson (J. Leddick, personal communication, December 2, 2013). The species was first identified in 2014, in an area of exposed sand and mud (Figure 3.3.5.1-3). In 2015, the species was not located, but several transects (Transects 11A-11D, near Pauchaug Boat Launch, in the report for Study No. 3.5.1) were established at the location. In general, the entire shoreline ranges from elevation 187.72 to 187.87 feet. In 2014, the intermediate spike rush was located at the transition from exposed substrate to vegetation at the normal high-water line. Associated species include joe-pye weed, jewel weed, monkey flower, woolgrass, and, at higher elevations, spiny cocklebur (FirstLight, 2016). The area of suitable sedge habitat is primarily within the short transition area from silt to the vegetated shoreline. Based on hydraulic modeling, the elevation ranges of suitable habitat at Transects 11A-11D is 181.5 feet to 187.9 feet. The median WSEL varies only one to two hundredths during most of the growing season at the surveyed location. The largest change from month to month is the median WSEL for April (185.17 feet) to May (183.4 feet) which represents a change of 1.8 feet. The annual median WSEL (i.e., 50% exceedance) at the surveyed location is 182.7 feet. The April and May median WSEL is 185.2 and 183.4 feet, respectively (FirstLight, 2016).

Frank's Lovegrass

Frank's lovegrass, a state species of concern, is an annual herb with repeatedly branched, erect culms, narrow blades (5-13 cm long and 1-3 mm wide), and small, ovate spikelets that are typically 3-5 flowered. This grass typically flowers from August through September. Frank's lovegrass is found along sandy riverbanks and sand bars and has been found only along the Housatonic and Connecticut Rivers in Massachusetts (NHESP, 2015). No observations of Frank's love grass were recorded in 2014, however a single clump was identified next to the walking trail along the shoreline just south of the Pauchaug Boat Launch in 2015 (Figure 3.3.5.1-1).

Ovate Spike-sedge

The ovate spike-sedge is an annual grass that grows in low (2-6 inches) tufts. The straight, ascending stems are deep green and have a single, tight cluster of inconspicuous flowers (a "spike") at the apex. The stems do not have leaf blades but do have leaf sheaths surrounding the stem. The ovate spike-sedge is often found growing on sandy freshwater margins. This species was not observed during the 2014 survey; however, one clump was recorded on the sandy shore south of the Pauchaug Boat Launch in 2015 (Figure 3.3.5.1-1). Associated species include soft-stemmed spike-sedge, threeway sedge, buttonbush, soft rush, and common bur-reed (NHESP, 2015). Similar to the habitat described for the intermediate spike sedge, the area of suitable sedge habitat is primarily within the short transition area from silt to the vegetated shoreline. The elevation ranges of suitable habitat is 181.5 feet to 187.9 feet near the Pauchaug Boat Launch. At the surveyed location the largest change from month to month, based on hydraulic modeling, is the median WSEL for April (185.17 feet) to May (183.4 feet) which represents a change of 1.8 feet. The annual median WSEL (i.e., 50% exceedance) at the surveyed location is 182.7 feet. The April and May median WSEL is 185.2 and 183.4 feet, respectively (FirstLight, 2016a).

Great Blue Lobelia

The great blue lobelia is a tall, showy perennial wildflower that inhabits circumneutral wetlands and transitional habitats. The species generally prefers open areas or areas of partial shade. While this species is listed, the plant was formerly cultivated and continues to be popular in gardening, and therefore some populations are likely introduced. A single stem of this species was located within the bypass reach in 2014. The plant was located within the exposed rocky habitat common to the area. Associated plant species include American water-horehound, purple loosestrife, smartweed, New York aster, and Tradescant's aster (FirstLight, 2016a).

Upland White Aster

The upland white aster is a small composite plant that flowers from July into early September. The species prefers rocky outcrops of sandstone, shale, or limestone. It is commonly found growing in cracks or fissures in bedrock outcrops. The upland white aster requires significant sunlight exposure and shading may be a threat. In addition, as the species is often located along exposed river banks, water level and recreational activities may pose threats to the species. Within the Project area, a number of polygons of upland white aster were mapped in 2014 in the bypass reach (Figure 3.3.5.1-1). Based on stem counts within these polygons, in excess of 638 individual plants were located within this area. The bypass reach is ideal habitat which includes exposed areas of bedrock (Figure 3.3.5.1-4). In addition, several smaller populations were identified within the TFI. In 2015, elevation transects at locations in the TFI were surveyed (Transects 6A-6C in the report for Study No. 3.5.1). These locations included both occupied and unoccupied habitats. Population mean densities were estimated at 0.13 stems/ft² across each of five transects surveyed at two locations near French King Bridge (FirstLight, 2016a). Associated species include big bluestem, dogbane, flat-top white aster, monkey flower, and joe-pye weed. In all but one instance, at surveyed locations, upland white aster occurs above the April median WSEL (182.0 feet) and the annual median WSEL (181.7 feet) based on hydraulic modeling (FirstLight, 2016a).

Sandbar Cherry

The sandbar cherry is member of the rose family and is a low growing shrub that can form mats up to 6 feet in breadth. The species, in Massachusetts, rarely grows above three feet in height. The species prefers flood-scoured areas, often along islands and shores. Habitat is generally dominated by cobble, gravel, and sloping rock at or near the floodline. In 2014, approximately 1,400 individuals were identified within several mapped polygons in the bypass reach (Figure 3.3.5.1-1). The habitat within this area, as described above, is ideal for species which prefer regularly scoured habitat. Figure 3.3.5.1-5 shows a typical view of sandbar cherry within the bypass reach. In addition, the species was identified on several islands below the bypass reach as well as the upstream extent of the TFI, below Vernon Dam (Figure 3.3.5.1-1). These smaller island populations were surveyed in 2015, the survey included occupied and unoccupied suitable habitat. Mean density for two of the transect (Transect 3, south of the Deerfield confluence, and Transect 9 near Vernon Dam) locations was calculated as 0.12 stems/ft², these locations were associated with larger islands. Mean density for the northern most population (just below Vernon Dam) was calculated at 0.02 stems/ft². Associated species include mountain alder, dogbane, cottonwood, sycamore, sandbar willow, black willow, and big bluestem. Based on hydraulic modeling, nearly all of the sandbar cherry identified during elevation surveys occur above not only the annual median WSEL, but also the April median WSEL.

Sandbar Willow

The sandbar willow is a small shrub, ranging from 5-10 feet in height, which forms interconnected thickets. In Massachusetts, the willow is commonly found on islands, sandbars, and beaches within the flood zone. It prefers sandy, gravely, or rocky substrates which are subjected to annual inundation by high water. The plants are usually low and sprawling, and in the Connecticut River drainage stems are generally less than six feet in height. The primary threat to this species is a scarcity of habitat, which is related to shoreline development. The species prefers habitat which is tied closely to the annual flood regimes and disturbance from water level fluctuations. Survey work completed in 2014 identified the sandbar willow in several locations (Figure 3.3.5.1-1). The species occupies several areas within the bypass reach as well as on islands near Sunderland and to the north near the Vernon Dam. All these habitats share common characteristics in that all are dominated by cobble and rock and are within actively flooded habitats. Mean density varied by transect location, and ranged from 0.01 stems/ft² to 0.07 stems/ft². Across three transects which were established at First Island, Second Island, and near Vernon Dam (Transect 1, 2, and 10) mean density was 0.04 stems/ft². Figure 3.3.5.1-6 shows a representative view of the typical willow habitat on First Island (near the Sunderland Bridge). Associated species include dogbane, purple loosestrife, black willow, blue vervain, and big bluestem. The majority of sandbar willows occur above the July median flow (9,500 cfs) at both survey locations. The sandbar willow appears to prefer habitats closer to the annual median and often slightly higher or lower than the modeled WSEL. (FirstLight, 2016a).

Tradescant's Aster

The Tradescant's aster is a small, white-rayed aster that rarely grows more than one and a half feet in height. It is often found with a basal rosette of leaves and a cluster of erect stems. This aster is typically found rooted in fissures and cracks of rocky stream shores or river banks. These habitats are generally subjected to flooding throughout the year. The plant flowers late in the summer, when water levels are normally lower. Due to the dynamic nature of the Tradescant's preferred habitat, invasion by exotic species or damage from development are uncommon. The primary threats are modification of flood regimes that would allow the establishment of other species, and occasional invasive plant species such as spotted knapweed (*Centaurea maculata*) and purple loosestrife, which have been found in Tradscant's aster's habitat. Surveys completed in 2014 identified the aster as occurring throughout the bypass reach as well as a few discrete patches; one occurring on the rock face just downstream from the French King Bridge and a few near the confluence with the Deerfield River (Figure 3.3.5.1-1). Populations within the bypass, mapped in 2014, are quite robust and approximately 16,770 stems were counted during fieldwork (Figure 3.3.5.1-7). The smaller patches, located near the confluence with the Deerfield River, were surveyed in 2015.

Density of the Tradescant's aster at this location is calculated at 0.10 stems/ft². In all locations, the habitat was dominated by exposed bedrock, boulders, and large cobbles. Associated species include mountain alder, big bluestem, dogbane, purple loosestrife, and seedbox (FirstLight, 2016a). At the survey location (referred to as Transect 4, near the confluence with the Deerfield River, and in the Bypass reach in the report for Study No. 3.5.1) the Tradescant's aster occurs in the elevation range of 109.9 feet to 112.4 feet. Based on the April and May median flows at Transect 4, of 33,100 cfs and 17,900 cfs, respectively it is likely that the survey location for the Tradescant aster is inundated for the majority of the days in April, May, and much of June based on hydraulic modeling. The licensed minimum flow from the Turners Falls Project (1,433 cfs), would be lower than the September median flow (4,400 cfs) at Transect 4, and likely all of the Tradescant's asters will be exposed during low or minimum flow scenarios even with inflow from the Deerfield River and other tributaries (FirstLight, 2016a).

Vertebrate Species

Birds

Five state-listed RTE bird species were identified as potentially occurring within the Project area by NHESP. During field surveys completed along the Connecticut River and Northfield Mountain, two of the five species were identified as occurring within the Project area. Table 3.3.5.1-3 lists the potentially occurring species as well as those identified in the Project.

Bald Eagle

The enforcement of federal endangered species laws and regulations and improved controls of herbicides and pesticides on agricultural lands have aided in the recovery of this species. While the species was removed from endangered species status, the Bald Eagle is still protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. It winters along the Connecticut River in the Turners Falls Development and Northfield Mountain Pumped Storage Development area. In 2001, the USFWS documented a nesting pair of Bald Eagles on Barton Island in Barton Cove, approximately five miles downstream of the Northfield Mountain Pumped Storage Development (FERC, 2001) and slightly upstream of the Turners Falls Dam. Bald Eagles also nest on Kidd's Island in the TFI. Bald Eagles are known to perch in riverbank trees and forage over the Connecticut River in the Turners Falls Development and Northfield Mountain Pumped Storage Development vicinity. Several Bald Eagles, adults and juveniles, have been observed perching or foraging in the TFI and Northfield Mountain in both 2014 and 2015, and three occupied Bald Eagle nests were located within the study area. These nests were found downstream on Third Island, Barton Island in Barton Cove, and along the east bank of the TFI across from Stebbins Island in the upper reaches of the TFI (FirstLight, 2016a).

Peregrine Falcon

There are 14 known Peregrine Falcon historic cliff nesting sites in Massachusetts. Today, two known occupied nesting sites are located downstream of the Turners Falls Development and Northfield Mountain Pumped Storage Development area at Mount Tom and Mount Sugarloaf (NHESP, 2007). Females begin breeding at age two or three, whereas males may breed as early as age one. Females typically lay four eggs in early April. The eggs will incubate over 28 days; by seven weeks after hatching (in mid-June), the juvenile chicks have fledged. Fledglings are fully independent of their parents by August. Peregrine falcons do not typically migrate for the winter season, with the exception of those that nest in the far north (e.g., in Labrador or Greenland).

Peregrine Falcons are not known to nest at the Turners Falls Development and Northfield Mountain Pumped Storage Development, but are known to have nests down river of the Turners Falls Development and Northfield Mountain Pumped Storage Development at Mount Tom and Mount Sugarloaf and could potentially utilize the Turners Falls Development and Northfield Mountain Pumped Storage Development area for foraging. A Peregrine Falcon was observed on the south eastern slope of Northfield Mountain in 2014.

Shortnose Sturgeon

The Shortnose Sturgeon is a federally-listed endangered species that occurs in the Connecticut River and is discussed with other migratory fish species in Section 3.3.3.1.2.

Mammals

No special status mammals were identified during consultation with state and federal agencies. However, on April 2, 2015 the northern long-eared bat (*Myotis septentrionalis*) was listed as federally threatened, and the USFWS published an interim final rule under section 4(d) of the ESA to exempt certain activities from the incidental take prohibitions of the ESA. The listing and interim final rule became effective on May 4, 2015. The primary reason for the listing of this species is the dramatic population decline which has resulted from the spread of white-nose syndrome. The northern long-eared bat overwinters in caves or old mines with high humidity and stable temperatures. During the summer the bats will roost in large diameter trees, preferring those with exfoliating bark. Reproduction begins in late summer or fall, with delayed implantation resulting in pupping in the following spring. The Project area includes old growth hemlock, shagbark hickory, silver maple, and several other species which are large in diameter and possess bark characteristics which could provide potential summer roosting habitat for the northern long-eared bat. During the 2014 and 2015 field work, this species was not observed in the Project area. FirstLight's draft biological assessment, to be included in the amended FLA, will assess whether any proposal set forth in the amended FLA is likely to affect any listed species. At this time, FirstLight is not proposing any actions that will involve prohibited take described in the 4(d) rule.

Herptiles

Consultation with the NHESP in 2011 (MDFW, 2011) identified two state threatened and three special concern herptile species that may occur within the Project area (Table 3.3.5.1-4). While specific survey methodologies for herptiles were not included as part of studies completed in 2014 and 2015, special care was taken during habitat, vegetation, wetland, and vernal pool mapping activities to opportunistically search for species. Several vernal pools and wetlands were mapped during fieldwork completed in 2014 and additional vegetation survey work occurred in 2015; no rare reptile or amphibian species were observed. While the species were not observed, it is likely that they occur within the Project area as a number of ephemeral pools were mapped and identified, particularly in the vicinity of Northfield Mountain.

Invertebrate Species

NHESP initially identified several state-listed endangered and threatened species of invertebrates potentially found at the Northfield Mountain Pumped Storage Development and Turners Falls Development. Table 3.3.5.1-5 lists these species along with other state-listed invertebrates species found during studies in the Project area. In 2014 and 2015, detailed studies were completed to document and analyze potential impacts to both tiger beetle populations, dragonflies, and freshwater mussels.

Clubtail Dragonflies

Clubtail dragonflies are large members of the taxon Anisotera and the family Gomphidae. They are so named for their club shaped abdomen terminus. Clubtails are a semi-aquatic insect in which the juvenile nymph inhabits aquatic habitat in streams, rivers, lakes and ponds. Breeding generally occurs in the spring and summer months with females depositing the fertilized eggs into the water. Nymphs emerge from the water on exposed rocks, woody debris, and emergent vegetation in the spring and undergo a metamorphosis into the adult, flighted stage, a process called eclosion.

Qualitative and quantitative surveys were performed in 2014-2015 (Study No. 3.3.10 *Assess Operational Impacts on Emergency of State-Listed Odonates*) to characterize the assemblage structure and emergence/eclosure behavior of odonates in the Project area. In 2014, odonate larvae and exuviae were surveyed between the Turners Falls Dam and the Route 116 Bridge in Sunderland, and in the TFI near Barton Cove, to establish a qualitative baseline for the odonate assemblage in these areas (Phase 1). Biologists conducted qualitative surveys of odonate larvae and exuviae at four areas (5 sites) between the Turners Falls Dam and the Route 116 Bridge in Sunderland, and one area (3 sites) in the TFI near Barton Cove.

Surveys were conducted on June 2, 6, 9, and 20 (2014). Table 3.3.5.1-6 lists the genera and species collected at each site. *Epitheca princeps*, a species common in lentic habitats, was the most common species collected at Sites 1-3 which are located in the lowermost portion of the TFI (Barton Cove) and contain mostly lentic habitat with submerged and emergent vegetation. Sites 4-8 were located below Turners Falls Dam and were generally more lotic; dominant taxa in these samples included *Gomphus sp*. (mostly *G. vastus*), *Ophiogomphus* (mostly *O. rupinsulensis*), *N. yamaskenensis*, *Boyeria vinosa*, and *Macromia illinoiensis*. There was very little variation in the odonate assemblage among sites 4-8. Most of the target state-listed species for Sites 4-8 were in the genus *Gomphus*. Based on historic survey data, which were generally more complete for the TFI, several uncommon species likely occur in these areas but were undetected in 2014.

Habitat parameters were recorded at each site. The most common habitat feature of nearshore areas and streambanks was a muddy slope of varying steepness, with lesser and variable amounts of sand, gravel, or cobble. Upslope, this mud transitioned into the riparian zone that was typically vegetated with trees (especially silver maple), low terrestrial herbaceous vegetation, moss, and vines, and contained varying amounts of large woody debris and detritus. The odonate surveys were typically done during periods of low flow, therefore relatively large amounts of the muddy bank were exposed and the distance from the water line to the interface between aquatic and terrestrial habitat was relatively great.

Less common nearshore habitat types included aquatic emergent vegetation and rock. Aquatic emergent vegetation was prevalent only in the more lentic habitats of Barton Cove (Site 1) and on the other side of Campground Point (Site 3). Elsewhere, aquatic emergent vegetation was either absent, or existed as a very sparse fringe of species that can tolerate daily exposure. Submerged aquatic vegetation, especially *Vallisneria*, was common in some areas but typically only as a narrow band in deeper waters.

Bare rock, an emergence substrate for odonates, is uncommon in the Connecticut River between the Deerfield River confluence and Route 116 Bridge. There are some isolated ledge outcrops, and the bridge abutments and areas near bridges often contained higher amounts of "unnatural" rock. The most "natural" rock is located in the Turners Falls bypass reach.

The results of the 2014 survey were used to develop a field monitoring plan for Phase 2 of the relicensing study, which involved quantitative surveys and behavior observations that was conducted in 2015. Concurrence on the monitoring locations and for the field methods was reached during an April 28, 2015 meeting with NHESP.

In 2015, FirstLight conducted quantitative surveys at five sites in the Connecticut River; the sites are listed below and shown in Figure 3.3.5.1-8.

- Site 1: Eastern shore near the Route 116 Bridge (Sunderland)
- Site 2: Massachusetts Division of Fisheries and Wildlife conservation lands on the eastern shore upstream from the Sawmill River confluence (Montague)
- Site 3: Area from bike path bridge to Montague City Road, opposite the Deerfield River confluence (Montague)
- Site 4: Upstream and downstream from the Rock Dam in the bypass reach (Montague)
- Site 5: Barton Cove (Gill)

At each site, FirstLight established six transects that were oriented perpendicular to the river and spanned the continuum from the water's edge into the upland terrestrial vegetation. Within and among the five sites, transects were established to provide adequate representation of available habitat type (such as natural vegetation, gradually sloping mud/sand, and rock) and of varying bank slopes (i.e., steep versus shallow). Each transect was three meters wide, and extended upslope from the water's edge a minimum of 12 meters (longer in some cases).

Surveys for emerging larvae, exuviae, and tenerals were conducted at each transect approximately every two weeks beginning on May 27 and ending on September 2, 2015. Biologists looked for larvae exiting the water or crawling on land, and attempted to track and record the time it took for individuals to complete the eclosure process and fly away. For each exuvia and teneral, the vertical height above the water's surface, the distance from the water's edge, and its eclosure structure/substrate was recorded.

A total of 17 confirmed species were collected in 2014 and 2015 combined, including the state-listed *Gomphus abbreviatus, Gomphus vastus, Gomphus ventricosus, Neurocordulia yamaskanensis*, and *Stylurus amnicola (*see Table 3.3.5.1-6). A total of 622 individuals representing 16 species were collected during the 2015 quantitative sampling. Species found most frequently in the riverine environments of Sites 1 to 4 included *Gomphus vastus, Boyeria vinosa, Stylurus spiniceps, Ophiogomphus rupinsulensis, Neurocordulia yamaskanensis, Dromogomphus spinosus, Gomphus abbreviatus*, and *Macromia illinoiensis*. Site 5 (Barton Cove) was inhabited by several species more tolerant of lentic conditions, such as *Epitheca princeps, Perithemis tenera*, and Libellula sp.

For all species combined, larvae crawled an average vertical height of 5.0 ft from the water's surface, and an average distance of 12.4 ft from the edge of the water. There was considerable variation within and among species. Among the riverine species, crawl height was greatest for *Macromia illinoiensis, Gomphus abbreviatus, Gomphus vastus*, and *Neurocordulia yamaskanensis*; each of these species crawled an average height of near or above 7 ft. Riverine species that crawled the shortest height from the water's surface included *Stylurus amnicola* (3.2 ft), *Ophiogomphus rupinsulensis* (3.3 ft), and *Stylurus spiniceps* (4.5 ft). The more lentic species collected in Barton Cove crawled shorter heights from the water's surface than the riverine species.

Average horizontal crawl distance was usually between 10 and 15 ft for most species, with maximum distances often 3-4 times greater than the average. Shortest crawl distance was for *Perithemis tenera* (a lentic species that prefers to emerge on aquatic vegetation) and *Stylurus amnicola*. Considering crawl height and crawl distance together, the riverine species that tended to eclose closest to the water were *Stylurus amnicola* and *Ophiogomphus rupinsulensis*. In general, species eclosed on a wide variety of available surfaces.

Based on the data FirstLight collected in 2015, it took an average of 36 minutes for tenerals to completely shed the larval exoskeleton, and a similar amount of time for tenerals to complete transformation to adults and take flight. Nine individuals were tracked from the beginning of eclosure to flight; average time was 70 minutes, and ranged from 54 to 73 minutes with one outlier of 123 minutes. Of the species for which some emergence speed data were collected, three were state-listed, including *Gomphus vastus* (1), *Gomphus abbreviatus* (1), and *Stylurus amnicola* (3). Neither the data collected as part of this study, nor existing data (which is sparse) suggest that the emergence/eclosure speed varies widely among species.

Hourly variability in the WSEL and rates of change were computed at each site and used to compare with odonate emergence and eclosure behavior (i.e., crawl height, crawl distance, and crawl speed), as discussed in the Environmental Effects section of this application.

Freshwater Mussels

Turners Falls Impoundment and Bypass Reach

In 2011, a freshwater mussel survey was conducted in a 20-mile reach of the TFI, and a 3.5-mile reach from Turners Falls Dam to the confluence with the Deerfield River (2.7 of the 3.5 miles is in the bypass reach), as well as 2.1 miles of the power canal (FirstLight, 2012c). The objective of the survey was to assess the distribution, abundance and habitat of freshwater mussels. The TFI and bypass reach surveys were conducted during low flow in August and the power canal survey was conducted during the September canal drawdown. Five freshwater mussel species were found, including the Eastern Elliptio, Alewife Floater, Eastern Lampmussel, Eastern Floater, and Triangle Floater. The Eastern Elliptio was found at 96.2% of the 52 sites sampled and was 100 to 1,000 times more abundant than other species. Over 400 Alewife Floaters were found with the highest densities in the upstream end of the TFI. Of the few Eastern Lampmussel that were found, they were mostly found in the TFI and not in the bypass reach or power canal. A total of eight Eastern Floaters were found in the TFI and in the power canal. One Triangle Floater was found near the mouth of the Deerfield River. Mussels were found in a wide range of water depths, flow conditions, and substrate conditions.

Freshwater mussels are an important part of the benthic fauna in the TFI, bypass reach, and power canal. The Eastern Elliptio is the dominant species forming expansive beds along much of the TFI. The Alewife Floater was broadly distributed in the survey area but in low densities in the canal, bypass reach, and lower two-thirds of the TFI. The Eastern Lampmussel was found in limited numbers throughout the survey area. The Triangle Floater was listed as Special Concern in Massachusetts until 2012 when it was removed from the list. Triangle Floaters are numerous in many Connecticut River tributaries including the Ashuelot and Millers Rivers which flow into the TFI. No state listed or federally threatened or endangered mussel species were found during the survey.

Connecticut River from Deerfield River confluence downstream to Sunderland Bridge

FirstLight conducted a quantitative survey and habitat assessment of freshwater mussels in 2014 in the Connecticut River from Cabot Station downstream to the Route 116 Bridge in Sunderland (Study No. 3.3.16 *Habitat Assessment Surveys and Modeling of Suitable Habitat for State-Listed Mussels Species in the Connecticut River below Cabot*). The objectives of the survey were to delineate populations of state-listed mussels and suitable habitat; characterize the distribution, abundance, demographics, and habitat use of these populations; and to identify potential habitat for state-listed species based on their habitat preferences. The target species included Yellow Lampmussel, Eastern Pondmussel, Tidewater Mucket and Dwarf Wedgemussel (federally-listed).

In July and August 2014, biologists conducted semi-quantitative (i.e., timed qualitative) surveys and habitat measurements at 26 sites in the study area. No live target mussel species were found. One old relic Yellow Lampmussel shell was found near Second Island. Eastern Elliptio was the only live mussel species found during the survey. At most sites, thousands or even tens of thousands of Eastern Elliptio were observed, and they occupied a wide range of depth, flow, and substrate conditions.

The mussel community in the reach from Cabot Station to the Route 116 Bridge appears to be strongly dominated by Eastern Elliptio, as no live mussels of other species were found. Eastern Elliptio are common to abundant in a wide range of habitat types, and the presence of a relatively high proportion of juveniles (which are usually underrepresented in qualitative surveys) suggests recruitment success is high.

The presence of more than 30 Alewife Floater shells suggest that live Alewife Floater may also exist within this reach, but at very low population densities and possibly confined to small patches that were undetected in the 2014 survey. Only old relict shells of Yellow Lampmussel (1) and Eastern Lampmussel (2) were found, which is consistent with results of the few reports (NHESP data) in this reach in recent years. To our knowledge, live Eastern Lampmussel and Yellow Lampmussel have never been documented in this reach, nor have Tidewater Mucket or Eastern Pondmussel. Dwarf Wedgemussel were not found in 2014, and the most recent report of Dwarf Wedgemussel in this reach was from ~1978 (shell only).

Water depths were variable; some areas (near islands and point bars) were very shallow or dewatered during low flow conditions, but maximum depths at survey sites ranged from 6-25 feet. Water velocity was usually light to moderate (typically in the range of 0.1 to 0.3 m/s), and flow refugia were present at nearly all sites, even where moderate to strong velocities were prevalent. Substrate was characterized by co-dominance of sand, gravel, and cobble, and extensive sandbars were present. Silt, sand, aquatic vegetation, and organic material (detritus and coarse wood) were common closer to shorelines and in flow refugia.

Tiger Beetles

A November 1, 2013 meeting, which included representatives of the USFWS and the (NHESP, part of MADFW, included discussion related to methods used for evaluating rare plants and special status species. On November 8, 2013, FERC ordered that a modified RSP be submitted by January 13, 2014. This section describes the results of data collected as part of RSP, which included agency comments received on August 29, 2013.

Cobblestone Tiger Beetle

One historic area of suitable cobblestone tiger beetle habitat occurs on the east bank of the Connecticut River near the confluence with the Deerfield River. Suitable habitat was found along the cobble shoreline downstream of Cabot Station, between the Route 2 Bridge and the Montague Wastewater Treatment Plant. Figure 3.3.5.1-9 shows a representative view of the suitable habitat. Based on site visits conducted in 2014 by Chris Davis (NHESP approved expert), no tiger beetles were observed. The site was visited twice during the 2014 field season. A search for additional, suitable habitat, was completed by boat as Chris Davis and field technicians searched from Cabot Station to the Oxbow state boat launch in Holyoke, MA. No additional suitable habitat was identified within this reach.

Puritan Tiger Beetle

Puritan tiger beetles are known to be present at Rainbow Beach, and surveys completed in August of 2014 confirmed the presence of Puritan tiger beetles. Chris Davis holds a collectors permit from the USFWS, and on August 8, 2014, two adult male Puritan tiger beetles were identified (Figure 3.3.5.1-10). Larval habitat for the Puritan tiger beetle is generally 10-20% vegetative cover with the remaining areas un-vegetated. A representative view of available habitat at Rainbow Beach is shown in Figure 3.3.5.1-11. Larval habitat at Rainbow Beach occurs throughout the area. In 2013, and based on several years of mark and recapture data, the population of Puritan tiger beetles at Rainbow Beach was estimated at 21 individuals. Common tiger beetle populations at the same location are estimated at approximately 3-5 thousand individuals.

In 2014, a topographic survey was completed at Rainbow Beach and North Bank. Elevation data at these survey transects was collected with a Real Time Kinematic (RTK) survey unit. Twenty-four transects were established in beetle habitat at Rainbow Beach and four transects were established at North Bank (Figure 3.3.5.1-12). Transects extended from the edge of water to the upper limit of beetle habitat. Elevations within the beetle habitat ranged from 100.8 feet at the lower limit to 115.9 feet at the upper limit, at both Sites.

The elevation survey completed at Rainbow Beach and North Bank, completed in 2014, included the survey of four transects at North Bank and 24 transects at Rainbow Beach. The elevation data collected as part of the survey was used to analyze changes resulting from Project operations and potential effects on Puritan tiger beetles.

Based on the results of the elevation survey, Puritan tiger beetle habitat occurs on Rainbow Beach from the low elevation of 101.3 feet to the high elevation of 115.9 feet, although habitat located at higher elevations is more vegetated. Rainbow Beach is not uniform and elevations vary depending on location. The northern portion of the beach is generally dominated by a consistent slope. The central portion of the beach includes an area of more level topography which transitions to a steep bank near the start of the riparian vegetation Similar in aspect, the southern portion of the beach maintains a more consistent slope. The North Bank habitat, which does not support breeding populations of Puritan tiger beetles, is very steeply sloping and has little level beach habitat (FirstLight, 2016a).

3.3.5.2 Environmental Effects

Vascular Plants

The identified RTE plants within the study area are commonly associated with riparian areas, and several are adapted to frequently flooded locations. Eighteen (18) survey transects were established to investigate the location of occupied and unoccupied habitat and examine relationships with WSEL developed as part of Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot*[41]. The hydraulic models, operated on an hourly time step, were used to predict WSELs at the surveyed transects. The elevation surveys identified location and occurrence data for several botanical RTE species. Based on the survey results, mountain alder (*Alnus viridis ssp. crispa*) generally occurs within the TFI above the April median WSEL and outside the most commonly occurring daily change in WSEL. Within the bypass reach, the mountain alder was not inundated during the demonstration flow study, which was conducted as part of the instream flow study (Study No. 3.3.3). While it is possible that varying flows may result in wetting of mountain alders within the TFI and below, this species appears to prefer habitats that are generally drier and more removed from Project operations. In addition, upland white aster (*Oligoneuron album*) and sandbar cherry (*Prunus pumila var. depressa*), based on the transects surveyed, generally occur above the median April WSEL and in all cases the species occur above the May median and annual median WSEL. This includes transects throughout the study area. Based on the WSEL data developed from the hydraulic models, these species occur within available and suitable habitat at elevations closer to the higher, and less commonly observed fluctuation zones.

The two species most commonly observed below the April WSEL, as well as below or near the annual median WSEL, are the Tradescant's aster (*Symphyotrichum tradescantii*) and the sandbar willow (*Salix exigua ssp. Interior*). Both species are adapted to frequently flooded areas, and this is exemplified by the result of the survey data. Tradescant's aster, which of all the species appears to be the "wettest", is often found at the lowest elevations. In the bypass reach, the population of Tradescant's aster is estimated at several thousand, the largest population within the study area. Based on modeling within the bypass reach, the Tradescant's aster is often inundated. It is likely that maintaining the current flow regime within the bypass reach would not negatively impact species currently present. Higher minimum flows in the bypass would likely not have negative impacts, as long as flows are reduced to allow plant exposure during July (FirstLight, 2016a). Botanical RTE species within the Project do not appear to be affected significantly by Project operations. Investigated plants are thriving within habitats that support their growth. All species investigated prefer habitats within or near the high waterline and are adapted to frequent flooding.

Vertebrate Species

Given the nature and scope of Project operations, no adverse effects on terrestrial vertebrate species are anticipated. In the event that minimal tree removal may be necessary for maintenance activities, FirstLight would follow USFWS's published conservation measures to avoid effects to the northern long-eared bat, should measures be required following consultation with state and federal agencies. Protected birds are

[41] Two HEC-RAS hydraulic models were developed on an hourly time step to predict WSEL at various locations. The models included a) Turners Falls Impoundment for the period January 1, 2000 to September 30, 2015 and b) from the Montague United States Geological Survey Gage to Holyoke Dam for the period January 1, 2008 to September 30, 2015. PHABSIM was used to determine a stage discharge relationship at Transect T-3 in the bypass reach.

currently utilizing habitat within the Project area and will continue to do so, regardless of Project operation. Some minor impacts related to recreational activity on the TFI, such as temporary dispersal, may occur as a result of boating or hiking. While no rare herptile species were identified within the Project area, it is not expected (should they occur) that they would be negatively impacted by Project operations. Vernal pools identified within the Project are not hydraulically connected to the TFI or the Upper Reservoir. There is the potential for impact as a result of ground disturbing or recreational activities. These effects would be minor and are not likely to adversely affect these species.

Invertebrate Species

Clubtail Dragonflies

FirstLight deployed a water level/temperature logger to record data at 15-minute intervals from each quantitative survey site in order to accurately evaluate water levels, standardize field measurements, and describe temperature in relation to odonate emergence behavior. Temporary water level/temperature loggers were installed at each site for the duration of the quantitative surveys to supplement data from the permanent gages at the Turners Falls Dam and the USGS Montague City gage. The 2015 quantitative survey report assessed the potential impacts of water level fluctuations on odonates at five sites in the Project area. Results are summarized in Table 3.3.5.2-1 and discussed below.

Site 1: Near the Route 116 Bridge, the Connecticut River undergoes relatively low daily and hourly water level fluctuations. Over the entire data collection period, which includes flows exceeding the hydraulic capacity of the Turners Falls Development, the daily fluctuation in WSEL ranged from 0.1 to 4.8 ft (average daily = 2.2 ft). The maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.41 ft/hr) and the average hourly rate of change was 0.15 ft/hr.

Site 2: The Connecticut River near Third Island undergoes relatively low daily and hourly water level fluctuations compared to areas closer to Cabot Station. Over the entire data collection period, which includes flows exceeding the hydraulic capacity of the Turners Falls Development, the daily fluctuation in WSEL ranged from 0.0 to 4.8 ft (average daily = 2.4 ft). The maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.51 ft/hr) and the average hourly rate of change was 0.18 ft/hr.

Site 3: The Connecticut River near Poplar Street, which is not far downstream from Cabot Station and directly across the river from the Deerfield River confluence, undergoes relatively high daily and hourly water level fluctuations. Over the entire data collection period, which includes flows exceeding the hydraulic capacity of the Turners Falls Development, the daily fluctuation in WSEL ranged from 0.2 to 6.7 ft (average daily = 3.1 ft). The maximum hourly rate of change in WSEL each day rarely exceeded 2.0 ft/hr (average = 1.09 ft/hr) and the average hourly rate of change was 0.24 ft/hr.

Site 4: The Connecticut River in the bypass reach, which is where Rock Dam is located, experienced relatively high daily and hourly water level fluctuations during the study period in 2015 compared to other sites, more so downstream from Rock Dam than upstream of it. Special bypass flow releases were being provided from May, June and early July 2015 for other relicensing studies, which caused atypical water level fluctuations in the bypass reach during this period. Therefore, a low flow period in late July-August when minimum flows were in the bypass reach was also evaluated.

For the entire monitoring period, the average daily range of WSEL was 1.9 ft downstream from Rock Dam and 0.9 ft upstream. During the period July 25-August 22, 2015, when bypass flows were stable and Cabot Station was operating, the maximum hourly rate of change in WSEL below Rock Dam was 1.91 ft/hr (average daily max = 0.97 ft.hr) which is comparable to Site 3 WSEL data below Cabot Station for this period. In contrast, upstream of Rock Dam the maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.55 ft/hr), and the average hourly rate of change was 0.07 ft/hr. Above Rock Dam, water levels are typically stable in the absence of spillage at Turners Falls Dam. During a low flow period in late July-August when minimum flows were in the bypass reach, the average daily rate of change in WSEL above Rock Dam was 0.09 ft/hr.

Site 5: Barton Cove experiences relatively low hourly water level fluctuations compared to other sites. The average daily range of WSEL in Barton Cove was 2.5 ft, and over the entire data collection period ranged from 0.6 to 4.5 ft. The maximum hourly change in WSEL at Barton Cove never exceeded 1.0 ft/hr (average = 0.56 ft/hr) and the average hourly rate of change was 0.20 ft/hr.

The speed with which larvae ascend the riverbanks, find a spot to eclose, complete the eclosure process, and take flight is important for understanding potential effects of water level fluctuations. Once the eclosure process begins, the insect is highly susceptible to rising water levels, wind, waves, and predators. Species that select eclosure sites far enough or high enough from the water to avoid inundation will be most successful at escaping one source of mortality. If larvae select eclosure sites within the zone that may be inundated as water levels rise, then it would need to complete the process and fly away quickly enough to avoid inundation.

In terms of understanding potential effects of water level fluctuations, the concern is for those species and individuals that remain close to the water's edge, especially in areas of the river where daily and hourly water level fluctuations and rates of change are greatest. Water level fluctuations and rates of change, resulting from Project operations, may affect odonate emergence in areas of the Connecticut River closest to Cabot Station. State-listed odonate species documented in these areas include *Gomphus abbreviatus*, *Gomphus vastus*, *Neurocordulia yamaskanensis*, and *Stylurus amnicola*.

Although most other riverine odonate species did, on average, crawl far enough and high enough from the water to escape risks of fluctuating water levels, a small proportion of all species eclosed close enough that inundation during eclosure was a risk to some individuals. Our observations and other studies are generally in agreement that most emergence (across all odonate taxa) occurs from pre-dawn through early afternoon. Project operations can affect the timing and magnitude of water level fluctuations and the rate of water level change at each site. In 2015, total change and rates of change were generally highest for the bypass reach and below Cabot Station, and lowest for downstream reaches and Barton Cove.

Flows through Cabot Station affect WSEL both upstream (up to, but not above, Rock Dam) and downstream from Cabot Station, but these effects diminish with increasing distance downstream from Cabot Station. At Third Island, approximately five miles downstream from Cabot Station, neither the hourly/daily changes in WSEL or rates of change appeared to have a strong effect on odonate emergence. Release of water through Station No. 1 could affect odonate emergence in downstream areas of the bypass reach, but specific effects would depend on the timing (time of day or time of year) of such releases. Neither hourly/daily changes in WSEL or rate of change in Barton Cove appear to affect odonate emergence.

Freshwater Mussels

FirstLight is in the process of developing binary habitat suitability index (HSI) criteria for all state-listed mussel species documented in the 35-mile reach between Cabot Station and Dinosaur Footprints Reservation. Based on 2014 survey results and prior data, these species include Yellow Lampmussel, Tidewater Mucket, and Eastern Pondmussel.

Using the binary HSI criteria, FirstLight will determine if any binary HSI thresholds are not met under a range of modeled operating conditions. In general the approach includes using the HEC-RAS hydraulic model to simulate the range of operating conditions at Holyoke Dam (WSEL at the dam) and the Turners Falls Development (up to its hydraulic capacity) to determine how operations impact depth, velocity, shear stress, and relative shear stress at model transects near documented state-listed mussel beds. If threshold levels are not exceeded in any transects, then no further assessment of documented state and federally listed mussel beds is proposed. If threshold levels are exceeded, then a more detailed assessment is proposed.

Tiger Beetles

Searches in 2014 resulted in no cobblestone tiger beetles being identified within the study area. Survey data collected in 2014 was used in conjunction with hydraulic modeling developed from Study No. 3.2.2 to examine the potential impact of WSEL fluctuations on the Puritan tiger beetle. One potential impact to the beetles are changes in WSEL, which may cause adult dispersal or flood larval burrows.

The effects of Holyoke Gas and Electric's (HG&E) run-of-river operation (plus or minus 0.2 feet as measured by at the Holyoke Dam) as specified under the new license issued in 1999 were evaluated by HG&E, the resource agencies, and stakeholders. These evaluations determined that while the new operating regime resulted in generally stable WSELs in the lower portion of the Holyoke impoundment, it produced some greater fluctuations in the upper portion of the impoundment, including near Rainbow Beach, and greater flow fluctuations downstream of Holyoke Dam. As a result, HG&E, has been operating its project since 2006 under a modified run-of river operations with WSELs at the Holyoke Dam between 99.47 and 100.67 feet. At flows above about 11,000 cfs, the hydraulic model (from the Montague USGS Gage to Holyoke Dam) as well as analyses conducted by HG&E, indicate that the constriction at "The Narrows" (about 3-miles upstream of the Holyoke Dam) decreases the sensitivity of the downstream boundary condition on the resulting WSELs in the rest of the Holyoke impoundment. For example, a stage versus discharge graph based on modeled output for 2012 in the Rainbow Beach area showed less than a 0.5 feet of difference between the low and high boundary conditions at the Holyoke Dam when flows are over 11,000 cfs (FirstLight 2016).

Based on the hydraulic model, the range of WSEL fluctuations over the course of the growing season (a period of record of May 21 to May 29 and June 9 to September 30 for a total of 123 days) at Rainbow Beach and North Bank are approximately 7.0 feet. Measured 15 minute interval WSELs from 2012 at Rainbow Beach were used to estimate effects of FirstLight's variation of discharges from Cabot Station and Station No.1 (a maximum generation capacity of 15,938 cfs) on the water level at Rainbow Beach. However, in this analysis data was not used from days (May 1 to May 20 and May 30 to June 8, 2012) when the average daily flow at the Montague USGS Gage was above 18,000 cfs during the period when Puritan tiger beetle are most active (May 1 to September 30). The flow of 18,000 cfs was determined as a reasonable boundary for flow at Montague USGS gage under peak generation at Cabot Station and Station No.1, flows from the Deerfield River, and flows from tributaries between the Montague Gage and Holyoke Dam. During this period (May to September), the maximum daily change in the inflow to the Holyoke Impoundment, as measured at the Montague USGS Gage, ranged from below 1,000 cfs on 9 days, 67 days (55%) between 6,000 and 13,000 cfs, and there were no days in excess of a daily change of 14,000 cfs. The resulting daily WSEL fluctuations at Rainbow Beach indicate that 79% of the days (97 days) had daily fluctuation of less than 0.9 feet (FirstLight, 2016b).

The WSEL of 103.5 feet represents the WSEL that is closely related to the existing edge of terrestrial vegetation. Elevation 103.5 feet at Rainbow Beach coincides with the edge of vegetation at Transect 5 and 9. Importantly, at all locations, the majority of the beach habitat is exposed at the median WSEL of 101.0 feet. In addition, the most commonly occurring (79% of the time) WSEL fluctuation (between 102.0 and 100.5 feet) is below the majority of existing habitat. During periods of WSEL at 103.5 feet, much of the beach habitat is inundated (FirstLight, 2016b). It should be noted that WSELs at and above 103.5 feet are the result of naturally occurring high flows above the hydraulic capacity of the Turners Falls Development.

Based on the results it is possible that changing WSEL may disperse Puritan tiger beetles individuals or impact habitat primarily within the lower portion of the habitat. Based on reviewing the 15-minute water level logger WSEL data located near Rainbow Beach from May 1 to August 20, 2012, the range of fluctuation most commonly observed at Rainbow Beach is at the lower elevation range of the available habitat. In addition, impacts from recreation at Rainbow Beach are likely to affect both adult and larval beetles. Boat wakes may temporarily and rapidly disperse individuals along the water line and foot traffic from recreators may result in mortality or dispersal. Rapid changes in WSEL is most likely to occur near the central portion of the beach where available beetle habitat is more level in topography and therefore more susceptible to changes in WSEL. At higher elevations, dense vegetation growth is limiting the available larval habitat.

3.3.5.3 Cumulative Effects

Northfield Mountain Pumped Storage Development operations, under FirstLight's proposed action, would continue to alter water levels on an intra-daily time step in the TFI. Modification of the water levels within the TFI and below Cabot Station do not appear to be significantly affecting botanical RTE species as a result of current Project operations. Investigated plants are thriving within habitats that support their growth. All species investigated prefer habitats within or near the high waterline and the investigated species are adapted to frequent flooding. Water level alterations may impact the species not accustomed to varying water levels, and may result in benefits to rare plant species by precluding competing vegetation. Current water level fluctuation may result in cumulative effects on the distribution of rare beetle species within the Project area. Downstream of the Turners Falls Development at Rainbow Beach, flow fluctuations from FirstLight, and effects of the water level fluctuations at the Holyoke Dam, will continue to influence WSELs that may affect Puritan tiger beetle habitat. In addition, water level management and recreation may result in a loss of potential Puritan tiger beetle habitat.

The northern long eared bat roosts in trees during the summer. The species may experience a cumulative loss of potential roosting sites through tree clear resulting from residential or commercial activities within the vicinity as well as from removal of trees which may be required to maintain portions of the Project area.

3.3.5.4 Proposed Environmental Measures

There are no proposed environmental measures at this time. Consultation with state and federal agencies will ensure that no prohibited take of the northern long eared bat occurs as a result of vegetation management activities. In addition, as set forth in Section 3.3.7, FirstLight will continue to make land management decisions that are consistent with existing land use categories and to be protective of sensitive resources. In addition, as set forth in Section 3.3.7, the Licensee has developed land use designations, which will be used by the Licensee via GIS mapping (including a privileged sensitive resources overlay map) to aid in land management activities, including vegetation management.

3.3.5.5 Unavoidable Adverse Impacts

As noted above, there are a number of ongoing studies related to aquatic resources. These studies will further assess whether there are unavoidable adverse effects to aquatic resources, including threatened and endangered aquatic resources. No unavoidable adverse impacts to terrestrial threatened and endangered resources would occur because FirstLight is proposing to continue to manage its lands to be protective of sensitive resources.

Table 3.3.5.1-1: Identified Submerged Vegetation within the Turners Falls Impoundment

Common Name	Scientific Name
clasping leaf pondweed	*Potamogeton perfoliatus*
coontail	*Ceratophyllum demersum*
curly-leaved pondweed	*Potomageton crispus**
Eurasian milfoil	*Myriophyllum spicatum**
fanwort	*Cabomba caroliniana**
large-leaf pondweed	*Potamogeton amplifolius*
milfoil	*Myriophylum Sppspp.*
muskgrass	*Chara ssp.*
pondweed	*Potamogeton Sspspp.*
variable leaf milfoil	*Myriophylum heterophyllum**
water chestnut	*Trapa natans**
waterweed	*Elodea nuttallii*
wild celery (Eelgrass)	*Vallisneria americana*

*Invasive Species

Table 3.3.5.1-2: Massachusetts Listed Vascular Plants Identified Within the Project Area

Common Name	Scientifc Name	State (MA) Status	Preferred Habitat
Frank's lovegrass	*Eragrostis frankii*	Special Concern	Open Sandy Margins
great blue lobelia	*Lobelia siphilitca*	Endangered	Circumneutral wetlands and transitional areas.
intermediate spike-sedge	*Eleocharis intermedia*	Threatened	Open Sandy Margins
mountain alder	*Alnus viridis ssp. crispa*	Threatened	Exposed ledges/ Boulders/ Cobble Bars
ovate spike-sedge	*Eleocharis ovata*	Endangered	Open Sandy Margins
sandbar cherry	*Prunus pumila var. depressa*	Threatened	Flooded Scoured Areas of Islands, Shores, & Peninsulas
sandbar willow	*Salix exigua ssp. interior*	Threatened	Island Sandbars, and Sandy Beaches
Tradescant's aster	*Symphyotrichum tradescantii*	Threatened	Rooted Fissures & Cracks of Rocky Streams
upland white aster	*Oligoneuron album*	Endangered	Open Rocky Habitat

Table 3.3.5.1-3: Special Status Bird Species That May Occur or Have Been Observed Within the Project Area

Common Name	Scientific Name	State Status	TF	NM
American Bittern	*Botaurus lentiginosus*	E		
Bald Eagle [1]	*Haliaeetus leucocephalus*	T	X	X
Grasshopper Sparrow	*Ammodramus savannarum*	T		
Peregrine Falcon	*Falco peregrines*	E		X
Vesper Sparrow	*Pooecetes gramineus*	T		

[1] No longer listed as federally Endangered, but still maintains federal protection under the Bald and Golden Eagle Protection Act.

Table 3.3.5.1-4: Herptile Species Identified by the NHESP That May Occur Within the Project Area

Common Name	Scientific Name	State Status[1]
eastern box turtle	*Terrapene Carolina*	SC
eastern spadefoot	*Scaphiopus holbrookii*	T
Jefferson salamander	*Ambystoma jeffersonianum*	SC
marbled salamander	*Ambystoma opacum*	T
wood turtle	*Glyptemys insculpta*	SC

[1]SC= Special Concern, T = Threatened

Table 3.3.5.1-5: Special Status Invertebrate Species Identified by the NHESP That May Occur Within the Project Area

Common Name	Scientific Name	State Status[1]	Federal Status[1]
Cobblestone Tiger Beetle	*Cicindela marginipennis*	E	-
Dwarf Wedgemussel	*Alasmidonta heterodon*	E	E
Midland Clubtail	*Gomphus fraternus*	E	-
Orange Sallow Moth	*Pyrrhia aurantiago*	SC	-
Puritan Tiger Beetle	*Cicindela puritana*	E	T
Rapids Clubtail	*Gomphus quadricolor*	E	-
Riverine Clubtail	*Stylurus amnicola*	E	-
Spine-crowned Clubtail	*Gomphus abbreviatus*	SC	-
Yellow Lampmussel	*Lampsilis cariosa*	E	-

[1]SC= Special Concern, T = Threatened, E= Endangered

Table 3.3.5.1-6: List of Odonate Species Collected in the Project Area during Phase 1 (2014) Qualitative Surveys and Phase 2 (2015) Quantitative Surveys

Species	Abbreviation	Status	2014 Phase 1 Survey Site								2015 Phase 2 Survey Site				
			1	2	3	4	5	6	7	8	1	2	3	4	5
Arigomphus furcifer	ArFu			X											
Basiaeschna janata	BaJa														X
Boyeria vinosa	BoVi		X			X	X	X	X	X	X	X	X	X	
Cordulegaster maculata	CoMa													X	
Dromogomphus spinosus	DrSp										X	X	X	X	X
Epitheca princeps	EpPr		X	X	X	X	X							X	X
Gomphus abbreviatus	GoAb	Special Concern				X	X	X	X	X	X	X		X	
Gomphus vastus	GoVa	Special Concern				X	X	X	X	X	X	X	X	X	
Gomphus ventricosus	GoVe	Threatened					X								
Hagenius brevistylus	HaBr										X	X	X		
Libellula sp.	Lisp														X
Libellulinae (unidentified)	Li														X
Macromia illinoiensis	MaIl		X	X	X	X	X	X	X	X	X	X	X	X	X
Neurocordulia yamaskanensis	NeYa	Special Concern	X	X	X	X	X	X	X	X	X	X	X	X	X
Ophiogomphus rupinsulensis	OpRu					X	X	X	X	X	X	X			
Perithemis tenera	PeTe					X	X	X	X	X					X
Stylurus amnicola	StAm	Endangered									X	X	X		
Stylurus spiniceps	StSp					X					X	X	X	X	

Phase 1 surveys sites are listed below. Also see Study Report 3.3.10 for maps and additional descriptions of Phase 1 survey sites:

Sites 1 – 3: Barton Cove

Site 4: Bypass Reach above and below Rock Dam

Site 5: Downstream from Railroad Bridge

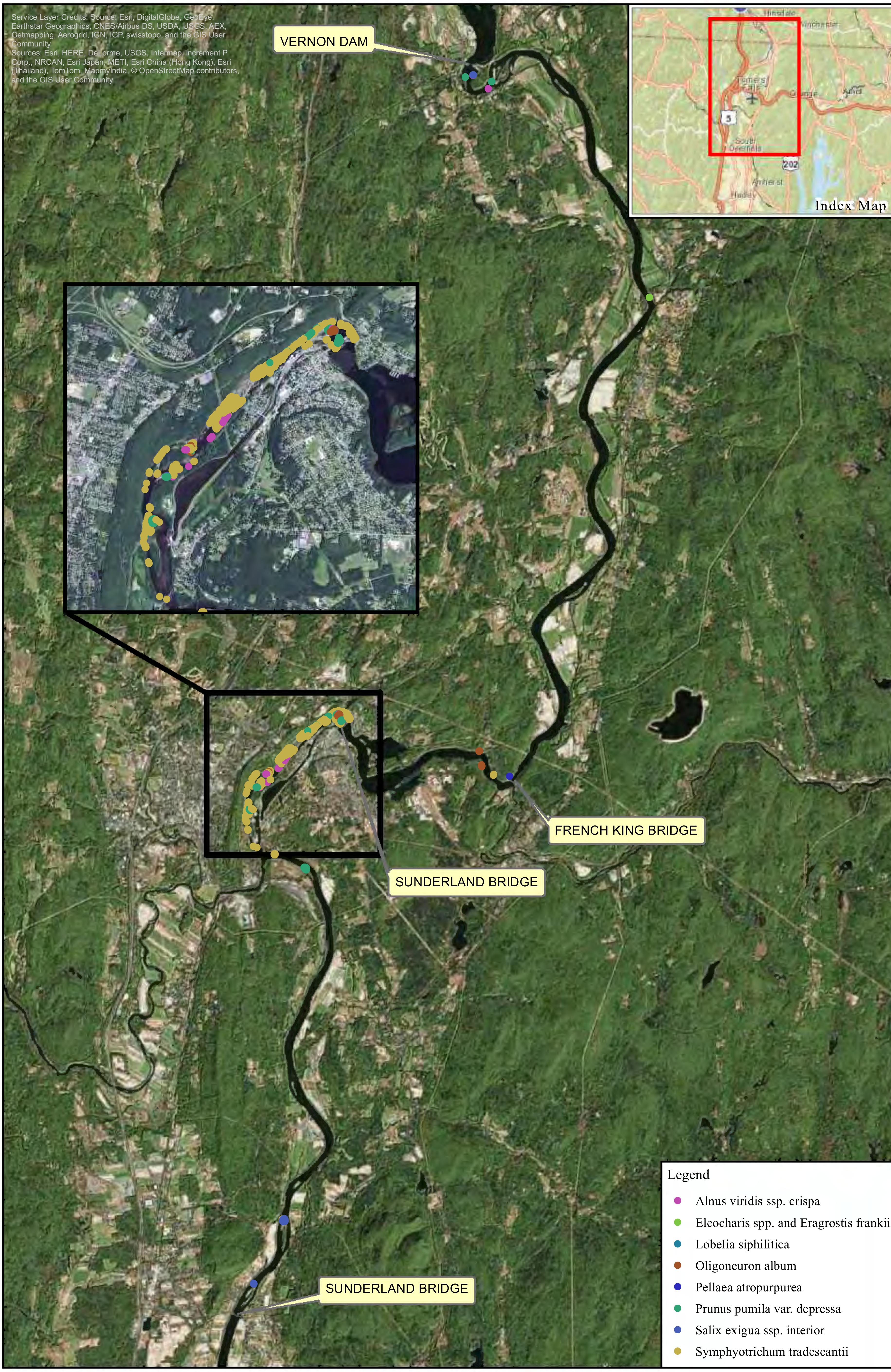
Site 6: Between Railroad Bridge and Third Island

Site 7: Upstream from Third Island

Site 8: Route 116 Bridge, Boat Ramp

Table 3.3.5.2-1: Summary Statistics for Water Surface Elevations (WSEL), Average Hourly Rates of Change in WSEL, and Maximum Hourly Rates of Change in WSEL, May 15-September 15, 2015

Statistic	Location					
	Barton Cove	Above Rock Dam	Below Rock Dam	Montague Gage	Third Island	Route 116 Bridge
Daily Water Level						
Mean	181.8	118.0	112.5	109.6	106.9	105.2
StDev	1.00	2.43	2.12	3.00	2.58	2.53
Minimum	178.2	115.4	110.7	105.4	103.4	101.8
25th Percentile	181.1	115.6	110.9	107.0	104.7	103.1
Median	181.8	118.0	111.9	109.3	106.4	104.7
75th Percentile	182.5	120.3	113.3	111.5	108.4	106.7
Maximum	184.1	123.9	120.8	118.4	114.9	112.8
Range	5.9	8.5	10.1	13.0	11.4	11.0
Average Hourly Rate of Change Each Day (ft/hr)						
Mean	0.20	0.07	0.15	0.24	0.18	0.15
StDev	0.06	0.09	0.10	0.11	0.09	0.07
Minimum	0.05	0.00	0.00	0.02	0.01	0.01
25th Percentile	0.16	0.01	0.09	0.17	0.13	0.11
Median	0.19	0.02	0.15	0.24	0.17	0.15
75th Percentile	0.24	0.11	0.20	0.30	0.24	0.19
Maximum	0.33	0.59	0.47	0.51	0.47	0.33
Maximum Hourly Rate of Change Each Day (ft/hr)						
Mean	0.56	0.55	0.99	1.09	0.51	0.41
StDev	0.13	0.82	0.51	0.45	0.20	0.18
Lowest Max	0.20	0.02	0.01	0.08	0.04	0.03
25th Percentile	0.47	0.03	0.72	0.81	0.40	0.32
Median	0.56	0.09	1.00	1.11	0.51	0.38
75th Percentile	0.65	0.85	1.32	1.37	0.64	0.48
Highest Max	0.83	4.27	2.54	2.58	1.12	1.15



FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Draft License Application
Exhibit E

0 0.75 1.5 3 Miles

N

Figure 3.3.5.1-1
Location of Identified
Rare Plants

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Figure 3.3.5.1-2: Typical Habitat Found Within the Bypass Reach, Below Turners Falls Dam.

Figure 3.3.5.1-3: View of Typical Shoreline Habitat Near the Pauchaug Boat Launch.

Figure 3.3.5.1-4: Upland White Aster Identified Within the Bypass Reach in 2014.

Figure 3.3.5.1-5: Typical Sandbar Cherry Located Within the Bypass Reach in 2014.

Figure 3.3.5.1-6: View of Typical Habitat for the Sandbar Willow at First Island, near Sunderland Bridge.

Figure 3.3.5.1-7: Typical Tradescant's Aster Habitat Identified Within the Bypass Reach in 2014

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N

0 150 300 600 Feet

Figure 3.3.5.1-8:
2015 Quantitative Odonate Survey Sites
Site 1: Eastern shore near the Route 116 Bridge (Sunderland)

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Figure 3.3.5.1-8:
2015 Quantitative Odonate Survey Sites
Site 2: Massachusetts Division of Fisheries and Wildlife conservation lands on the eastern shore upstream from the Sawmill River confluence (Montague)

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0 150 300 600 Feet

Figure 3.3.5.1-8:
2015 Quantitative Odonate Survey Sites
Site 3: Area from bike path bridge to Montague City Road, opposite the Deerfield River confluence (Montague)

Path: W:\gis\maps\Exhibit_E\figure_3_3_5_1_8.mxd

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Exhibit E

0 300 600 1,200 Feet

Figure 3.3.5.1-8:
2015 Quantitative Odonate Survey Sites
Site 4: Upstream and downstream from the Rock Dam in the bypass reach (Montague)

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Exhibit E

0 300 600 1,200 Feet

Figure 3.3.5.1-8:
2015 Quantitative Odonate Survey Sites
Site 5: Barton Cove (Gill)

Path: W:\gis\maps\Exhibit_E\figure_3_3_5_1_8.mxd

Figure 3.3.5.1-9: Suitable Cobblestone Tiger Beetle Habitat Located Downstream of Cabot Station.

Figure 3.3.5.1-10: Adult male, Puritan Tiger Beetle Identified at Rainbow Beach in 2014.

Figure 3.3.5.1-11: Typical Puritan Tiger Beetle Habitat Observed in 2014 at Rainbow Beach.

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Figure 3.3.5.1-12:
Tiger Beetle Elevation Transects

Path: W:\gis\maps\Exhibit_E\figure_3_3_5_1-12.mxd

3.3.6 Recreation Resources

3.3.6.1 Affected Environment

3.3.6.1.1 Regional Recreation

The Northfield Project is situated on the Connecticut River, within the states of Massachusetts (MA), New Hampshire (NH), and Vermont (VT). The majority of the Project lands are located within the county of Franklin, Massachusetts, specifically in the towns of Erving, Gill, Greenfield, Montague, and Northfield. Northern sections of the TFI reach into the towns of Vernon, Vermont and Hinsdale, New Hampshire. Turners Falls Dam is located at RM 122 of the Connecticut River, (above the Long Island Sound) in the towns of Gill and Montague, MA. The TFI is approximately 20 miles long, with 5.7 miles located within the states of NH and VT.

Recreation sites and facilities in the vicinity of the Northfield Mountain Pumped Storage Development include hiking trails, fishing access, picnic areas, camping, wildlife management areas, boat launches, hunting, observation areas, and bike trails. There are recreation sites in near proximity to the Project that provide hiking and nature observation opportunities, as well as numerous state lands for hiking, hunting and enjoyment of the outdoors. Some of the nearby recreation sites include the King Philip's Hill Trail, Brush Mountain Conservation Area, Stacy Mountain Preserve and the Erving State Forest. The Connecticut River Greenway State Park in Massachusetts is a linear state park paralleling the river for the 69 mile portion that flows through the state and connects key recreational areas including boat launches and other public lands. The park includes over 12 miles of permanently protected shoreline. The Connecticut River is also a National Blueway; and although the program was dissolved in 2014, the Connecticut River has retained its designation.

There are several other FERC licensed hydroelectric projects located near the Northfield Project that also provide a variety of recreation opportunities for the public. These Projects include the Holyoke Project (FERC No. 2004), approximately 35 miles downstream of the TFI and the Vernon Project (FERC No. 1904), located on the Connecticut River main stem, immediately upstream of the TFI. In addition, the nearby Deerfield Project (FERC No. 2323) is located approximately 2.9 miles downstream of the Turners Falls Dam on the Deerfield River. Recreation resources and opportunities in the general vicinity of the Project are discussed in more detail in FirstLight's PAD (FirstLight, 2012d), and in several of the recreation studies conducted by the Licensee, including Study No. 3.6.1 Recreation *Use/User Contact Survey* (FirstLight, 2015b), Study No. 3.6.*2 Recreation Facilities Inventory and Assessment Report* (FirstLight, 2014b), 3.6.3 *Whitewater Boating Evaluation* (FirstLight, 2015d), 3.6.4 *Assessment of Day Use and Overnight Facilities Associated with Non-motorized Boating* (FirstLight, 2015e), and 3.6.7 *Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use* (FirstLight, 2015f).[42]

In addition to recreation sites and facilities in the vicinity of the Project, there are also whitewater boating opportunities in the region including several reaches of the Deerfield River, the Ashuelot River, the West River, and the Millers River. Some of these opportunities are subject to natural flows while others are supported by scheduled whitewater releases. Whitewater boating opportunities in the Northfield Project region are discussed in detail in Study Report 3.6.3 *Whitewater Boating Evaluation* (FirstLight, 2015d).

Recreation facilities that provide access to the Project or are immediately adjacent to the Project were inventoried as part of Study 3.6.2 *Recreation Facilities Inventory and Assessment Report* (FirstLight, 2014b) and Addendum, (FirstLight, 2015c). Existing recreation sites and trails at the Northfield Project are

[42] The study reports for these studies can be found on the Northfield Project relicensing website at www. northfieldrelicensing.com. The report for Study No. 3.6.1 was filed with FERC as part of a USR on March 1, 2016. The report for Study No. 3.6.2 was filed with FERC as part of the ISR on September 15, 2014 and an addendum to the report was filed with FERC on June 15, 2015. The reports for Study Nos. 3.6.3, 3.6.4, and 3.6.7 were filed with FERC as part of a USR on September 14, 2015.

identified on Figure 3.3.6.1.1-1. The current licenses for the Northfield Mountain Pumped Storage Project and Turners Falls Project require FirstLight to operate and maintain certain public recreation facilities at the two projects. These sites are included in the Projects' respective Recreation Plans (Exhibit R) and are therefore considered Project Recreation Sites. In addition to these Project Recreation Sites, there are a number of other public recreation sites located in the immediate vicinity of the Projects, many of which provide access to Project lands and waters. Some of these sites are formal recreation sites that FERC has previously approved as non-project use of Project lands. Some of the sites are informal areas where no improvements have been made, and no facilities exist, but where the public is provided access to Project lands and waters and are using that access for recreational purposes. Such areas are common at hydropower projects and often include such activities as informal access paths for shoreline fishing, footpaths to the water's edge for carry-in boat launching, or local swimming holes accessed via footpath, bridge or roadway. The more significant of these informal access areas located within the Project boundary were inventoried as part of Study 3.6.2 *Recreation Facilities Inventory and Assessment* (FirstLight, 2014b).

There are also private recreation facilities at the Project. Private recreation facilities such as boat docks, piers, picnic areas, or campsites. Some private facilities are located within the Project boundary, and may be on property owned by FirstLight, and have been approved as "non-project use of project lands" as allowed under the standard land-use articles in the existing FERC licenses. There are a number of such approved facilities and uses on the TFI, mostly associated with residences or camps located along the shoreline of the TFI, some of which are on leased FirstLight lands. There are also a small number of private clubs or organizations that also maintain approved recreation facilities on the TFI. There are no commercially operated recreation facilities at the Northfield Project.

3.3.6.1.2 Project Recreation Sites

Table 3.3.6.1.2-1 lists the Commission approved Project recreation sites for the Northfield Project. Below is a summary of the Commission approved Project sites. Additional information can be found in the Study 3.6.2 *Recreation Facilities Inventory and Assessment Report* (FirstLight, 2014b) and Addendum (2015c).

Bennett Meadow Wildlife Management Area (WMA). Bennett Meadow WMA is located on the western shore of the Connecticut River, south of the Route 10 Bridge in Northfield, MA. The site is owned by FirstLight and is managed primarily by the MADFW for wildlife management. A portion of the lands within the WMA is managed for agricultural purposes. While there are no developed recreation facilities, existing agricultural roads provide access for walking and hiking, as well as hunting.

Munn's Ferry Boat Camping Recreation Area (Munn's Ferry). Munn's Ferry is located on the east side of the Connecticut River in Northfield, MA. This site is owned and managed by FirstLight. This site provides four tent campsites with platforms and a single lean-to site, all complete with trash can, picnic table, fire ring, and grill. Pit toilets are available at the site. A dock and bank fishing opportunities are also available at the site.

Boat Tour and Riverview Picnic Area. The Boat Tour and Riverview Picnic Area is accessed by Pine Meadow Road in Northfield, MA. This site is owned and managed by FirstLight and provides a picnic area and riverboat tours. Amenities include picnic tables, a pavilion that can be rented for events, as well as restroom facilities that are ADA compliant. There are two parking areas with a total of approximately 54 parking spaces with two ADA signed spaces. Riverboat tours are conducted on the Quinnetukut II. The Quinnetukut II provides a 12-mile sightseeing trip, guided by an on-board interpreter, through the French King Gorge and Barton Cove portions of the TFI.

Northfield Mountain Tour and Trail Center (NMTTC). Northfield Mountain Tour and Trail Center is located off Rt. 63 in Northfield, MA. FirstLight owns and manages this site. Amenities include an ADA accessible Visitor Center with public restrooms, picnic tables, grills, a fire ring, and interpretive displays. There are approximately 25 miles of trails (Northfield Mountain Trail System) accessible from the NMTTC Visitor Center that can be used for hiking, biking, horseback riding, snowshoeing, cross-country skiing, and other non-motorized multi-use activities. The site has a parking area with approximately 50 parking spaces and three ADA parking spaces.

Barton Cove Nature Area and Campground. This campground is located north of the Turners Falls Dam in Barton Cove, on Barton Cove Road in Gill, MA. The Nature Area and Campground are owned and managed by FirstLight. The campground has two group campsites, two trailer sites, and 27 tent sites, one of which is considered ADA accessible. Each campsite has a picnic table, fire ring, and garbage can, while the group sites have a grill and additional picnic tables. The Nature Area and Campground has a set of flush toilets, two showers, along with vault and portable restrooms.

Barton Cove Canoe and Kayak Rental Area. The Barton Cove Canoe and Kayak Rental Area is located on the northern shore of the Connecticut River, off of Route 2 in Gill, MA. This rental area is owned and managed by FirstLight and offers paddling and picnicking. Site amenities include a natural gravel carry-in canoe/kayak launch, picnic tables, and a portable toilet. There is also the option for a paddlecraft rental, which includes a PFD and a paddle or oar. The parking area holds approximately 28 vehicles.

Gatehouse Fishway Viewing Area. The Gatehouse Fishway Viewing Area is located on the north side of 1st Street across from the town operated Unity Park in Montague, MA. The viewing area is owned and managed by FirstLight. The site consists of a visitor center which provides the public an opportunity to view fish when the Gatehouse fishway is operating. The first floor of the visitor center is ADA accessible with a closed-circuit TV feed from the viewing window to a TV monitor that allows for ease of access for those with limited mobility. There are interpretive panels that provide information about anadromous fish, along with bathrooms, and benches on the outside of the facility. The site also contains the picnic area on the north site of 1st Street with picnic tables, grills, a bike rack, and parking for approximately 29 vehicles.

Turners Falls Branch Canal Area. The Turners Falls Branch Canal Area is located off of Power Street in Montague, MA, This site is owned and managed by FirstLight. The site provides fishing access and has benches for anglers to use while fishing.

Cabot Woods Fishing Access. Cabot Woods Fishing Access is located on Migratory Way in Montague, MA. This site is owned and managed by FirstLight and is open to day use activities. Amenities at this site include picnic tables, parking areas, and informal angler access trails. The two (2) parking areas provide approximately 17 parking spaces and two (2) ADA parking spaces. The first parking area is located outside of a gate at the northerly terminus of Migratory Way where it joins G Street. The second lot is located roadside along Migratory Way, inside of the gate.

Turners Falls Canoe Portage. The Turners Falls canoe portage operation provides boaters with a means of circumventing the Turners Falls Dam. Boaters wishing to proceed downriver of Barton Cove call FirstLight for vehicular portage. They are then picked up and driven downstream of the Turners Falls Dam to the Poplar Street Access site in Montague, where they can continue their trip. (The Poplar Street Access is outside of the Project boundary.) Signs explaining the canoe portage operation procedures and providing the portage request call-in number are located at the following recreation sites: Munn's Ferry Boat Camping Recreation Area, Boat Tour and Riverview Picnic Area, Barton Cove Nature Area and Campground, Barton Cove Canoe and Kayak Rental Area, and at the Poplar Street Access site. Instructions are to paddle to the Barton Cove Canoe and Kayak Rental Area, unload gear, and then call (413) 659-3761 to request a pick up. Typically a vehicle for the portage will arrive within 15 to 90 minutes of the telephone call. Barton Cove Canoe and Kayak Rental Area has a phone that boaters can use from Memorial Day through Labor Day. During the off-season, boaters need to use their own phones to make the portage request.

3.3.6.1.3 Other Formal Recreation Sites

Other formal recreation sites that provide access to the Project are summarized below. Most of these sites are fully or partially within the Project boundary, although one site is fully outside the Project boundary. Additional information regarding the recreation sites can be found in the Study No. 3.6.2 *Recreation Facilities Inventory and Assessment Report* (FirstLight, 2014b) and Addendum (2015c).

Governor Hunt Boat Launch and Picnic Area. This site is located immediately downstream of the Vernon Hydroelectric Project (Project No. 1904) dam and is owned and managed by the Licensee of that project. While this recreation site is within the Vernon Project boundary, a portion of the site along the shoreline, which includes the boat launch is also located within the Northfield Project boundary.

Fort Hill Rail Trail. The Fort Hill Rail Trail is a multiple use trail, located in Hinsdale, New Hampshire. The trail is nine miles long and travels from Route 63 along the Connecticut River to the old bridge on Route 119. A small portion (approximately 190 feet) of the trail crosses through the Northfield Project boundary, over the Ashuelot River. The trail is owned and maintained by the State of New Hampshire.

Pauchaug Wildlife Management Area (WMA). The Pauchaug WMA is located on the eastern side of the Connecticut River in Northfield, Massachusetts. This WMA is owned and managed by MADFW. The site is open for hunting and is also used for walking/hiking, bird-watching, and bank fishing. The site is located within the Northfield Project boundary. There are no formal amenities within the WMA.

Pauchaug Boat Launch. This site is owned and managed by the MADFW as part of the Pauchaug WMA. The boat launch is located on state owned property on the eastern shore of the Connecticut River, upstream of the Schell Bridge in Northfield, Massachusetts. Facilities at this site include a hard surface boat launch with two launching lanes, parking, informational signage, and portable sanitation (seasonal). This site lies within the Northfield Project boundary.

Northfield Connector Bikeway. The Northfield Connector Bikeway is an 11-mile shared roadway route connecting the Canalside Trail Bike Path (also known as the Canalside Rail Trail) with the Town of Northfield. There is a spur off the main route to the Northfield Mountain Trail System. The route travels along the shoulders of existing roads from the East Mineral Road Bridge along Dorsey Road, River Road, Pine Meadows Road, Ferry Road, and finally onto Route 63, in Northfield, Massachusetts. The bikeway is part of the public roadway and signage is maintained by the Franklin Regional Council of Governments. Approximately 4,580 feet of the 11-mile trail passes through the Northfield Project boundary near the NMTTC Visitor Center.

Cabot Camp Access Area. This area is located within the Northfield Project boundary at the end of Mineral Road in Montague, Massachusetts. The site is owned and managed by FirstLight and is open to the public for shoreline access and bank fishing. A parking area which provides parking for approximately 15 vehicles is available at the site.

State Boat Launch. This launch is located upstream of the Turners Falls Dam. A portion of this site is within the Northfield Project boundary, off of Route 2 in Gill, Massachusetts. A portion of this site is owned by FirstLight, and a portion is owned by the Commonwealth of Massachusetts. The boat launch site is managed by the Commonwealth of Massachusetts, and is open to the public free of charge. The site offers boat launching, and bank fishing opportunities. There is a hard surface boat ramp with two launching lanes, a dock and portable sanitation facility (seasonal) at the site.

Canalside Trail Bike Path. This hard surface trail begins within the Gatehouse Fishway Viewing Area and ends at McClelland Farm Road in northeast Deerfield, Massachusetts. The trail is 3.27 miles long, with approximately 1.5 miles within the Northfield Project boundary. The trail runs along the Turners Falls Power Canal in Montague, Massachusetts and along the Connecticut River. The trail property is owned by FirstLight and is leased to and managed by the Massachusetts Department of Environmental Management (now the Massachusetts Department of Conservation and Recreation).

Poplar Street Access Site. The Poplar Street Access site is located outside the Northfield Project boundary, downstream of Cabot Station, on Poplar Street in Montague, Massachusetts. This site is owned by FirstLight and is utilized for carry-in boat access, fishing and as the downstream put-in location for the Canoe Portage. A parking area that can hold approximately 16 vehicles, a FERC Part 8 sign, and a trash can are available at the site.

3.3.6.1.4 Informal Recreation and Access Areas

Informal areas within the Project provide various recreation opportunities. Informal fishing access, whitewater boating access, climbing areas, and camp sites make up a majority of these opportunities. These areas have been created through repeated use by the public and have not been improved by the Licensee or other authorized entities.

Ashuelot River Informal Campsite. The informal campsite is located just downstream of the confluence of the Ashuelot River with the Connecticut River on the east side of the Connecticut River. The site is located on private property and FirstLight maintains flowage rights over the property. The area appears to be used for camping and picnicking.

Schell Bridge Informal Fishing and Swimming Access. The Schell Bridge informal fishing and swimming access is located on the western shore of the Connecticut River just south of the Pauchaug Boat Launch in Northfield, MA. This site is located partially within the Northfield Project boundary on private property and FirstLight holds flowage rights to the property. The area appears to be used for fishing and swimming.

Informal Multi-Use Access. This informal multi-use access area is located on the western shore of the Connecticut River, in Northfield, MA, upstream of the Route 10 Bridge. The access area is located on property owned by FirstLight within the Northfield Project boundary. It appears that this access area is used as an informal fishing access and campsite.

Informal Munn's Ferry Fishing Access. This informal access area is partially located within the Project boundary on the west side of the river in Gill, MA across from the Munn’s Ferry Boat Camping Recreation Area. The access area is located on private property and FirstLight has flowage rights for the property. The area appears to be utilized for informal fishing access.

Turners Falls Station No. 1 Fishing Access. Station No. 1 is located in Montague, MA. The area is owned by FirstLight and is used as an informal fishing access. There is a parking lot associated with Station No. 1, which is maintained by FirstLight.

Turners Falls Dam Downstream Put-in. This informal area is located within the Northfield Project boundary immediately downstream of the Turners Falls Fishway on river left. The area is owned by FirstLight and appears to be used informally for angling and launching of carry-in boats.

Rose Ledge Climbing Area. This area is an informal climbing area located within the Northfield Project boundary on land owned by FirstLight. The area consists of a 40’- 60’ cliff line that is used for rock-climbing. There are no formal amenities associated with the Rose Ledge Climbing area. Access to the area is via an informal foot path stemming from the NMTTC Trail System’s Lower Ledge Trail. Climbers may park at the parking lot located at the NMTTC. Additional parking for the climbing area is located outside of the Project boundary on private property.

Farley Ledge Climbing Area. This informal climbing area is located partially within the Northfield Project boundary. A loop trail encompasses the climbing ledges associated with Farley Ledge and provides access to the crags. The Western Massachusetts Climbing Coalition (WMCC) owns property that provides parking and access to the loop trail. The total area encompassed by the trail along with the property that provides access to the site is approximately 51 acres. Approximately 46% of this land is located within the Northfield Project boundary. Farley Ledge is part of a larger chain of ledges (Farley Ledges) utilized for rock-climbing. There are no formal amenities associated with this area within the Project boundary. There are three (3) parking areas associated with the climbing area, which are located on private property outside the Project boundary.

3.3.6.1.5 Use at Formal Recreation Sites

FirstLight conducted an in-depth study from January 2014 to December 2014 to assess the type and level of use at formal recreation sites in the Northfield Project (Study No. 3.6.1 *Recreation Use/User Contact Survey*, FirstLight, 2015e). Data collection objectives included the determination of the amount of recreation use and demand at Project recreation sites and user opinions with regard to existing recreation sites and perceived adequacy of recreation facilities. The data regarding the type and amount of use was obtained using spot counts, calibration counts, traffic counters, and when applicable, FirstLight registration data. Using these methods, the study was able to determine the type and amount of use at sites based in recreation days, a recreation day being defined by FERC as each visit by a person to a development for recreational purposes during any portion of a 24-hour period. Data regarding user opinions were obtained through the recreation user survey, the residential abutters' survey, and the Northfield Mountain trail user survey. Spot counts, calibration counts, the recreation user survey, and the Northfield Mountain trail user survey were conducted at parking locations associated with the formal recreation sites.

Based on data collected between January 2014 and December 2014, the total annual recreation use of surveyed recreation sites at the Northfield Project in 2014 was estimated to be 152,769 recreation days. Table 3.3.6.1.5-1 provides a breakdown of estimated use by season. As shown, approximately half of the recreation use occurred during the summer with 50% of recreation days. Recreation use was lowest in winter (10%) with moderate use in spring (16%) and fall (23%).[43]

Table 3.3.6.1.5-2 shows a breakdown of recreation use by activity type per recreation site surveyed. As shown, recreationists participated in a wide variety of activities at the Northfield Project. Project-wide, walking, hiking, and jogging was found to be the most popular recreation activity at the Northfield Project with 29% of recreation days. Motor boating was the second most popular activity (12%), followed by fishing (7%), bike riding (6%), picnicking (5%), climbing (4%), non-motorized boating (4%), cross-country skiing (3%), fishway viewing (3%), and camping (2%).[44] Hunting, ice fishing, ice skating, riding horses, sightseeing and birding received 1% or less of recreation days.

In addition to determining the type and amount of use at each of the surveyed recreation sites, the degree to which each recreation site had the capacity to sustain the recreation activity occurring at a site was estimated. Table 3.3.6.1.5-3 provides a breakdown of percent capacity utilized for each site. Percent capacity was determined by the available amount of parking at each site versus the average number of parking spaces that were occupied during surveys during summer weekends.

Governor Hunt Boat Launch: Annual recreation use at the boat launch was 1,812 recreation days in 2014. The portion of the site within the Northfield Project boundary was estimated to be utilized at 50% of capacity. Motor boating (53%) was the most popular recreation use at the boat launch followed by non-motor boating (15% of the use) and fishing (12% of the use).

Pauchaug WMA: There were a total 1,005 recreation days spent at the WMA. The site was estimated to be utilized at 1% of capacity. Forty-four percent (44%) of the recreation use at the WMA was for hunting followed by walking, hiking and jogging at 32% of use.

Pauchaug Boat Launch: Annual recreation use at the boat launch was 9,630 recreation days. The site is utilized at 20% of capacity. Motor boating accounted for 49% of the recreation use at this site, followed by fishing at 12% of the use, and non-motorized boating at 10% of the use.

Bennett Meadow WMA: There were a total 3,729 recreation days spent at the WMA. The site was utilized at 10% capacity. Walking, hiking and jogging accounted for 41% of the use. Hunting was also a popular activity at this site, particularly during the fall, accounting for 25% of the use.

Munn's Ferry Boat Camping Recreation Area: Annual recreation use at the camping area was 1,716 recreation days. The site is utilized at 40% capacity. Motor boating and camping were the most popular uses of this area and accounted for 39% and 30%, respectively.

Boat Tour and Riverview Picnic Area: Annual recreation use at the area was 13,651 recreation days. The site was utilized at 10% capacity. On an annual basis, 20% of the use was for riverboat trips on the

[43] Figures shown do not total to 100% because of rounding.
[44] Bike riding includes both biking on hardened surfaces and mountain biking.

Quinnetukut II (2,733 riverboat trips). During the period that the Quinnetukut II was operating (June 28 through October 19), it accounted for 43% of use at the site. Other popular recreation activities included walking, hiking, and jogging at 29% of use, followed by picnicking at 18%. Based on data maintained by FirstLight, use of the Quinnetukut II has declined since the 1980's (FirstLight, 2015d).

Northfield Mountain Tour and Trail Center (NMTTC): The total number of recreation days at the NMTTC during 2014 was 20,024. This included use of the Visitor Center, registered programs, and trail use. Trail use was the most popular recreation activity at the NMTTC, which includes hiking, biking, horseback riding, snowshoeing and cross-country skiing. The NMTTC is utilized at 10% capacity.[45] The NMTTC is discussed in more detail in section 3.3.6.1.11.

Cabot Camp Access Area: Annual recreation use at the area was 5,326 recreation days. The site was utilized at 15% capacity. The most popular recreational activities were fishing (26% of the use at the site) and walking, hiking, and jogging (19% of the use).

Barton Cove Nature Area and Campground: The total number of recreation days at the nature area was 7,842, while the campground had a total of 2,963 recreation days. The most popular recreation activities at the nature area were walking, hiking, and jogging and fishing. Camping was the most popular recreation activity at the campground. Based on parking area usage levels, the Nature Area was utilized at 20%. Utilization of the campground was based on campsite use, and was estimated to be utilized at 40%.

Barton Cove Canoe and Kayak Rental Area: Annual recreation use during 2014 at the rental area was 4,455 recreation days. The area was utilized at 25% capacity. Sixty percent (60%) of the use at the site was by individuals who were participating in non-motorized boating. Twelve percent (12%) of the use was picnicking.

State Boat Launch: The total number of recreation days during 2014 at the boat launch was 15,126. While the launch was utilized at 65% on average during summer weekends, there were times when the site was used above 100% capacity, such as fishing tournaments. Boating (motorized at 74% of use and non-motorized boating at 11%) is the most popular recreation activity at this site.

Gatehouse Fishway Viewing Area: Annual recreation use during 2014 at the fishway viewing area was 27,345 recreation days. This includes individuals touring the fishway and utilizing the picnic area along the river. The visitor center associated with the fishway was utilized at 90% capacity. The parking lot serving the Gatehouse Fishway Viewing Area, which includes the picnic area was at 25% capacity. Based on existing use records maintained by FirstLight since the 1980s, visits to the fishway have declined. Walking, hiking, and jogging (36% of use) and fishway viewing (19% of use) were the most popular activities at the site.

Turners Falls Branch Canal Area: The total number of recreation days spent at this area and Station No. 1, combined, in 2014 was 1,264. Parking for this area is available at Station No. 1. Percent capacity utilization at Station No. 1 was 1%. The area was primarily utilized for walking, hiking, and jogging (26% of use), fishing (21% of use), bike riding (21% of use), and cross-country skiing (14% of use).

Cabot Woods Fishing Access: There were a total of 18,230 recreation days spent at the fishing access during 2014. The site was utilized at 25% capacity. The most popular recreation activities included walking, hiking, and jogging (53% of use), fishing (11% of use) and bike riding at 10% of use. There are two parking areas associated with the fishing access, as well as 3,100 feet of Migratory Way, which links the two parking areas. This helps to account for the primary use of the access being attributable to walking, hiking, and jogging and bike riding.

[45] This is based on parking lot capacity.

Turners Falls Canoe Portage: FirstLight provided a total of nine vehicle portages around the Turners Falls Dam between May 17th, 2014 and September 3rd, 2014. Of these, three vehicle portages were related to camp groups totaling 39 boaters. The remaining six vehicle portages totaled 14 boaters.

Poplar Street Access Site: Annual recreation use during 2014 at this access area was 1,877 recreation days. The site was utilized at 10% capacity for fishing (41% of use), walking, hiking, and jogging (23%), and non-motorized boating (21%).

Of the formal recreation sites for which percent capacity utilization was calculated, only two sites were used at greater than 30% capacity – the State Boat Launch, which was utilized at 65% capacity on summer weekends and the Gatehouse Fishway Viewing Area building, which during the short viewing season had the heaviest utilization at 90%. Six of the formal recreation sites were utilized at 10% of capacity or less. Observed capacity utilization was lowest at Pauchaug WMA (1%) and Turners Falls Branch Canal/Station No. 1 (1%). The other WMA, Bennett Meadows (10%), also has a low level of utilization.

Project-wide, the formal recreation sites have sufficient capacity to meet recreational demands, with several of the sites having significant excess capacity.

3.3.6.1.6 Use of Informal Recreation Areas

Use of the informal recreation areas was estimated based on field observations of compaction, litter and other indicators noted during site visits, as well as spot counts and calibration counts made at Station No. 1 Fishing Access, Rose Ledge parking area, and at Farley Ledge's Wells Street and Route 2 parking lots.[46] It appeared that the majority of the informal recreation areas received low to moderate use with a few exceptions.

Ashuelot River Informal Campsite. This site is located on private property and appears to receive moderate use based on physical improvements and compaction at the site.

Schell Bridge Informal Fishing and Swimming Access. This area appears to see moderate use based on the amount of compaction along the shoreline. Individuals appear to use this area for informal fishing access and swimming.

Informal Multi-Use Access. This informal multi-use access area appears to have been used for informal fishing access and camping. This use appears to vary from moderate to minimal use. Site indicators were compaction and erosion.

Informal Munn's Ferry Fishing Access. This area appears to be utilized for informal fishing access, however this use appears to be minimal based on site indicators such as compaction and vegetation.

Station No. 1 Fishing Access. This area appears to see minimal use based on parking area information that was collected during 2014. The area is used as an informal fishing access.

Turners Falls Dam Downstream Put-in. This area appears to receive minimal use with some individuals participating in kayaking or bank fishing. There was no compaction noted, however the area does appear to receive some unauthorized improvements such as an informal fire ring and graffiti.

Rose Ledge Climbing Area: While the climbing area itself was not surveyed for use, the parking area, which is located on private property outside of the Project boundary, was utilized at 60% capacity.

Farley Ledge Climbing Area: This climbing area appears to receive moderate to heavy use based on compaction and anecdotal information. There are three parking areas associated with Farley Ledge Climbing Area, which are located on lands owned by others outside of the Project boundary. The Route 2

[46] Turners Falls Station No. 1 Fishing Access is utilized for parking by recreationists utilizing the Turners Falls Branch Canal Area and is discussed in section 3.3.6.1.5.

parking area was frequently used and saw utilization of 60% capacity during 2014.[47] The Wells St. parking area saw utilization of 30% capacity during 2014.

3.3.6.1.7 Recreationist's Opinions of Project Recreational Opportunities

As part of Study 3.6.1 *Recreation Use/User Contact Survey*, recreationists were asked their opinions regarding the recreational opportunities offered in connection with the Project. Based on the results of the survey of recreationists, visitors traveled an average of 23 miles to utilize recreation sites within the Northfield Project. The majority (69%) of the recreationists were from 10 or fewer miles away, while 2% of the people traveled 100 or more miles. Respondents agreed that the overall quality of the Project recreational opportunities was excellent (41%), fair to excellent (44%), or fair (12%). Two percent (2%) of respondents considered the overall quality to be less than fair.[48]

Surveyed visitors were asked to rate their perception of the level of use at the Project on a scale of 1 ("not crowded") to 5 ("extremely crowded"). Recreationists perceived the amount of use at Project recreation sites to be "not crowded" (39%), "somewhat crowded" (21%), and between "not crowded" and "somewhat crowded" (19%). Only six (6) percent perceived the use at the Project sites to be "extremely crowded."

The majority of recreationists (93%) responded that they were satisfied (37%), moderately satisfied (43%), or extremely satisfied (13%) with water levels in the river when asked: Overall, how satisfied were you with the river water level during your trip?

Recreationists were also asked about their levels of satisfaction with the number of facilities at the Project. Ninety-six percent (96%) of recreationists surveyed were satisfied (3), moderately satisfied (4), or extremely satisfied (5) with the number of recreation facilities at the Project. Extremely satisfied (36% of responses) was the most frequently given rating for the number of recreation facilities available. Thirty-one percent (31%) reported being moderately satisfied (4), with 29% being satisfied.

Visitors were asked their opinions of the Project with respect to several recreation attributes and conditions. Parking received very positive responses. Eighty percent (80%) of respondents rated the parking as excellent (46%) or between fair and excellent (35%), while fourteen percent (14%) rated the parking as fair. Facility conditions also received very positive responses, with 42% rating the facility conditions as excellent (the most common response), 40% rating the facility conditions as between fair and excellent, and 14% rating the conditions as fair. Regarding the variety of amenities, 88% rated the existing variety of amenities as fair or better. Only 12% of respondents felt that the variety was poor or between poor and fair. With respect to river access, survey respondents had positive perceptions, with 43% of respondents rating the access to be excellent (the most common response), 36% between fair and excellent, and 14% fair. Restrooms were the one area in which visitors had more mixed responses, with 50% rating the restrooms as fair or better and the remaining 50% rating the restrooms as poor or between poor and fair.

3.3.6.1.8 Residential Abutters' Opinions of Project Recreational Opportunities

As part of Study 3.6.1 *Recreation Use/User Contact Survey*, a mail survey of the 211 residential landowners abutting the Northfield Project boundary and within the Northfield Project boundary was conducted. While some of these properties directly abut the Connecticut River, there are residences that do not. The residential abutters' survey intended to capture recreation users at the Project who access through private lands, as opposed to through the formal recreation sites at the Project. Of the 211 surveys mailed to residential landowners, 95 surveys (or 45%) were completed and returned. The majority of the residential abutters who responded to the survey were year round residents. The residential abutters were asked: Overall, how satisfied were you with the river water level during your trip? Forty-three percent (43%) responded that they were satisfied, moderately satisfied, or extremely satisfied with water levels in the river; 19% indicated

[47] The Route 2 and Wells Street parking areas were surveyed to capture individuals utilizing Farley Ledges. Climbers utilizing the Overflow parking would likely utilize the Route 2 area for access.
[48] Percentages shown do not sum to 100% due to rounding.

that they were slightly satisfied, while the remaining 39% gave water levels a rating of 1, indicating that they were "not satisfied at all".

Fifty-eight percent of the 95 respondents stated that they access the Connecticut River from their property for recreation purposes. When asked if they ever use the recreation sites associated with the Project, 42 (47%) of the 89 respondents answering the question stated yes. The majority of the respondents (81 of 89) stated that they utilized the Connecticut River or amenities at Northfield Mountain for recreation purposes. Of these respondents, the majority (60%) use the Connecticut River or amenities at Northfield Mountain for recreation purposes approximately 1-25 days per year. Respondents utilized a variety of recreation sites within the Northfield Project boundary including: Barton Cove Nature Area and Campground, the NMTTC, the Gatehouse Fishway Viewing Area, Boat Tour and Riverview Picnic Area, the State Boat Launch, and the bike paths. The most popular recreation activities reported by the residents include walking and nature observation, in all four seasons.

3.3.6.1.9 Recreation Use of the Bypass Reach for Whitewater Boating

The bypass reach of the Connecticut River begins at the Turners Falls Dam and extends downstream 2.7 miles to Cabot Station. The bypass reach is created by the power canal, which parallels the river on the east side, and is used to divert river flows to Cabot Station and Station No. 1. Flows in the bypass reach vary depending on time of year, operational needs and constraints, tributary inflows, and weather events. Flows range from leakage to extremely high flows when the river flow exceeds the hydraulic capacity of the power canal (approximately 18,000 cfs). Under current operation of the Turners Falls Development, the availability of flow in the bypass reach is dependent on river flows, which are largely determined by hydrologic conditions in the basin and discharge from the upstream hydropower projects on the river.

Under the current FERC license, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow, whichever is less below the Turners Falls Development. This is typically maintained through discharges at Cabot Station (located at the downstream terminus of the power canal) and/or Station No. 1 which is located approximately 0.9 miles down the bypass reach. The FERC license also requires a continuous minimum flow of 200 cfs in the bypass reach starting on May 1, and increasing to 400 cfs when fish passage starts. This flow is provided through July 15 unless the upstream fish passage season has concluded early, in which case the 400 cfs flow is reduced to 120 cfs to protect Shortnose Sturgeon. The 120 cfs continuous minimum flow is maintained in the bypassed reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15th.

The 2.7 mile bypass reach from the Turners Falls Dam to Cabot Station exhibits variable boating characteristics that include whitewater features interspersed with longer stretches of flat water or riffles, depending on the flow. The first approximately 2,500 feet of the bypass reach are characterized by a series of rock ledges and outcroppings, which create a whitewater play area under a range of flows. Downstream the reach is characterized by a series of riffles and some flat water just before the Station No. 1 powerhouse, located about 4,000 feet downstream of the Turners Falls Dam. Below Station No. 1 is an area of riffles and small rapids, interspersed with flat water. Approximately 4,000 feet downstream of Station No. 1 is Rawson Island. There are boatable channels on both sides of the island, although the larger left channel contains a feature consisting of a natural bedrock vertical drop in the river gradient known as Rock Dam. The right channel contains a series of riffles and rapids. The remainder of the bypass reach is a mixture of flat water and riffle areas. The bypass reach is accessible to whitewater boaters from three locations: the informal put-in area downstream of Turners Falls Dam, Station No. 1 Fishing Access, and Cabot Woods Fishing Access.

To evaluate the potential of the bypass reach to support whitewater boating, the Licensee conducted a controlled release whitewater boating study (FirstLight, 2015d).

The study was designed to provide information on the boating conditions at various flows in the bypassed reach. A total of six flows (2,500, 3,500, 5,000, 8,000, 10,000 and 13,000 cfs) were evaluated over a three-day period in the summer of 2014. Participants paddled a variety of watercraft including kayaks, closed canoes, open canoes, rafts and a stand-up paddleboard. During the study, boaters utilized the International Scale of River Difficulty to rate whitewater in the bypassed reach under each of the flows. Boaters rated the bypassed reach Class I to Class IV, depending on the type of boat, the level of flow, and the features of the bypassed reach. For most evaluation flows, the Class IV rating was assigned to a single feature, Rock Dam. The reach was found to be boatable at all six evaluation flows i.e., between 2,500 cfs and 13,000 cfs.

When Connecticut River flows exceed about 18,000 cfs, the excess flow is likely to be spilled into the bypassed reach at the Turners Falls Dam, under normal Project operations. Bypass flows above 2,500 cfs naturally occur during the spring but may also occur occasionally during the summer and fall. Based on a review of the hydrologic record (Table 3.3.6.1.9-1), flows in excess of 2,500 cfs typically occur in the bypass an estimated 43 days between April and November, under the existing normal operation of the Project. The study evaluation flows of 2,500 cfs to 13,000 cfs typically occur in the bypass an estimated 19-20 days between April and November, again under the existing normal operation of the Project. Additional boating flow days may occur in the bypass reach when the power canal is shut down for maintenance or other reasons.

Current use of the bypass reach for boating is limited, even though the reach is available for boating during periods of spillage from Turners Falls Dam. This may be indicative of low demand, or may be due to a general lack of knowledge of periods of spill into the bypass reach. Anecdotal information collected from boaters in preparation for the boating study indicated whitewater boaters have run the bypass reach when there is water available but no information specifically correlating bypass flows with recreational boating opportunities in the bypass reach was found. In fact, research found that existing published boating guides (AMC) and other resources (AW national river database) contained very limited information on the bypass reach. This research suggested that although existing USGS gage data are available and can be used to estimate flows in the bypass reach, boaters may not be aware that it exists or do not know how to use it (FirstLight, 2015d).

Although the boaters who participated in the study found the bypass reach to provide an acceptable boating experience for most watercraft, other regional rivers were rated more desirable. Other regional whitewater boating opportunities identified include several reaches of the Deerfield River, the Ashuelot River, the West River and the Millers River (Figure 3.3.6.1.9-1). Scheduled releases occur on the West River, Millers River, and two reaches of the Deerfield River. These releases provide whitewater boating opportunities throughout the recreation season including in the summer and on weekends.

3.3.6.1.10 Recreational Use of the Project for Boating

Project waters are utilized for both motorized and non-motorized boating. Public motorized boating use is generally accessed by launching at the Governor Hunt Boat Launch, the State Boat Launch, and Pauchaug Boat Launch, which provide trailered boating access. An estimated 18,470 recreation days, or 12% of the total number of recreation days at the Project, were spent participating in motor boating.

The Project is also used for non-motorized boating, which had an estimated 6,656 recreation days in 2014. Non-motorized boating at the Project is supported through several Project recreation sites. Barton Cove Canoe and Kayak Rental Area rents kayaks and is open from Memorial Day weekend to Labor Day weekend. Hours of operation on weekdays are from 9:00 a.m. to 5:00 p.m., while on weekends the rental area is open from 9:00 a.m. to 6 p.m. A total of 2,681 recreation days were spent participating in non-motorized boating from the Barton Cove Canoe and Kayak Rental Area. In addition, non-motorized boating access within the Northfield Project is available at the Governor Hunt Boat Launch and Picnic Area (operated by TransCanada as part of the Vernon Hydroelectric Project); Pauchaug Boat Launch; the Boat Tour and Riverview Picnic Area; the Cabot Camp Access Area, the Barton Cove Nature Area and Campground; and the State Boat Launch. These sites are located approximately 1.3 to 8.2 miles apart.

The TFI is part of the Connecticut River Paddlers' Trail. According to the National Park Service (NPS) a water trail (paddlers' trail) is defined as a recreational route on a waterway with a network of public access points supported by broad-based community partnerships. Initially developed in 1992, the Connecticut

River Paddlers' Trail is a series of primitive campsites and river access points extending from the headwaters of the Connecticut River to the NH/VT/MA state line. In 2012, partnerships were formed to establish a "southern" trail chapter to extend the river trail to Long Island Sound (FirstLight, 2015e). With respect to the TFI, a 2013 Friends of the Connecticut River Paddlers (FCRPT) report stated that "in general, most access points are well maintained, well-spaced, and are in adequate condition" (Pollock, 2013).

Numerous stakeholders requested a study of Project facilities that support multi-day non-motorized boating trips. In response, Study No. 3.6.4 *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* was conducted in 2014 (FirstLight, 2015e). The focus of the study was to determine the number of existing overnight and access facilities that support self-powered boating trips and the adequacy of the spacing. The study also included the feasibility of alternate walkable canoe portages and the need for additional future facilities. The study area was the Connecticut River from Vernon Dam to the Sunderland Bridge (Route 116) in Sunderland, MA; a distance of approximately 32.5 miles, of which 9.5 miles or river downstream of Cabot Station, which is outside the Project boundary.

There are three existing campsites and, as described above, seven access sites along the approximate 20-river miles between the Turners Falls Dam and the Vernon Dam that can be used by paddlers traversing the Connecticut River Paddlers' Trail. Campsites are located on Stebbins Island (operated by TransCanada as part of the Vernon Hydroelectric Project (FERC No. 1904); and at FirstLight's Munn's Ferry Boat Camping Recreation Area and Barton Cove Nature Area and Campground. The distance between the existing campsites within the Northfield Project boundary ranges from 6.8 to 10.4 miles.

Water access camping is available from Memorial Day through Columbus Day at the Munn's Ferry Boat Camping Recreation Area and from Memorial Day through Labor Day at the Barton Cove Nature Area and Campground. Combined there are a total of 36 campsites along the TFI, five of which are water access only. There are an additional four to five camping areas at Stebbins Island, which is owned by TransCanada. The island is located approximately one (1) mile downstream of Vernon Dam.

Existing camping use at the Munn's Ferry Boat Camping Recreation Area and Barton Cove Nature Area and Campground are below capacity, and annual weekday use has declined over the last five years. Weekend use at Munn's Ferry Boat Camping Recreation Area dropped significantly from 2011 to 2012 but has remained relatively stable since with an occupancy rate of approximately 30% in 2012 - 2014. Weekend use at Barton Cove Nature Area and Campground has declined significantly between 2010 and 2014 from an occupancy rate of 67.1% to 37.6%.

In the reach of river from downstream of the Turners Falls Dam to the Sunderland Bridge, there are three access sites for use by paddlers. One of these is the Poplar Street access located downstream of Cabot Station, which serves as both a take-out location for boaters utilizing the Turners Falls bypassed reach and as a put-in location for the canoe portage and boaters traveling downstream. In addition, the Sunderland Bridge Boat Launch, an unimproved boat launch located on river left at the Route 116 Bridge crossing, is provided by the Town of Sunderland. Individuals also utilize the Sunderland Bridge access located on river right across from the Sunderland Bridge Boat Launch. This is a carry-in access site, located within a State right-of way. There are no formal campsites in the 9.5 mile stretch of the study area below the Project boundary, although there are several informal campsites on private and state property.

Canoe Portage Use

FirstLight operates and maintains a canoe portage around the Turners Falls Dam during daylight hours for the paddling season, which is typically mid-May to mid-November. The existing canoe portage is comprised of a free vehicular shuttle service from Barton Cove Canoe and Kayak Rental Area to the Poplar Street Access Site. Portage is provided, by request, on an as-needed basis, for groups with four or fewer boats. Larger groups are asked to provide FirstLight with a one month advance notice. A telephone number to arrange a portage is provided on the FirstLight website and is posted on sign kiosks at several of the

Project Recreation Sites located on the TFI. The telephone number is also posted in several regional and local recreational guides.

Use of the Turners Falls portage is light. As previously discussed, FirstLight provided a total of nine vehicle portages around Turners Falls Dam between May 17, 2014 and September 3, 2014. Of these, three vehicle portages were related to camp groups totaling 39 boaters. The remaining six vehicle portages totaled 14 boaters.

Study No. 3.6.4 also examined the feasibility of developing a walkable portage trail around Turners Falls Dam utilizing the Canalside Trail Bike Path and public side streets. It was found, that using existing access areas and side streets would result in a portage of approximately three (3) miles. Overall, the study concluded that the existing vehicle portage provided by FirstLight also provides sufficient portage around Turners Falls Dam (FirstLight, 2015e).

3.3.6.1.11 Recreational Use of the Northfield Mountain Tour and Trail Center

The NMTTC is a four-season facility that provides many on-site recreational opportunities, environmental and educational programs. The NMTTC also serves as a base for management and oversight of other FirstLight Project recreation facilities. Public recreation facilities and amenities at the NMTTC include a Visitor Center, Trail System, Mountain Top Observation Area located on the Upper Reservoir, and a number of additional amenities such as picnic tables, grills, informational kiosks and a yurt.

The NMTTC, located on Route 63 in Northfield, MA, offers a variety of public and school programs through the Visitor Center. Public programs are both educational and recreational in nature, and are scheduled and offered year-round, many at no charge to participants. Programs include such activities as guided hikes, animal track identification, and winter tree identification. School programs are scheduled during the school year and offer opportunities for hands-on environmental education and recreation.

Individuals utilize the NMTTC and associated amenities for a variety of activities including hiking, mountain biking, horseback riding, cross-country skiing, snowshoeing and access to informal climbing opportunities. Individuals can also use the hiking trails to reach the Mountain Top Observation Area which has views of the Upper Reservoir.

At the request of stakeholders, FirstLight conducted a study to evaluate the number of existing recreation facilities and amenities associated with the NMTTC including a review of the trail system. Study No. 3.6.7 *Recreation Study at Northfield Mountain, Including Assessment of Sufficiency of trails for Shared Use* was conducted in 2014. The study found that the NMTTC is a well-utilized regional recreation resource that provides a wide variety of opportunities, programs and amenities, which supported an estimated 20,024 recreation days in 2014 (FirstLight, 2015f). Visitors to the NMTTC participated in environmental and recreation programs, and used the trail network for a variety of recreational activities.

Registration and use records available demonstrate that over the long-term NMTTC environmental program use has declined. This long-term decline appears to reflect a change in interest and participation, and is not a result of reduced program offerings, which have remained relatively constant. Over the past five years, however, with a few exceptions due to unusual circumstances, recreation use associated with the NMTTC, as well as environmental program registrations, have remained relatively consistent (FirstLight, 2015f).

Surveyed visitors were overwhelmingly satisfied with the amenities provided at the NMTTC. One hundred percent (100%) of respondents to the survey question asking about their overall satisfaction with the NMTTC said they were extremely satisfied (46%), moderately satisfied (33%), or satisfied (21%). Visitors' responses to the question "What did you like most about your recreational experience today?" included "world class touring center", the trails, the Visitor Center exhibits and the variety of programs. Visitors also reported liking most that the NMTTC was not crowded and was quiet. Surveyed visitors were asked to rate the variety of amenities at the NMTTC on a scale of 1 ("poor") to 5 ("Excellent"). Eighty-one percent (81%) of those who responded rated that the variety of amenities available at the NMTTC was a 4 or 5. In addition, there were many more responses to the two positive open-ended questions ("what did you like most about your recreation experience today?" and "what, if anything, enhanced your recreation experience today?") than responses to the two open-ended negative questions ("what did you like least about your recreation experience today?" and "what, if anything, detracted from your recreation experience today?").

3.3.6.1.12 Recreational Use of the Northfield Mountain Tour and Trail Center Trail System

The NMTTC Trail System is an approximately 25-mile network of trails that supports cross-country skiing, snowshoeing, hiking, biking, and horseback riding. The Trail System includes approximately 25 individually named trails (Figure 3.3.6.1.12-1). The NMTTC Trail Systems receives moderate use, and Study No. 3.6.7 *Recreation Study at Northfield Mountain, Including Assessment of Sufficiency of Trails for Shared Use* found that the NMTCC Trail System supported an estimated 16,123 recreation days in 2014 (FirstLight, 2015f). A review of FirstLight records for the period 2010 through 2014 show that, after adjusting for special events and closures in various years, trail use has remained relatively consistent of the 2010-2014 period.

Study No. 3.6.7 also found that the Trail System is well designed, well maintained and with few exceptions, in good condition. The trails were designed and built to a very high standard at the time that they were constructed in the 1970's. Although the trails were designed primarily for hiking and cross-country skiing, the trail assessment (Study No. 3.6.7) found that the cross-country ski trails are well adapted to handle mountain biking and can also accommodate horseback riding use, while remaining in good condition. The hiking and snowshoe trails are not as suitable for mountain biking or horseback riding use (FirstLight, 2015f).

The vast majority of visitors to the NMTTC Trail System are very satisfied with the number of trails and with the difficulty of the trails. Ninety-four percent (94%) of respondents strongly agreed or agreed that the trails are in good condition, with 95% strongly agreeing or agreeing that the trails are well maintained. Surveyed visitors also disagreed or strongly disagreed (61% of responses) that more trails are needed while another 26% of respondents remained neutral. The majority of respondents (85%) either agreed or strongly agreed that the grooming of winter trails is sufficient. The majority of respondents (96%) also agreed or strongly agreed that the hours of operations are adequate, while the remaining 4% were neutral. When asked how any of the trail variables could be improved, only nine (9) users chose to respond while an additional 23 recreationists chose not to respond.

In addition to the trails provided at the NMTTC System, there are 133 properties with hiking and/or mountain biking trail opportunities within 25 miles of the NMTTC. Of the 133 properties, 64 provide both hiking and mountain bike trails, 62 provide only hiking trails, and seven provide only mountain bike trails. The properties are owned and managed by a variety of federal, state, and local agencies, land trusts, and private entities. All but two of the properties are open to the public on a year-round basis.

3.3.6.2 Environmental Effects

The continued operation of the Northfield Project, as proposed, will have a beneficial effect on existing recreational use of the Project, the recreation opportunities provided by the Project, or use of the Project recreation sites. There are 10 Commission-approved Project recreation sites (listed in Table 3.3.6.1.2-1), which provide the public with a variety of recreational opportunities including boating, fishing, camping, swimming, picnicking, hiking, cross-country skiing, snowshoeing, horseback riding, rock-climbing, and mountain biking.

Recreation-related studies conducted by FirstLight as part of the relicensing process demonstrate that the existing Project recreation sites, combined with other public recreation sites and facilities, as well as informal access areas, provide the public with a diversity of recreation opportunities, and an abundance of options for accessing and utilizing Project lands and waters for recreation. An inventory of both Project and other improved recreation sites found that with few exceptions all of the sites and their associated facilities and amenities are well maintained and are functioning as designed. A survey of site users also found that users felt that the existing sites were generally well operated and maintained. The major recreation facilities at the most popular Project recreation sites received favorable marks from most users, including the Barton Cove Campground, the Barton Cove Canoe and Kayak rental area, the Gatehouse Fishway Viewing Area, and most notably, the NMTTC and NMTTC Trail System. Continued operation of these Project recreation sites will ensure that the public continues to benefit from the recreational opportunities afforded by Project lands and waters.

The continued operation and maintenance of the existing Project recreation sites is supportive of current recreation use and demand levels. Use surveys conducted as part of Study No. 3.6.1 demonstrate that current facility capacities do not exceed 50% with one exception. A portion of the Gatehouse Fishway Viewing Area building was utilized at 90% capacity during the fishway viewing season. In addition, the State Boat Launch, which is a non-Project recreation site, was utilized at 65% capacity during 2014. However, even these two sites are expected to provide adequate use capacity for the foreseeable future.

The NMTTC is the most popular of the Project recreation sites, and in addition to the facilities and amenities provided at the NMTTC, the Visitors Center also serves as the base of operations for some of the other Project recreation facilities, including the QII riverboat tour, and the fishway viewing area. Study No. 3.6.7 results found that visitors to the NMTTC consistently gave it favorable marks for its facilities and amenities, as well as for how the facilities are operated and maintained by FirstLight. Continued operation of the NMTTC will continue to provide the region with a recreational resource offering a variety of recreational experiences, including the provisions of educational and recreational programs offered through the NMTTC. Study No. 3.6.7 results also found that users of the NMTTC Trail system consistently gave it favorable remarks and there were almost no negative comments. Study No. 3.6.7 found the trails overall, to be well maintained and in good condition. The Trail System will continue to operate year-round and provide hiking, mountain biking and horseback riding opportunities in the spring, summer and fall, as well as skiing and snowshoeing opportunities in the winter. The Trail System will also continue to provide parking and access for those wishing to access the New England National Scenic Trail, and the popular Rose Ledge climbing site. Continued maintenance of the trails by FirstLight will ensure that the trails remain in good repair, functional and sustainable for existing uses well into the future.

Continued operation of the Project, as proposed, including the operation and maintenance of the existing Project recreation sites will also be supportive of the Connecticut River Paddlers' Trail's goals of expanding the Connecticut River Trail to include the TFI and Project areas downstream of Turners Falls Dam. Study No. 3.6.4 found that existing access and camping opportunities located throughout the TFI are located and spaced consistent with water trail design standards and practices. FirstLight's proposed maintenance of its existing campsites and access areas will ensure that these facilities will be available for water trail users and multi-day through paddlers in the future. FirstLight also proposes to continue to operate the Turners Falls Dam vehicle portage between Barton Cove (take-out), as it does currently, which will also support water trail users and through-paddlers. In addition, as set forth in Section 3.3.6.4, FirstLight proposes to improve the Poplar Street Access Site (put-in), which also will support water trail users and through-paddlers.

Continued operation of the Project will also continue to support existing recreational use of the bypass reach for recreation. The bypass reach will continue to receive seasonally variable minimum flows (120-400 cfs) during periods of normal Project operation and when river flows are less than the hydraulic capacity of the power canal. Periodically, the bypass reach will receive significant flows, if the canal is shut down for maintenance or other reasons, as well as when river flows exceed the hydraulic capacity of the canal (>18,000 cfs). Study No. 3.6.3 demonstrated that the bypass reach is suitable for whitewater boating at the evaluated range of flows (2,500 cfs – 13,000 cfs). In addition, although not evaluated, flows in excess of 13,000 may also be suitable for whitewater boating. Bypassed reach flows in excess of 2,500 cfs, would be expected to occur most frequently in the spring, but the evaluated flows (between 2,500 and 13,000 cfs) can be expected to provide boatable conditions in the bypassed reach approximately 19-20 days between April and November, in an average hydrologic year. Flows in excess of 2,500 cfs (and greater than 13,000 cfs) can be expected to occur approximately 43 days between the months of April and November in an average hydrologic year, i.e., additional days which may also be suitable for boating. Study No. 3.6.3 also found that there are numerous other regional whitewater boating opportunities, including several reaches of the Deerfield River, the Ashuelot River, the West River, and the Millers River. Some of these boating opportunities are dependent on natural flows, but several of these opportunities are available through the recreation season through scheduled flow releases, including reaches on the Deerfield River, the West River, and Millers River. Scheduled releases at these rivers provide regional boaters with significant whitewater boating opportunities, including in the summer and weekends. Access for whitewater boaters wishing to utilize the bypassed reach is available for "put-in" at an informal area below the Turners Falls Dam, at the Cabot Woods Fishing Access; and for "take-out" at the Station No. 1 Fishing Access and at the Poplar Street Access Site. FirstLight's proposal to continue to operate and maintain these sites, and to continue to allow public access to the informal access areas will ensure that the bypassed reach can continue to be utilized for whitewater boating, whenever flow conditions allow.

Continued operation of the Project will also continue to support boating use of Project waters. Boat launching for trailered boats is currently provided at two formal recreation sites: the Pauchaug Boat Launch and the State Boat Launch. The Pauchaug Boat Launch is owned and managed by the Commonwealth of Massachusetts. The boat launch is located on state property on the eastern shore of the TFI, and within the Project boundary. Both the boat launch and parking lot are maintained by the state. The boat launch itself is a hard surface ramp with two launch lanes. The State Boat Launch site is on property partially owned by the state, and partially by FirstLight, and the site is operated and maintained by the state. Both boat launches provide trailered boats access to Project waters and are expected to remain functional under the proposed operation of the Project.

The continued operation of the Project will have no impact on the recreational use of the Northfield Mountain Pumped Storage Development's Upper Reservoir. For both safety and security reasons, public recreational use of the Upper Reservoir is currently restricted to the observation platform, which is maintained as part of the NMTTC, and which is accessed via the NMTTC Trail System. There is no boating, fishing or swimming allowed on the Upper Reservoir, and therefore no boat launches or recreation access sites, other than the viewing platform. Because there is no boating allowed on the Project's Upper Reservoir, proposed modifications of the operation of the Upper Reservoir will also have no impact on recreational use of that reservoir.

Existing Project recreation sites and facilities are currently meeting recreation demand and are adequate to meet demand in the reasonably foreseeable future.

3.3.6.3 Cumulative Effects

In Scoping Document 2 FERC identified that recreational uses may be cumulatively affected by the proposed operation and maintenance of the five Connecticut River Projects. The presence of the dams may have a cumulative effect on recreation for multi-day paddling trips on the Connecticut River. During licensing studies it was determined that the availability and types of recreation facilities along the Connecticut River within the Northfield Project adequately supports multi-day paddling trips and are also consistent with plans for Connecticut River water trail expansion.

3.3.6.4 Proposed Environmental Measures

FirstLight proposes to implement a Recreation Management Plan (RMP) during the term of the new license, which provides for the operation and maintenance of proposed Project Recreation sites. A draft RMP is included in Appendix C. These proposed Project Recreation sites consist of the existing Commission-Approved Project Recreation sites with two exceptions. First, the Licensee plans to improve carry-in boat access to the Poplar Street Access Site and include the land necessary for the site within the Project boundary. Initial concepts for proposed improvements at the Poplar Street Access site include a staircase with boat slide and improved parking.

Second, FirstLight is proposing that the Bennett Meadow WMA, which currently is a Commission-Approved (Project) recreation site be considered as a non-Project recreation site. The site is primarily a wildlife management area that is managed by MADFW. It is also managed for agriculture purposes, although the WMA does provide recreation opportunities for hunting, walking, and hiking. The WMA contains steep banks, which makes access to Project waters difficult. There are no recreational facilities at the site. As noted in the Recreation Use/User Contact Survey, the WMA was utilized at less than 10% of capacity by the public during 2014. The proposal to consider the Bennett Meadows WMA as a non-Project recreation site will not have an adverse impact on recreational use and opportunities in the Project vicinity because the WMA is managed for other purposes, does not provide direct access to Project waters, has no recreational facilities, and receives low usage.

The continued operation and maintenance of the proposed Project recreation sites, including the proposal to improve and maintain Poplar Street Access Site as a Project recreation site, will continue to provide multiple recreational opportunities at the Project and is supportive of anticipated recreation use and demand levels over the term of a new license.

3.3.6.5 Unavoidable Adverse Impacts

No unavoidable adverse impacts are expected to recreational resources in the Northfield Project. Implementation of the RMP would assure that the effects of the Project on recreational resources will be taken into account.

Table 3.3.6.1.2-1: Commission Approved Recreation Facilities at the Turners Falls Project (FERC No. 1889) and Northfield Mountain Project (FERC No. 2485)

Recreation Site Name	Recreation Facilities/Amenities
Bennett Meadow Wildlife Management Area	• Hunting Area
Munn's Ferry Boat Camping Recreation Area	• water access only campsites (approximately 4 Tent platform sites and 1 shelter site) • pedestrian foot bridge • restrooms • picnic area (1 table) • dock
Boat Tour and Riverview Picnic Area	• parking area (approximately 54 single vehicle spaces; 2 ADA) • restroom (ADA compliant) • picnic area (approximately 12 tables) • pedestrian foot bridge • picnic pavilion (approximately 8 tables) • interpretive boat tour • dock
Northfield Mountain Tour and Trail Center	• parking area (approximately 50 single vehicle spaces; 3 ADA) • restroom • picnic area (approximately 7 tables) • overlook • visitor center and interpretive displays • winter area • trail system
Barton Cove Nature Area and Campground	• nature area parking area (approximately 26 single vehicle spaces) • campground parking (approximately 28 single vehicle spaces) • showers • restroom facilities (2 facilities; ADA compliant) • picnic area (approximately 15 tables) • overlook • interpretive sign • walk-in campground (2 group sites; 28 campsites; 1 ADA campsite) • nature trail • dock
Barton Cove Canoe and Kayak Rental Area	• parking area (approximately 28 single vehicle spaces) • picnic area (approximately 6 tables) • seasonal restroom • paddlecraft rental service • canoe put-in and take-out (serves as portage take-out) • on-call vehicular canoe & kayak transport service

Recreation Site Name	Recreation Facilities/Amenities
Gatehouse Fishway Viewing Area	• parking area (approximately 27 single vehicle spaces; 2 ADA spaces) • picnic area (approximately 6 tables) • bike rack • trail • fishway viewing visitor center (ADA accessible) • restrooms (ADA accessible) • interpretive sign
Turners Falls Branch Canal Area	• overlook (approximately 4 benches)
Cabot Woods Fishing Access	• parking areas (approximately 17 single vehicle spaces; 2 ADA spaces) • picnic area (approximately 3 tables)
Turners Falls Canoe Portage	• canoe portage take-out (at Barton Cove Canoe & Kayak Rental area) • canoe portage put-in (at Poplar Street Access Site) • On-call vehicular canoe & kayak transport service

Table 3.3.6.1.5-1: Estimated Use of Surveyed Sites by Season

Recreation Site	Estimated Annual Use (2014)	Estimated Winter Use	Estimated Spring Use	Estimated Summer Use	Estimated Fall Use
Governor Hunt Boat Launch	1,812	13%	11%	67%	9%
Pauchaug WMA	1,005	15%	0%	23%	62%
Pauchaug Boat Launch	9,630	1%	7%	68%	23%
Bennett Meadow WMA	3,729	2%	14%	40%	44%
Munn's Ferry Boat Camping Recreation Area	1,716	0%	0%	84%	16%
Boat Tour and Riverview Picnic Area	13,651	17%	23%	39%	21%
Northfield Mountain Tour and Trail Center	20,024	24%	12%	33%	31%
Cabot Camp Access Area	5,326	4%	10%	62%	24%
Barton Cove Nature Area	7,842	15%	19%	45%	21%
Barton Cove Campground	2,963	0%	5%	92%	3%
Barton Cove Canoe and Kayak Rental Area	4,455	2%	0%	98%	0%
State Boat Launch	15,126	1%	2%	74%	23%
Canalside Trail Bike Path	6,362	1%	13%	54%	31%
Gatehouse Fishway Viewing Area	27,345	7%	28%	46%	20%
Turners Falls Branch Canal/Station No. 1 Fishing Access	1,264	27%	29%	20%	24%
Cabot Woods Fishing Access	18,230	17%	19%	38%	27%
Poplar Street Access	1,877	14%	5%	56%	25%
Rose Ledge Climbing Area Parking	1,790	2%	27%	54%	17%
Farley Ledge Climbing Area—Wells Street Parking	2,390	7%	51%	29%	13%
Farley Ledge Climbing Area—Route 2 Parking	6,232	4%	22%	48%	25%
Total Project Recreation Site Use	152,769	10%	16%	50%	23%

Note: Percentages of estimated use by season at each recreation site may not sum to 100% due to rounding.

Table 3.3.6.1.5-2: Percent of Recreation Use by Activity at Each Site

Recreation Site	Walk/ Hike/ Jogging	Motor Boating	Fishing	Ride Bikes	Picnicking	Climbing	Non-motor boating	Fishway Viewing	Cross-country Ski	Camping	Riverboat	Sight see	Hunt	Birding	Ice Fish	Ride Horses	Snow Shoe	Whitewater boat (Bypass only)	Ice Skate/ Boat	Unidentified Recreation Activity
Governor Hunt Boat Launch/Picnic Area	0%	53%	12%	0%	0%	0%	15%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%
Pauchaug WMA	32%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	0%	0%	0%	0%	0%	0%	23%
Pauchaug Boat Launch	4%	49%	12%	0%	1%	0%	10%	0%	0%	0%	0%	2%	2%	0%	0%	0%	0%	0%	0%	20%
Bennett Meadow WMA	41%	0%	1%	0%	1%	0%	1%	0%	0%	0%	0%	4%	25%	0%	0%	0%	0%	0%	0%	27%
Munn's Ferry Boat Camping Recreation Area	0%	39%	0%	0%	5%	0%	9%	0%	0%	30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%
Boat Tour and Riverview Picnic Area	29%	3%	2%	2%	18%	0%	1%	0%	0%	0%	20%	1%	0%	0%	0%	0%	0%	0%	0%	24%
Northfield Mountain Tour and Trail Center	49%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%	1%	0%	0%	0%	3%	1%	0%	0%	29%
Cabot Camp Access Area	19%	1%	26%	2%	1%	0%	1%	0%	0%	0%	0%	8%	0%	0%	0%	0%	0%	3%	0%	39%
Barton Cove Nature Area	31%	0%	23%	6%	5%	0%	4%	0%	0%	0%	0%	1%	0%	1%	9%	0%	0%	0%	1%	19%
Barton Cove Campground	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Barton Cove Canoe and Kayak Rental Area	0%	8%	4%	0%	12%	0%	60%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	14%
State Boat Launch	1%	74%	2%	0%	1%	0%	11%	0%	0%	0%	0%	1%	0%	2%	0%	0%	0%	0%	0%	8%
Canalside Trail Bike Path	41%	0%	0%	55%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Gatehouse Fishway Viewing Area[2]	36%	0%	6%	8%	14%	0%	0%	19%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	15%
Turners Falls Branch Canal/Station No. 1 Fishing Access	26%	0%	21%	21%	0%	0%	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%
Cabot Woods Fishing Access	53%	0%	11%	10%	3%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	20%
Poplar Street Access	23%	0%	41%	3%	0%	0%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	11%
Rose Ledge Climbing Area Parking	19%	0%	0%	0%	0%	75%	0%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	4%
Farley Ledge Climbing Area—Wells Street Parking	71%	0%	0%	0%	0%	25%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Farley Ledge Climbing Area—Route 2 Parking	20%	0%	0%	0%	0%	75%	0%	0%	2%	0%	0%	1%	0%	0%	0%	1%	1%	0%	0%	1%
Total Project-Wide Use of the above Sites.	29%	12%	7%	6%	5%	4%	4%	3%	3%	2%	2%	1%	1%	1%	1%	1%	0%	0%	0%	18%

[2]. *Use includes visitors utilizing the Visitor Center and the associated picnic area, which includes a portion of the Canalside Trail Bike Path.*

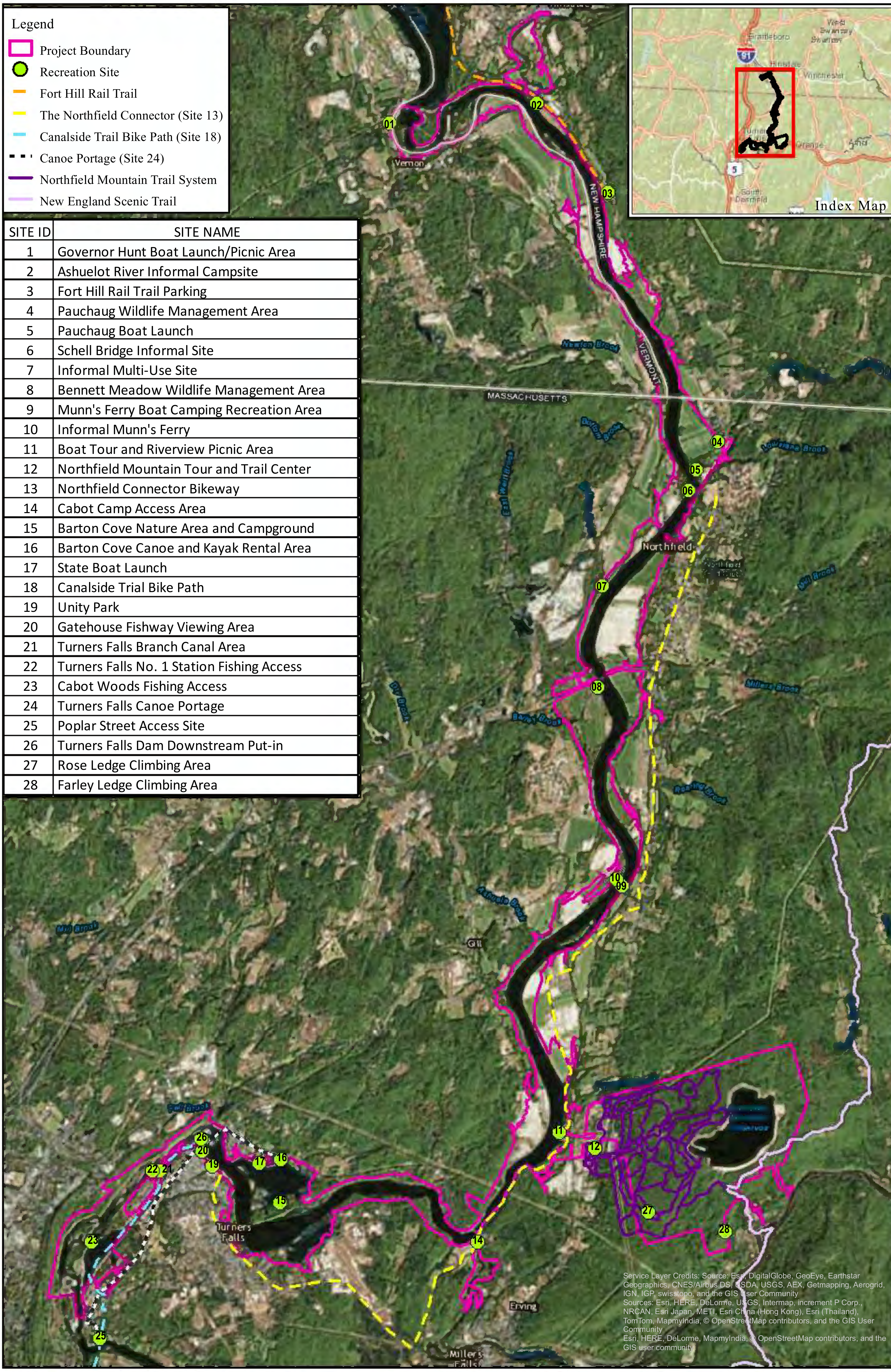
Table 3.3.6.1.5-3: Capacity Utilization by Site

Season	Recreation Days	Percent Capacity Utilized
Governor Hunt Boat Launch	1,812	50%
Pauchaug WMA	1,005	1%
Pauchaug Boat Launch	9,630	20%
Bennett Meadow WMA	3,729	10%
Munn's Ferry Boat Camping Recreation Area	1,716	40%
Boat Tour and Riverview Picnic Area	13,651	10%
Northfield Mountain Tour and Trail Center	20,024	10%
Cabot Camp Access Area	5,326	15%
Barton Cove Nature Area	7,842	20%
Barton Cove Campground	2,963	40%
Barton Cove Canoe and Kayak Rental Area	4,455	25%
State Boat Launch	15,126	65%
Canalside Trail Bike Path	6,362	NA
Gatehouse Fishway Viewing Area	27,345	25%
Turners Falls Branch Canal/Station No. 1 Fishing Access	1,264	1%
Cabot Woods Fishing Access	18,230	25%
Poplar Street Access	1,877	10%
Rose Ledge Climbing Area Parking	1,790	60%
Farley Ledge Climbing Area—Wells Street Parking	2,390	30%
Farley Ledge Climbing Area—Route 2 Parking	6,232	60%
Annual Total	152,769	

Table 3.3.6.1.9-1: Average Number of Days Per Month Spill Flows Equal or Exceed Boating Evaluation Flows*

Month	Total No. of Days per Month (flow between 2,500 and 13,000 cfs)	Total No. of Days in the Month (flow between 2,500 and 13,000 cfs)	%	Average number of Days per Month (flow between 2,500 and 13,000 cfs)	Total No. of Days per Month (flow greater than 13,000 cfs)	%	Average number of Days per Month (flow greater 13,000 cfs)	Total No. of Days per Month (flow greater than 2,500 cfs)	%	Average number of Days per Month (flow greater 2,500 cfs)
April	579	2160	26.8%	8.0	1052	48.7%	14.6	1631	75.5%	22.7
May	489	2232	21.9%	6.8	394	17.7%	5.5	883	39.6%	12.3
June	129	2160	6.0%	1.8	67	3.1%	0.9	196	9.1%	2.7
July	49	2232	2.2%	0.7	28	1.3%	0.4	77	3.4%	1.1
August	39	2232	1.7%	0.5	22	1.0%	0.3	61	2.7%	0.8
September	32	2160	1.5%	0.4	22	1.0%	0.3	54	2.5%	0.8
October	103	2232	4.6%	1.4	92	4.1%	1.3	195	8.7%	2.7
Total	1420	15408	9.2%	19.7	1677	10.9%	23.3	3097	20.1%	43.0

*Based on period of record 1941-2013



SITE ID	SITE NAME
1	Governor Hunt Boat Launch/Picnic Area
2	Ashuelot River Informal Campsite
3	Fort Hill Rail Trail Parking
4	Pauchaug Wildlife Management Area
5	Pauchaug Boat Launch
6	Schell Bridge Informal Site
7	Informal Multi-Use Site
8	Bennett Meadow Wildlife Management Area
9	Munn's Ferry Boat Camping Recreation Area
10	Informal Munn's Ferry
11	Boat Tour and Riverview Picnic Area
12	Northfield Mountain Tour and Trail Center
13	Northfield Connector Bikeway
14	Cabot Camp Access Area
15	Barton Cove Nature Area and Campground
16	Barton Cove Canoe and Kayak Rental Area
17	State Boat Launch
18	Canalside Trial Bike Path
19	Unity Park
20	Gatehouse Fishway Viewing Area
21	Turners Falls Branch Canal Area
22	Turners Falls No. 1 Station Fishing Access
23	Cabot Woods Fishing Access
24	Turners Falls Canoe Portage
25	Poplar Street Access Site
26	Turners Falls Dam Downstream Put-in
27	Rose Ledge Climbing Area
28	Farley Ledge Climbing Area

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

N

0 0.5 1 2 Miles

Figure 3.3.6.1.1-1:
Existing Recreation Sites
and Facilities

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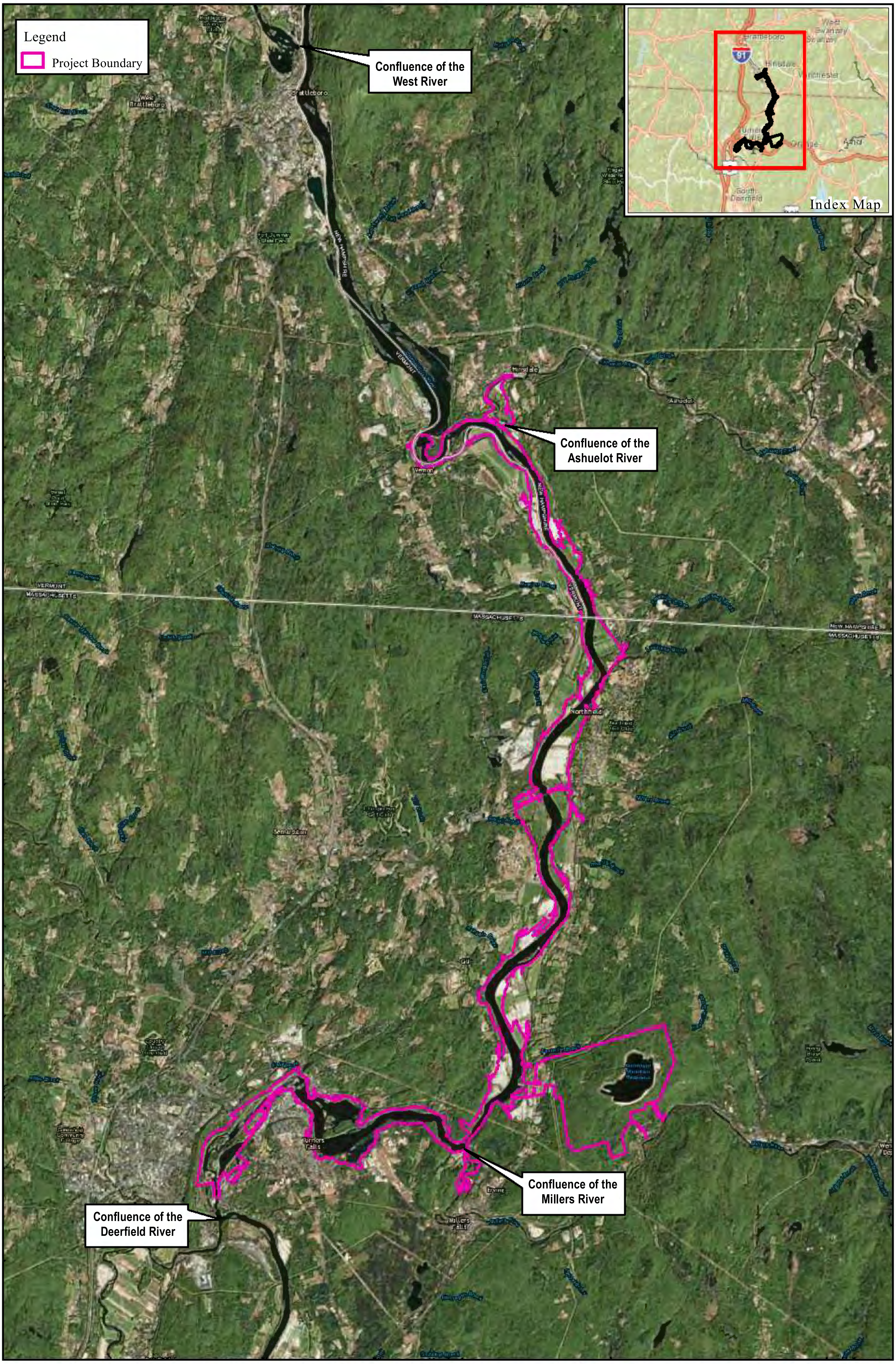

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

Figure 3.3.6.1.9-1:
Regional Rivers Containing Whitewater Boating Opportunities

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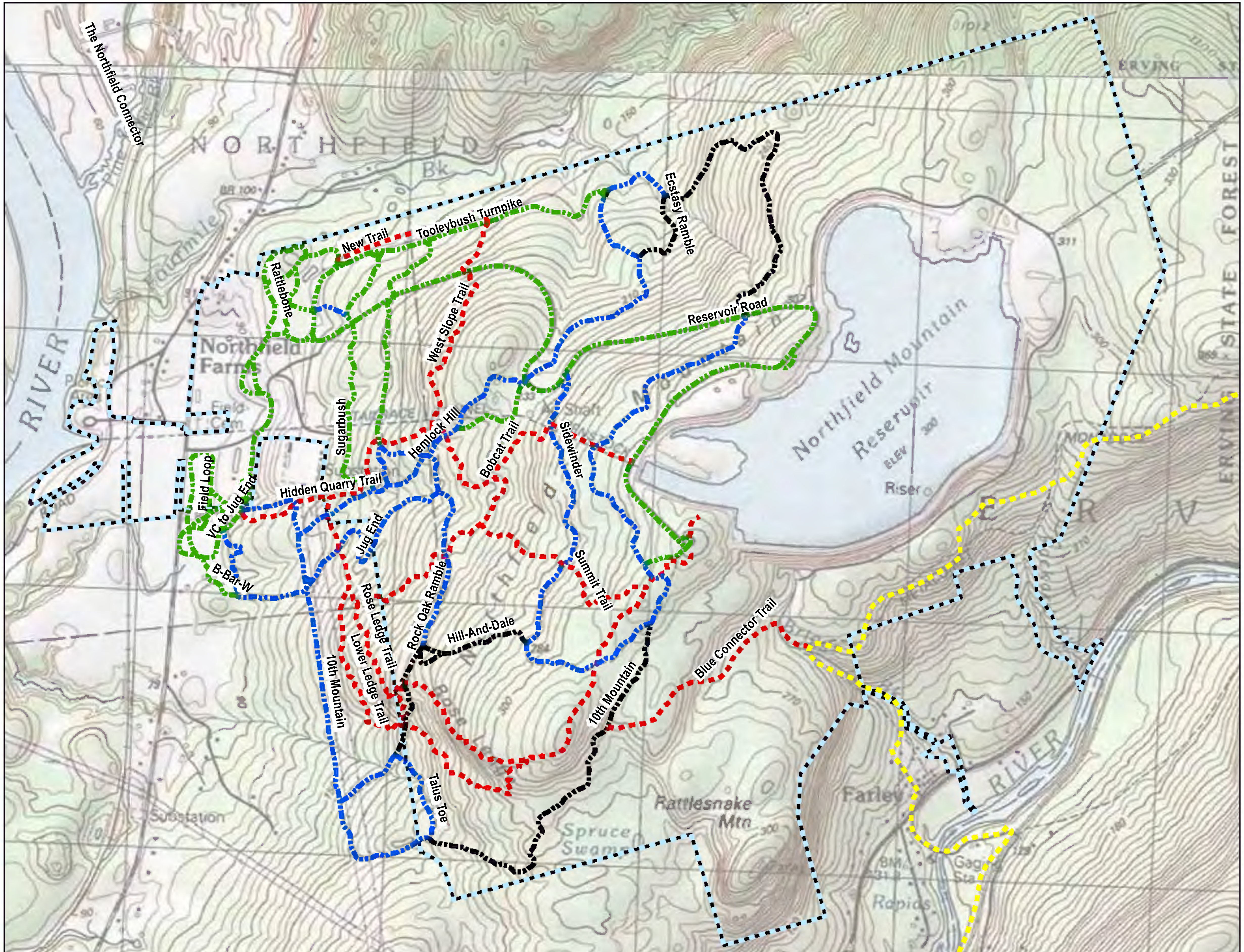


FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

Figure 3.3.6.1.12-1:
Northfield Mountain Trail System

Legend

Trail Rating
- Most Difficult
- More Difficult
- Easier
- Snowshoeing/Hiking Only
- New England National Scenic Trail
- Northfield Mountain Project Boundary

Note:
Blue Connector Trail digitized based on best available imagery.

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap

0 625 1,250 2,500 Feet

1 inch = 1,250 feet

FirstLight GDF SUEZ

3.3.7 Land Use

3.3.7.1 Affected Environment

3.3.7.1.1 Project Lands

The Northfield Project is situated on the Connecticut River, within the states of MA, NH, and VT. The Project is comprised of two developments, the Turners Falls Development and the Northfield Mountain Pumped Storage Development. The Turners Falls Dam is located at RM 122 of the Connecticut River, (above the Long Island Sound) in the towns of Gill and Montague, MA. The TFI is approximately 20 miles long, with 5.7 miles located in the towns of Vernon, Vermont and Hinsdale, New Hampshire. The Northfield Mountain Pumped Storage Development is located approximately 5.2 miles upstream of the Turners Falls Dam and utilizes the TFI as its lower reservoir. The Upper Reservoir is located atop Northfield Mountain to the east of the TFI. With the exception of the northern portion of the TFI extending into VT and NH, Project lands are located within the county of Franklin, MA, specifically in the towns of Erving, Gill, Greenfield, Montague, and Northfield.

An overview of the existing Project boundary is shown in Figure 3.3.7.1.1-1. As shown, the boundary extends upstream along the Connecticut River approximately 20 miles to TransCanada's Vernon Hydroelectric Project Dam, located in the towns of Vernon, VT, and Hinsdale, NH. The Project extends to the east up to Northfield Mountain, to include the Northfield Mountain Upper Reservoir, north of State Route 2. The Project extends downstream of the Turners Falls Dam to Cabot Station, a hydroelectric generating facility, which is part of the Turners Falls Development.

The existing Project boundary encompasses 7,246 acres: 2,238 acres of flowed land and 5,008 acres of upland, at minimum flow conditions.[49] When the river is at maximum flow (50 year flood) conditions, there are 3,981 acres of flowed land and 3,265 acres of upland.[50] There are no federal lands within the Project boundary, with the exception of land associated with the Conte Fish Lab, which is owned and operated by the USGS, and which is not necessary for Project purposes. As discussed in more detail in Section 3.3.7.4, FirstLight is proposing to remove the lands associated with the Conte Fish Lab from the existing Project boundary.

The land use in and around the Project boundary consists primarily of recreation, agricultural, and forested lands. There are pockets of developed areas around the Project that consist of roads, industrial buildings and residences. There are also a variety of wetland areas along the banks of the river and in low lying areas within the Project area. There is a distinct difference in land uses between the lands north of the NMTTC and the lands surrounding the Turners Falls Dam. The land in and around the northern portion of the Project is mostly rural and there is very little developed land. Land that is developed consists of residential areas, roads and farming complexes. The lands surrounding the southern portion of the Project are more developed in nature, consisting primarily of residences and industrial lots with pockets of parks and greenspace. There are recreational use areas that are dispersed throughout the Project area with boat launches, hunting areas and fishing areas.

3.3.7.1.2 Land Use Designation of Lands within the Project Boundary

As part of Study No. 3.6.5 (*Land Use Inventory*), lands within the existing Project boundary were classified and mapped in eight (8) proposed land use designations (Figure 3.3.7.1.2-1) (FirstLight, 2015i). National Land Cover Database (NLCD) layers were utilized in combination with Massachusetts Geographic Information System (MassGIS) layers to develop the land use designations. This information was then reviewed and refined by utilizing information gathered from Study No. 3.4.1 *Baseline Study of Terrestrial Wildlife and Botanical Resource* (FirstLight, 2015g); Study No. 3.5.1 *Baseline Inventory of Wetland, Riparian and Littoral Habitat in the TFI, and Assessment of Operational Impacts on Special Status Species*

[49] The minimum flow represents the minimum flow required to maintain elevation 176.0 feet throughout the TFI.
[50] The maximum flow condition represents the 50 year flood scenario of 126,000 cfs.

(FirstLight, 2015c); Study No. 3.7.1 *Phase IA (Reconnaissance) Archaeological Surveys* (Sara *et al*. 2014a, 2014b) and Study No. 3.7.2 *Historic Architectural Resources Survey & National Register Evaluation* (FirstLight, 2014c, 2015j), as appropriate.

The eight (8) proposed land use designations for lands within the Project boundary are:

- **Agricultural – Crops**: generally tilled land used to grow row crops. Boundaries follow the shape of the fields and include associated building (e.g. barns). This category also includes turf farms that grow sod.
- **Agricultural – Pasture/Grass**: Fields and associated facilities (barns and other outbuildings) used for animal grazing and for the growing of grasses for hay.
- **Natural/Undeveloped**: Vacant land, idle agriculture, rock outcrops, and barren areas. Vacant land is not maintained for any evident purpose and it does not support large plant growth. This designation also includes shrub cover, and some immature tress not larger or dense enough to be categorized as forested. It also includes areas that are more permanently shrubby.
- **Developed**: areas with a mixture of constructed materials and vegetation that is mostly in the form of grass.
- **Forested**: areas where tree canopy covers at least 50% of the land. Both coniferous and deciduous forests belong to this class.
- **Wetland**: Areas of vegetation, where the soil or substrate is periodically saturated with or covered with water.
- **Open Water**: areas of open water.
- **Recreation:** Lands managed for developed public recreational facilities and activities. This includes recreational sites described in the report for Study No. 3.6.2 *Recreation Facilities Inventory and Assessment Addendum* (FirstLight, 2015c) and recreation facilities managed by private landowners.[51]

Table 3.3.7.1.2-1 provides a summary of the acreages of lands within the existing Project boundary for each land use designation. As shown, the majority of land within the Project boundary is Recreation (1,835 acres), Agricultural-Crops (1,010 acres), and Forested (951 acres).

3.3.7.1.3 Conservation Lands within 200 feet of the Project Boundary

As part of Study No. 3.6.5, several different types of protections were identified on lands within the Project boundary and within 200 ft of the Project boundary using publicly available information (FirstLight, 2015i). These protections include agricultural preservation restrictions and conservation restrictions. Approximately 715 acres of conserved land in the State of Massachusetts were identified as either within the Project boundary (approximately 414 acres) or within 200 ft of the Project boundary (approximately 301 acres). The purpose of the conservation protections fall into four categories: wildlife management; recreation; natural, undeveloped, and scenic; and agricultural preservation. The majority of the land conserved within the Project boundary is conserved for agriculture and wildlife management while the majority of the land conserved within 200 ft of the Project boundary is conserved for agriculture and recreation. This information was obtained from the MassGIS Protected and Recreational Open Space data layer. There were no conserved lands identified within the Project boundary or within 200 ft of the Project boundary in New Hampshire or Vermont. This information was based on data collected from the National Conservation Easement Database. An online search of land trusts and land conservation organizations working in the vicinity of the Projects did not identify any additional conserved lands within the Project boundary or within 200 feet of the Project boundary.

[51] Recreation facilities managed by private landowners are the Turners Falls Rod and Gun Club, the Franklin County Boat Club, and Turners Falls Schuetzen Verein.

3.3.7.1.4 Special Designated Areas

Portions of land within and adjacent to the Project are designated under various national and statewide programs dedicated to promoting outdoor recreation needs, as well as conservation and protection of the natural environment.

National Trails System

The National Trail System Act of 1968 authorized creation of a trail system comprised of National Recreational Trail, National Scenic Trails, and National Historic Trails. National Recreation Trails may be designated by the Secretary of Interior or the Secretary of Agriculture to recognize exemplary trails of local and regional significance in response to an application from the trail's managing agency or organization. There is one National Scenic trail that passes through the Project boundary. The New England National Scenic Trail (NET) is a 220-mile hiking trail that travels through 39 communities in CT and MA. Approximately 6,600 feet of the trail passes through the Northfield Project boundary near the southern edge of the Northfield Mountain Pumped Storage Development's Upper Reservoir. The portion of the NET that lies within the Project boundary is not operated or maintained by FirstLight. However, there is a connector trail that provides access to the NET from the NMTTC Trail System that is maintained by FirstLight.

Massachusetts Natural Heritage and Endangered Species Program

The Natural Heritage and Endangered Species Program (NHESP) focuses on protecting and conserving vertebrate and invertebrate animals, as well as native plants, that are officially listed as Endangered, Threatened, or of Special Concern in the state of Massachusetts. NHESP gathers and provides information on priority habitat for all rare listed state species of plants and animals. Rattlesnake Mountain, which includes Farley Ledge, sits on the southern border of the Northfield Mountain Pumped Storage Development boundary and is identified as priority habitat.

Wild and Scenic Rivers

The Federal government has developed a scenic and wild river program intended to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The Project is not located within or adjacent to a river designated as part of the National Wild and Scenic River System.

National Natural Landmarks

The National Natural Landmarks Program administered through the National Park Service recognizes and encourages the conservation of sites containing outstanding biologic and geologic resources. Though there are National Natural Landmarks in the state, there are none within or adjacent to the Project boundary.

3.3.7.1.5 Non-Project Uses of Project Lands

FirstLight has an established Permit Program through which it administers non-project uses of Project lands including lands it owns in fee, or in which it has an interest (Howard, 2008). Under its Permit Program it is FirstLight's policy to "protect the scenic, recreational, and other environmental values of the Project, consistent with safe, efficient operation." The Permit Program follows the requirements of the Standard Land Use Articles in the current licenses for the Turners Falls and Northfield Mountain Pumped Storage Developments.

Consistent with the Standard Land Use articles, FirstLight's Permit Program recognizes four categories of proposed uses of Project lands that require varying levels of FERC notification and control requirements:

Category A: Miscellaneous uses and/or conveyances of interests not addressed in subsequent categories which may require FERC approval. For Category A uses, FirstLight assesses the proposed use, and determines on a case by case basis the best method of processing the proposed use/conveyance request such as processing the proposed use under Category B, C, or D, or obtaining prior FERC approval prior to granting permission. Category A uses are typically temporary use of non-project lands for one-time events, such as running races, state cross-country meets, horseback riding, and triathlons.

Category B: Uses associated with single-family residential dwellings abutting the Project boundary such as (1) landscape planting; (2) non-commercial piers, landings, boat docks or similar facilities; and (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline. For Category B uses, FirstLight has an established program for issuing permits without prior FERC approval or notification for the specified types of use and occupancy of Project lands and waters, which may be subject to the payment of a reasonable fee to cover the costs of administering the permit program. For proposed uses in this category, FirstLight places an emphasis on multiple use and occupancy of facilities for access to Project lands or waters. FirstLight also ensures, to the extent practical, that the uses and occupancies for which it grants permission are maintained in good repair and comply with applicable State and local environmental, health, and safety requirements. Before granting permission for construction of bulkheads or retaining walls, FirstLight inspects the site to consider whether planting vegetation, grading or the use of riprap would be adequate to control erosion at the sites, and to determine that the proposed construction is needed and would not change the basic contour of the reservoir.

Category C: Municipal and utility uses such as (1) replacement, expansion, realignment, or maintenance of bridges and roads for which all necessary State and Federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas and electric distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project reservoir. For Category C uses, consistent with the Standard Land Use articles, no later than January 15 of each year, FirstLight prepares a report for the Project, which is filed with FERC, that briefly describes each conveyance made during the calendar year.

Category D: Uses such as (1) construction of new bridges or roads for which all necessary State and Federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary Federal and State water quality certificates or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary Federal and State approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 watercraft at a time and are located at least one-half mile from any other private or public marina; (6) recreational development consistent with an approved Exhibit R or approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed or a particular use is five acres or less: (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from the edge of the project reservoir at normal maximum surface elevation: and (iii) no more than 50 total acres of project lands for each project development acres conveyed under this category in any calendar year. For Category D uses, prior to conveying any interest in Project lands or waters, FirstLight conducts an internal review of the proposed use, and prepares information about the proposed use, including the location of the lands to be conveyed, the nature of the proposed use, and the identity of any Federal or State agencies consulted or approvals needed. At least 45 days prior to conveyance, FirstLight files the information on the proposed use and conveyance with FERC. Unless FERC, within 45 days from the filing date, requires FirstLight to file an application for prior approval, FirstLight then conveys the intended interest at the end of that period.

For both Category C and D uses, before notifying FERC, FirstLight consults with Federal and State fish and wildlife agencies, as appropriate, and the State Historic Preservation Officer.

For all categories of uses, FirstLight also reviews the proposed use/conveyance to ensure that it is not inconsistent with any FERC approved recreational resources.

Proposed uses of Project lands in all categories of uses are, to the extent practical, reviewed by FirstLight to ensure that the proposed use or conveyance of rights will not adversely affect the operation of the Project.

Permits granted by FirstLight under its Permit Program for non-project use of Project lands are generally in the form of a 5-year revocable license agreement. The license agreements regulate such use and occupancy through numerous provisions protecting Project and natural resources and thus are consistent with the "protection and enhancement of the project's scenic, recreation, or other environmental values…"[52] License agreement terms can vary and all can be terminated upon 6 months' notice by either party. The license agreements also expressly state that they are "subject to the terms and conditions as imposed by the FERC Project Licenses or to be imposed by FERC in connection with any order relative to the Projects." As a result of this provision, the ability of the Commission to further condition or even prohibit such authorized use and occupancy in order to meet the public interest standard of Section 10(a) of the Federal Power Act is fully preserved by FirstLight. All license agreements have in common the provisions below:

- The license holder must allow unobstructed use of the property by the public without regard to race, color, religious creed or national origin.
- The license is not transferable.
- The license holder must obtain all necessary federal, state, and local permits.
- Excavation, clearing, grading or filling of property is prohibited.
- Docks, piers, walls or other waterway improvements are prohibited unless all state and federal approvals have been obtained.
- Construction of any structures, fixtures or improvements on the property is prohibited without prior written approval by FirstLight.
- Parking or storage of vehicles or equipment on Project Property is prohibited, unless expressly authorized by conditions of the license.
- Hazardous materials may not be used or stored on the property unless otherwise authorized by the conditions of the license.
- Removal of timber, vegetation or plantings is prohibited without prior written permission from FirstLight.
- FirstLight reserves its right to flood and flow water on the property.
- The application of any fertilizer, pesticides and herbicides is prohibited (applicable to vegetated shoreline sites).
- FirstLight may require the license holder to plant and maintain native vegetation to reduce or prevent erosion and run-off into the Connecticut River (applicable to vegetated shoreline sites).

These requirements provide a comprehensive regulatory structure that assures that the granting of permission for non-project uses does not adversely affect the Project's scenic, recreational and environmental values.

Non-project uses at the Project generally include camps (24) within the Project boundary, docks (46[53]), landscape uses for abutters (8), and water withdrawals (8). Thirty-three of the 46 docks are located either in Barton Cove or just upstream of Barton Cove. In addition, FirstLight annually grants a number of permissions for temporary use of non-project lands for one-time events, such as running races, state cross-country meets, horseback riding, and triathlons. The camps and associated docks located within the Project boundary are a historic use with most dating to the 1920s. Most of the landscape uses date from 1972 through 1984. Five of the water withdrawals date from 2002 through 2011 and three water withdrawals date from 1990 or before. The Turners Falls Rod and Gun Club (sporting club with two docks) was constructed in the 1920s-1930s and the boat docks have been in place for 40 years. The Franklin County

[52] Article 52(a) of the Northfield License and Article 43(a) of the Turners Falls License.

[53] Of these 46 docks, four are associated with Project recreation sites that are available for public use. These include the docks at the State Boat Launch, Barton Cove Nature Area, Boat Tour and Riverview Picnic Area and Munn's Ferry Boat and Camping Recreation Area.

Boat Club (public marina with four boat docks) has been in existence at the current location within the Project boundary since 1971.

3.3.7.2 Environmental Effects

The Licensee's land management of lands within the Project boundary has been consistent with the land use categories developed for the Project and has been protective of sensitive resources. Continued operation of the Northfield Project, as proposed, will enable Project lands or the land uses surrounding the Project to continue. Project lands will continue to be a mix of forested, developed and agricultural lands which, for the most part, will remain available for public use for recreation. Non-project uses of Project lands will continue to be approved and managed by FirstLight in accordance with the terms of the standard land use articles that are anticipated to be included in the new license. As they do currently, under the new license, FirstLight will carefully manage non-project use of Project lands by issuing short-term license agreements/leases (typically 5 years) to ensure that uses of the lands are consistent with Project purposes, that non-project uses of the lands are limited to the uses specified under the terms of the license agreement/lease, and that disturbance to the land, vegetation, and any other natural features are minimized. FirstLight will revoke or not renew license agreements or leases for such non-project use of Project lands if terms of those license agreements/leases are violated. For requested non-project uses of Project lands that have the potential to impact significant resources, including wetlands, historic properties, traditional cultural sites, RTE species or their habitats, or other important habitats, FirstLight will consult with the appropriate agencies before approving the requested non-project use of Project lands. For requested non-project uses of Project lands that require prior FERC approval, FirstLight will consult with the appropriate agencies and then prepare a request package for FERC that includes the results of the consultation and information about the proposed use of the lands. Overall, the continued operation of the Project, as proposed, will maintain the character of surrounding lands and will promote public interaction with the surrounding nature through the NMTTC, parks, trails and campgrounds. Use of adjacent lands is not anticipated to be affected by FirstLight's proposal for relicensing the Project.

3.3.7.3 Cumulative Effects

There are no cumulative effects identified for land use in the Northfield Project.

3.3.7.4 Proposed Environmental Measures

FirstLight is proposing minor modifications of the Northfield Project boundary so as to consolidate the two separately licensed projects, into a single licensed project. Minor modifications are also being proposed to remove lands that are not necessary for Project purposes from the Project boundary. Overall, the proposed Project boundary will look very similar to the existing Project boundaries for the two projects, with these exceptions:

FirstLight is proposing to remove the USGS-owned and operated Conte Fish Lab from the Project boundary. The lands associated with the Lab being proposed to be removed have a land use designation of Developed and Forested. Figure 3.3.7.4-1 depicts the proposed parcel to be removed from the Project boundary. The Lab is owned, operated and maintained by the USGS for purposes of research, and serves no Project purpose. None of the facilities that comprise the Lab or the property owned by the USGS contains lands, waters, facilities or structures that are necessary for Project purposes. Nor are there any significant natural or recreational resources located on Conte Lab property. FirstLight's Phase IA (Reconnaissance) Archaeological Survey for MA identified several previously recorded archaeological resources on this parcel. These resources have not been investigated for NRHP eligibility. Removal of the parcel from the Project, however, will not result in an adverse effect to these resources because the parcel is owned by USGS (a federal governmental entity) and therefore will still be subject to Section 106 requirements. FirstLight's historical structures survey did not identify any eligible historic structures on this parcel. There are two parking lots owned by FirstLight, within the vicinity of the Conte Lab, which can be utilized for recreational access to the Cabot Woods Fishing Access site. These parking lots will remain within the Project boundary.

FirstLight is also proposing to remove an 8.1 acre parcel of land (Figure 3.3.7.4-2), which is a part of a larger parcel of land known as the Fuller Farm property. The parcel is located on the easterly side of Millers Falls Road (State Route 63) in Northfield, MA and has a land use designation of Developed, Agricultural – Pasture/Grass, and Forested. FirstLight's predecessor purchased the farm as part of a much larger tract when acquiring land to construct the Northfield Mountain Pumped Storage Development. When the design was finalized, the farm and land were not necessary for Project purposes, even though they continued to remain in the Project boundary along with the larger tract, some of which contains recreational trails or is used for recreational programming. The 8.1 acre farm property, however, includes residential and agricultural structures, and the underlying lands are not necessary for power generation, recreation, or any other Project purpose. The 8.1 acre parcel has never been used for, and is not needed for, operation and maintenance of the Project. The parcel is also not needed for recreational opportunities. The Project currently provides ample recreational opportunities and the portion of the larger tract that contains recreational trails and is used for recreation programming will remain in the Project boundary.

FirstLight's historical structures survey found that the buildings (house, barn, and outbuildings) (known as the Fredrick Morgan, Sr. house/Morgan-Fuller Residence in MHC's Inventory of Historic and Archaeological Assets) located on the 8.1 acre parcel are not eligible for listing on the National Register of Historic Places due to lack of historic/architectural significance and lack of integrity (FirstLight, 2015c). FirstLight's Phase IA (Reconnaissance) Archaeological Survey for Massachusetts identified the 8.1 acre parcel as sensitive for the presence of archaeological resources (Sara *et al*. 2014a, 2014b).[54] While FirstLight's Phase IA reconnaissance level archaeological survey included the 8.1 acre parcel in its recommendations for intensive (Phase IB) survey, the parcel is not in a location that is susceptible to erosion or in an area that suggests there are Project-related effects on the property.

Maps showing the location of the parcels to be removed from the Project boundary are contained in Exhibit G.

The Licensee has developed land use designations, which will be used by the Licensee via GIS mapping (including a privileged sensitive resources overlay map) to aid in land management activities, including vegetation management. FirstLight will continue to make land management decisions that are consistent with these land use designations and to be protective of sensitive resources. There are no other environmental measures related to land uses proposed at this time.

3.3.7.5 Unavoidable Adverse Impacts

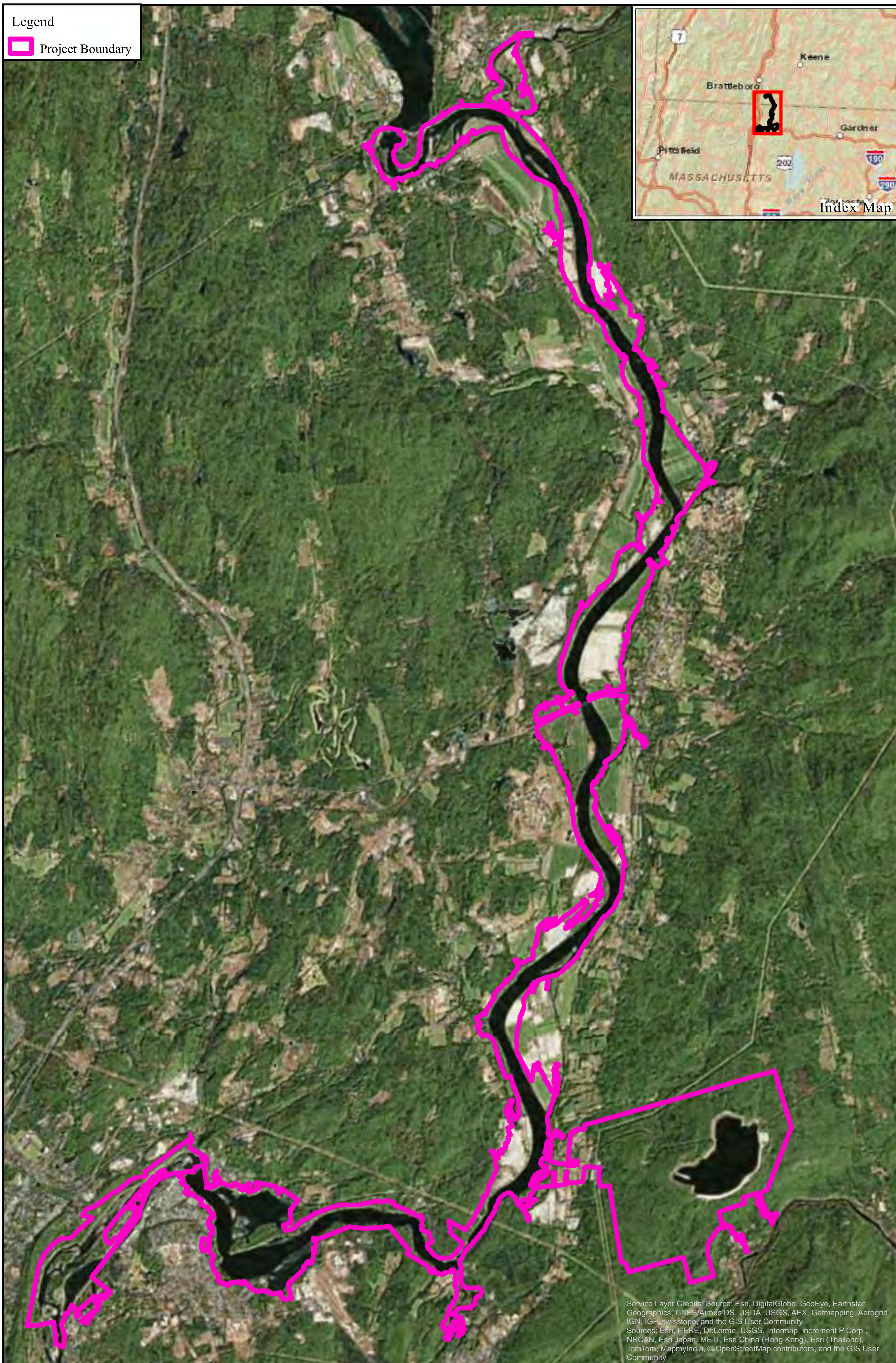
No unavoidable adverse impacts are expected to land use in the Northfield Project.

[54] The Study Report for the Phase IA Archaeological Investigation for Massachusetts was submitted to the MHC and filed with FERC as "privileged" on December 31, 2015. Technical revisions, as requested by the MHC, were submitted to the MHC and filed with FERC as "privileged" in May 2015.

Table 3.3.7.1.2-1: Land Use Designations within the Project Boundary

Land Use Designation	No. of Acres Within the Project Boundary	% of Land within the Project Boundary
Agricultural – Crops	1,010[1]	13.9
Agricultural - Pasture/Grass	37	0.5
Natural/Undeveloped	37	0.5
Developed	333	4.6
Forested	951	13.1
Open Water	2,647	36.5
Wetland	396	5.5
Recreation	1,835[2]	25.3
Total	**7,246**	**100**

[1] The majority of the agricultural cropland within the Project boundary is on lands which FirstLight does not own in fee.
[2] Approximately 1,673 of these acres are the Northfield Mountain Tour and Trail Center.



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FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

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Figure 3.3.7.1.1-1:
Existing Project Boundary

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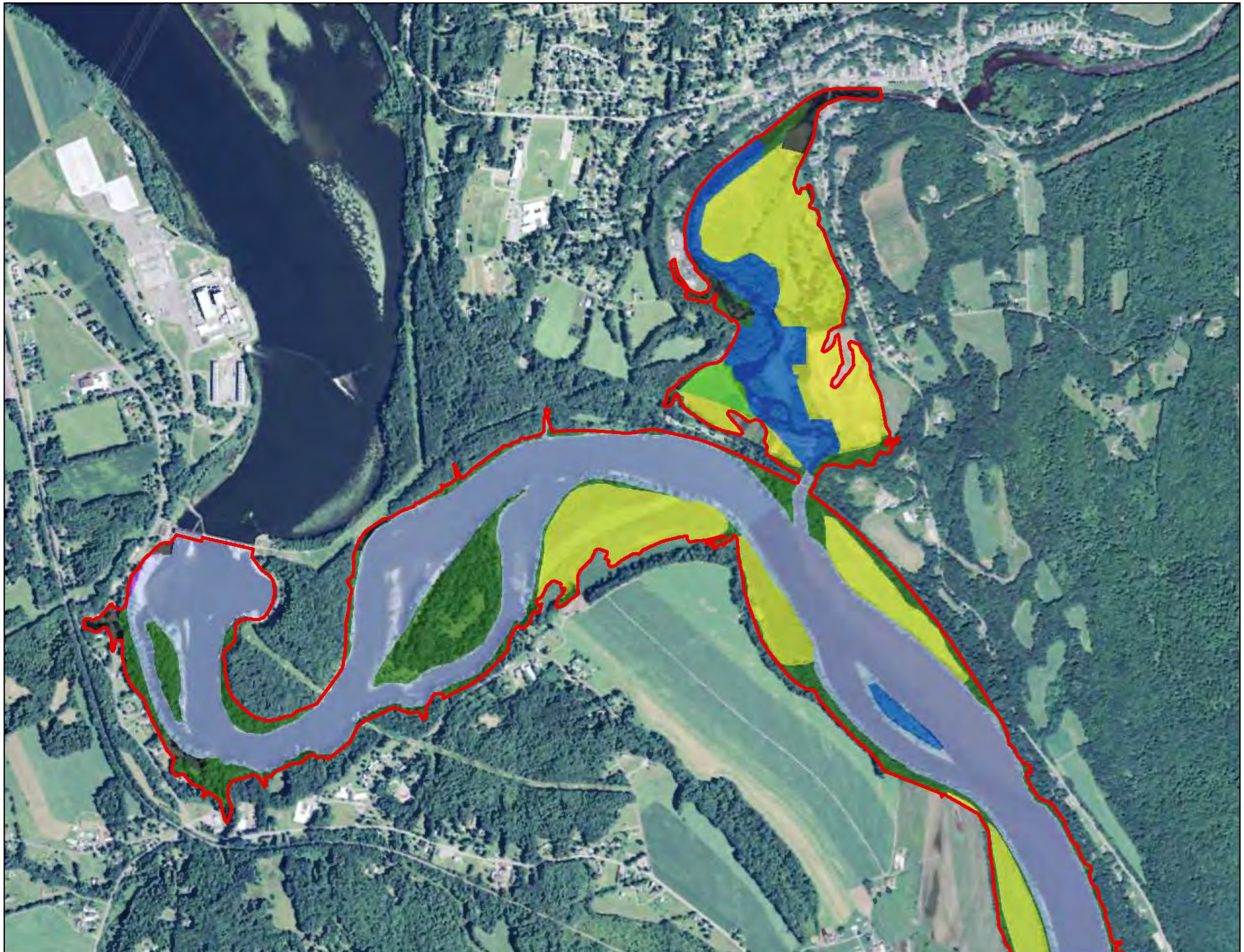

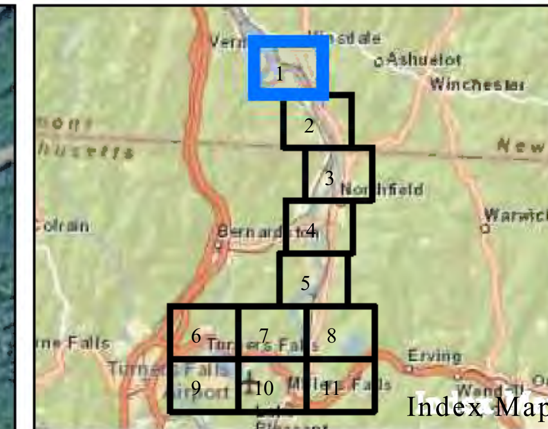

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 1

Legend

N

- Project Boundary Polygon

Land Use

- Agricultural - Crops
- Agriculture - Pasture/Grass
- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

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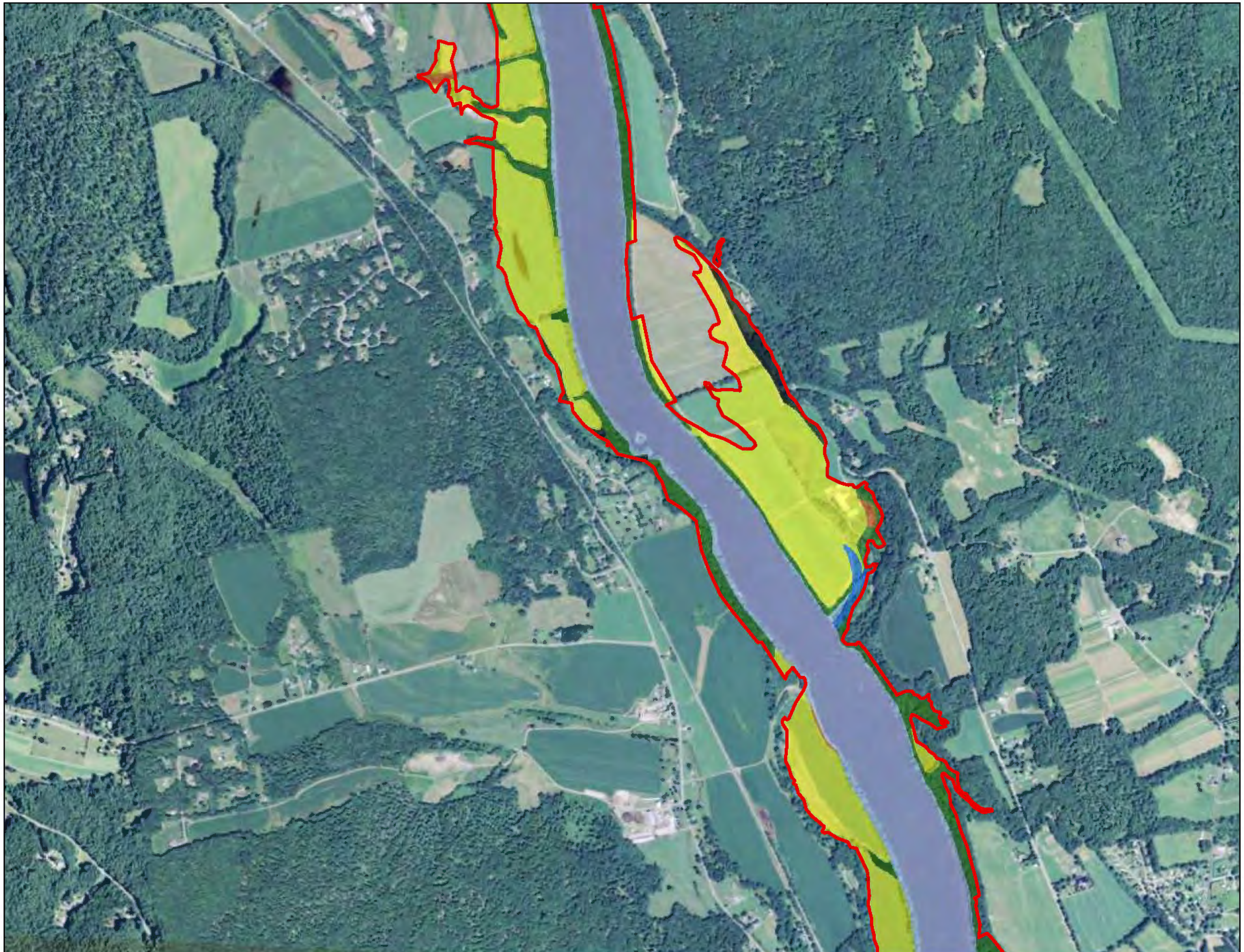

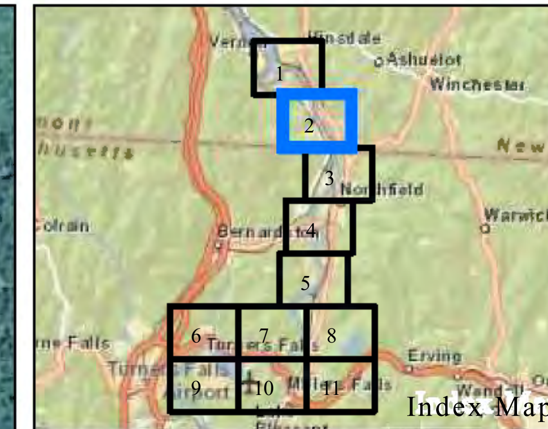

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 2

N

Legend

Project Boundary Polygon

Land Use

Agricultural - Crops

Developed

Forest

Natural/Undeveloped

Open Water

Wetland

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

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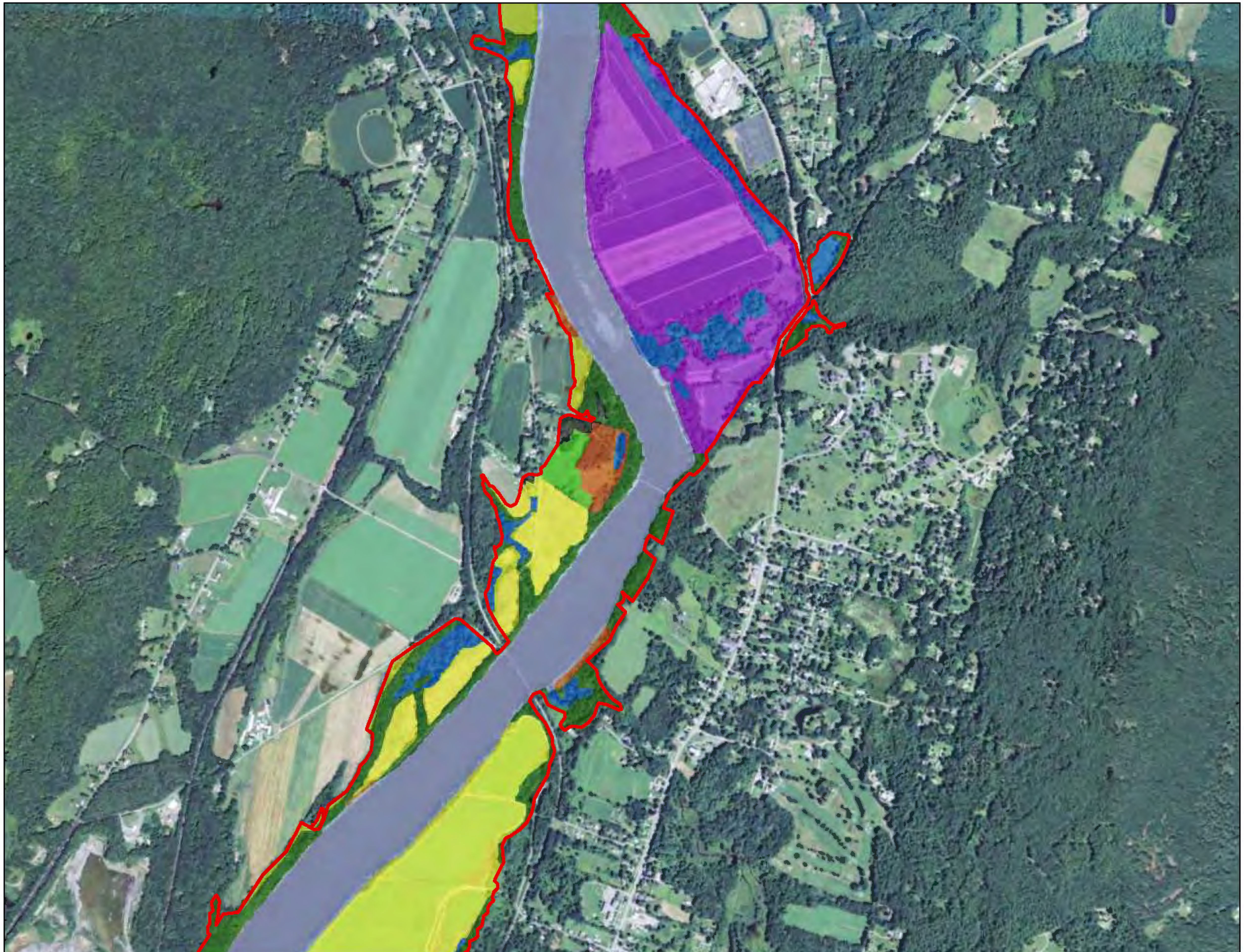

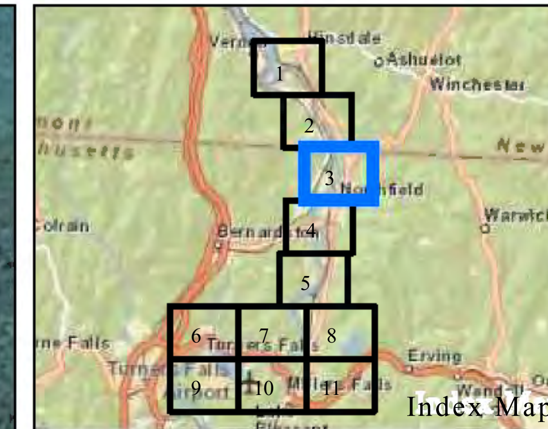

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 3

Legend

N

- Project Boundary Polygon

Land Use

- Agricultural - Crops
- Agriculture - Pasture/Grass
- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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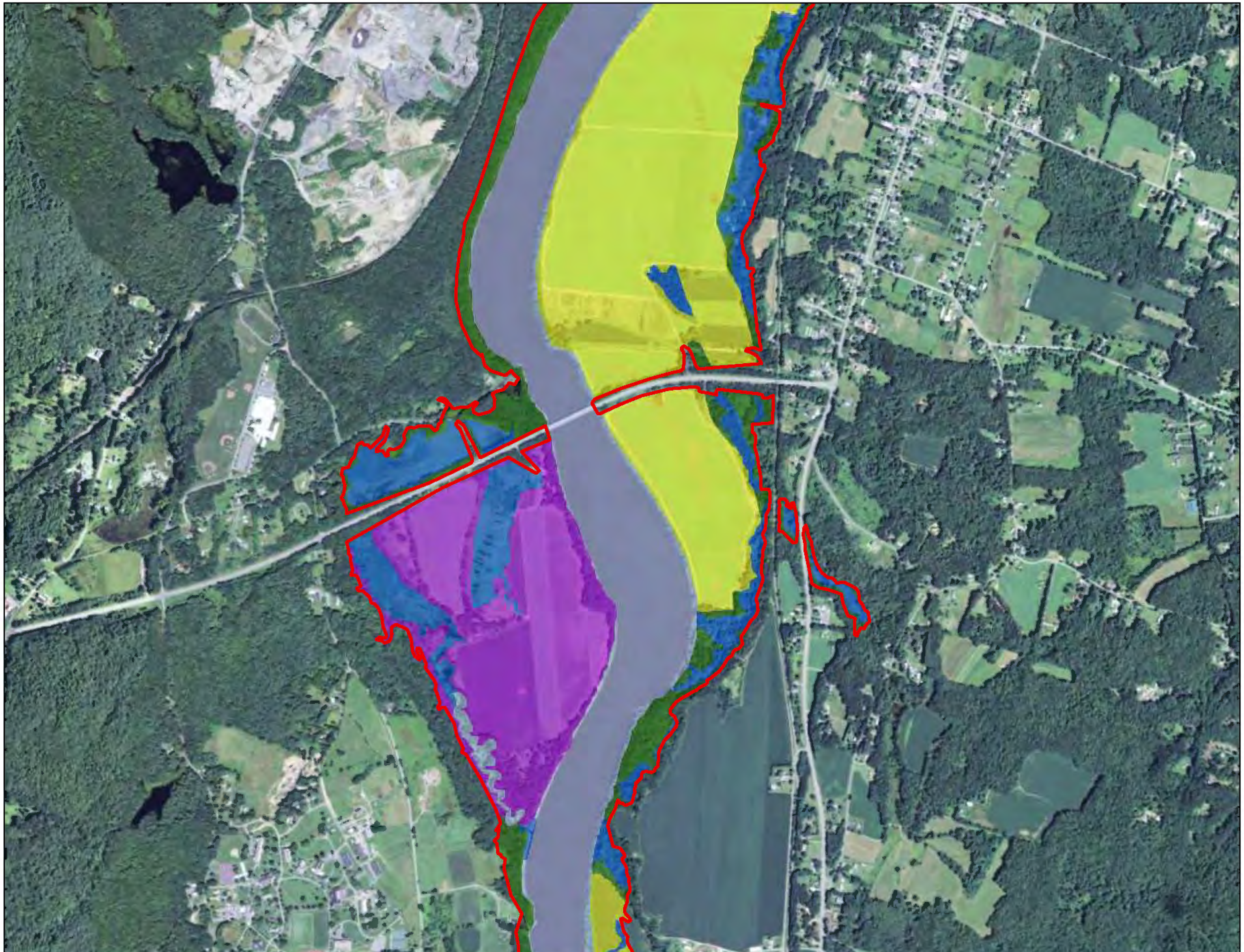

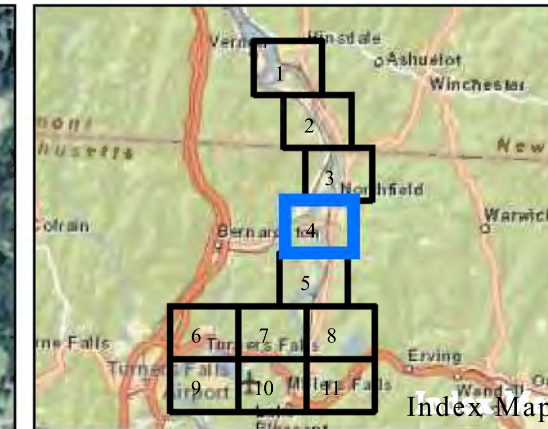

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 4

N

Legend

- Project Boundary Polygon

Land Use

- Agricultural - Crops
- Developed
- Forest
- Open Water
- Recreation
- Wetland

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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1 inch = 1,155 feet

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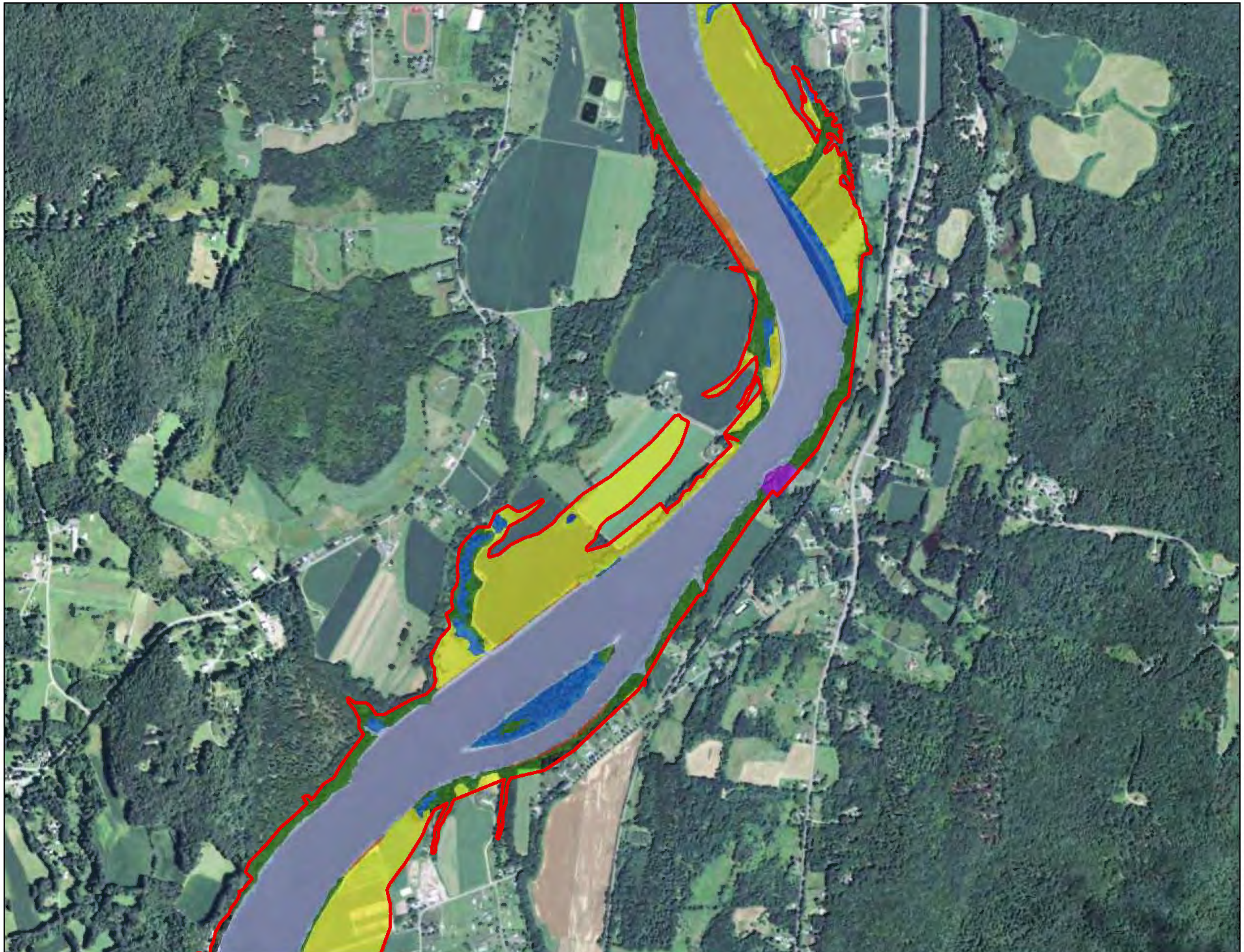

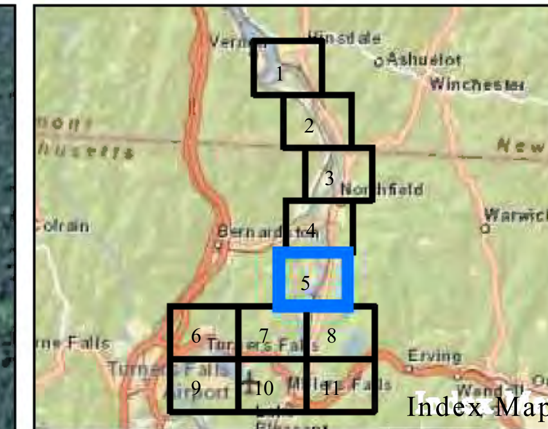

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 5

Legend

- Project Boundary Polygon

Land Use

- Agricultural - Crops
- Agriculture - Pasture/Grass
- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

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1 inch = 1,155 feet

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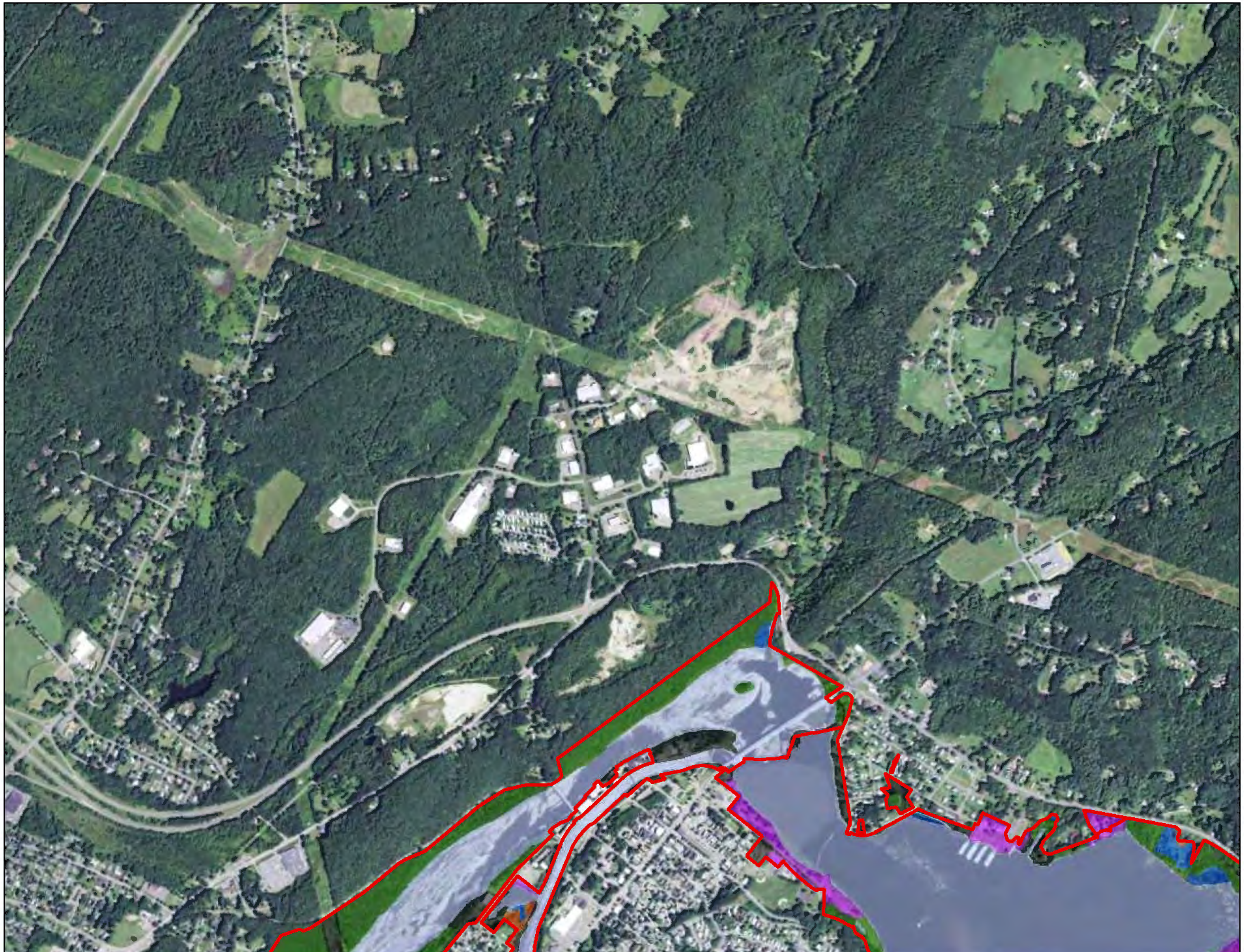

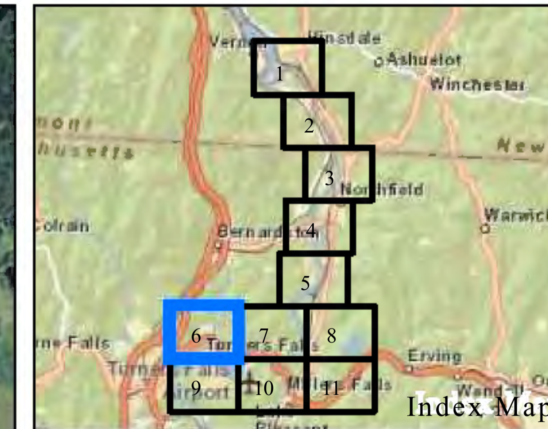

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 6

N

Legend

- Project Boundary Polygon

Land Use

- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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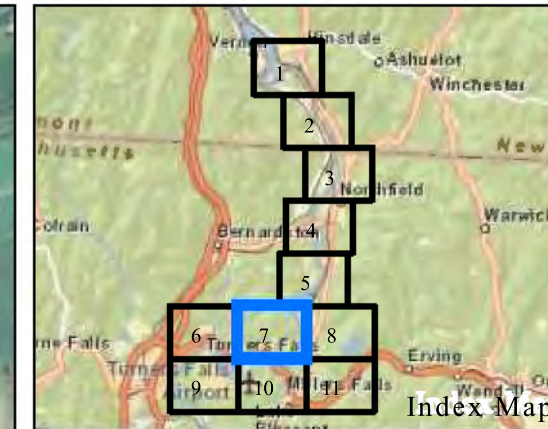


Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)
Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 7

Legend

Project Boundary Polygon

Land Use

- Agricultural - Crops
- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

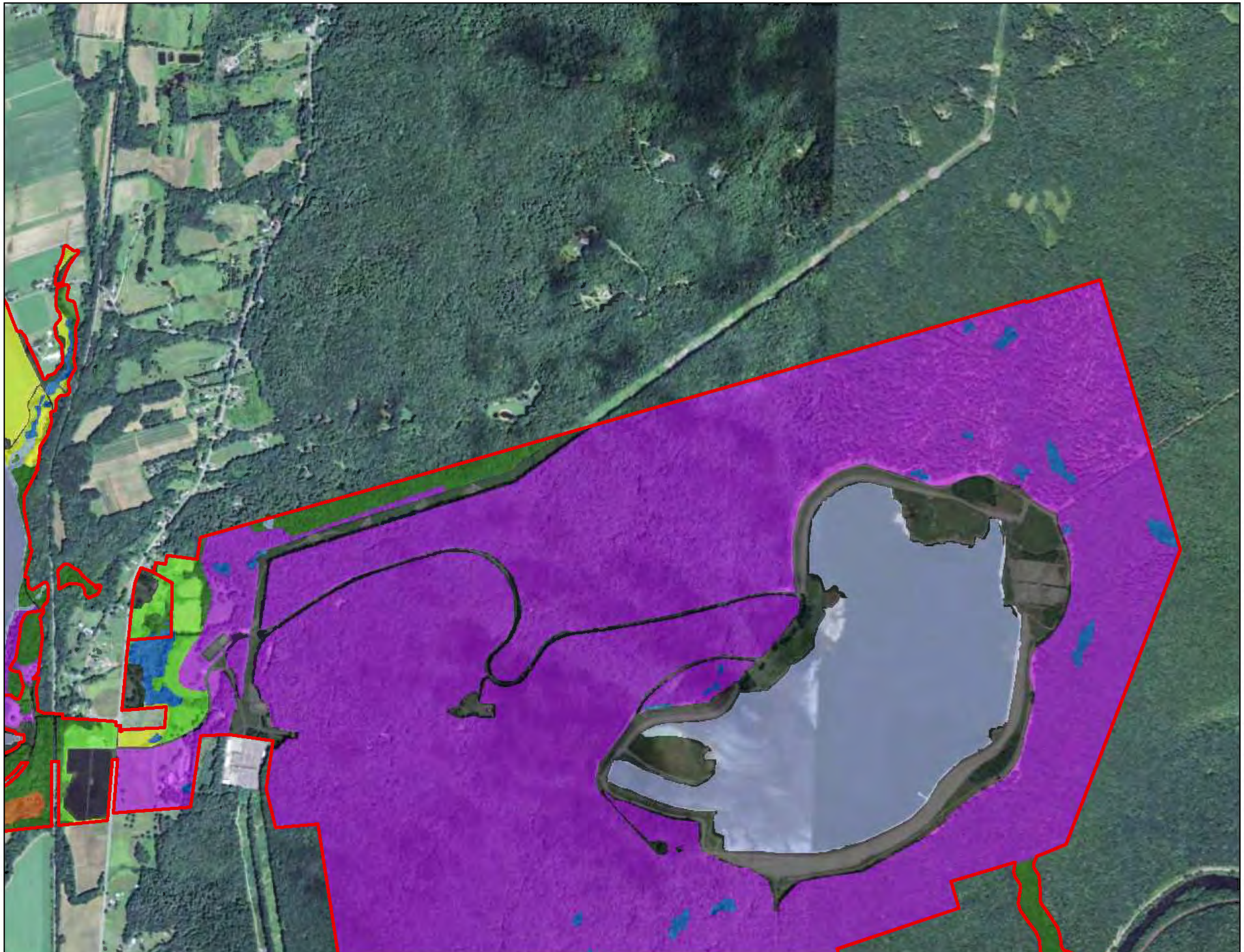
N

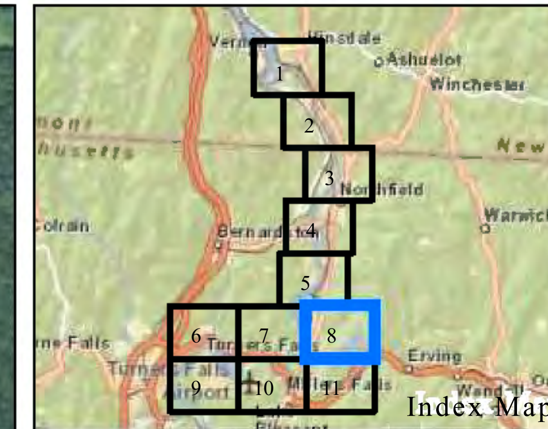
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

0 0.125 0.25 0.5 Miles

1 inch = 1,155 feet

FirstLight GDF SUEZ





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

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 8

Legend

- Project Boundary Polygon

Land Use

- Agricultural - Crops
- Agriculture - Pasture/Grass
- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

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1 inch = 1,155 feet

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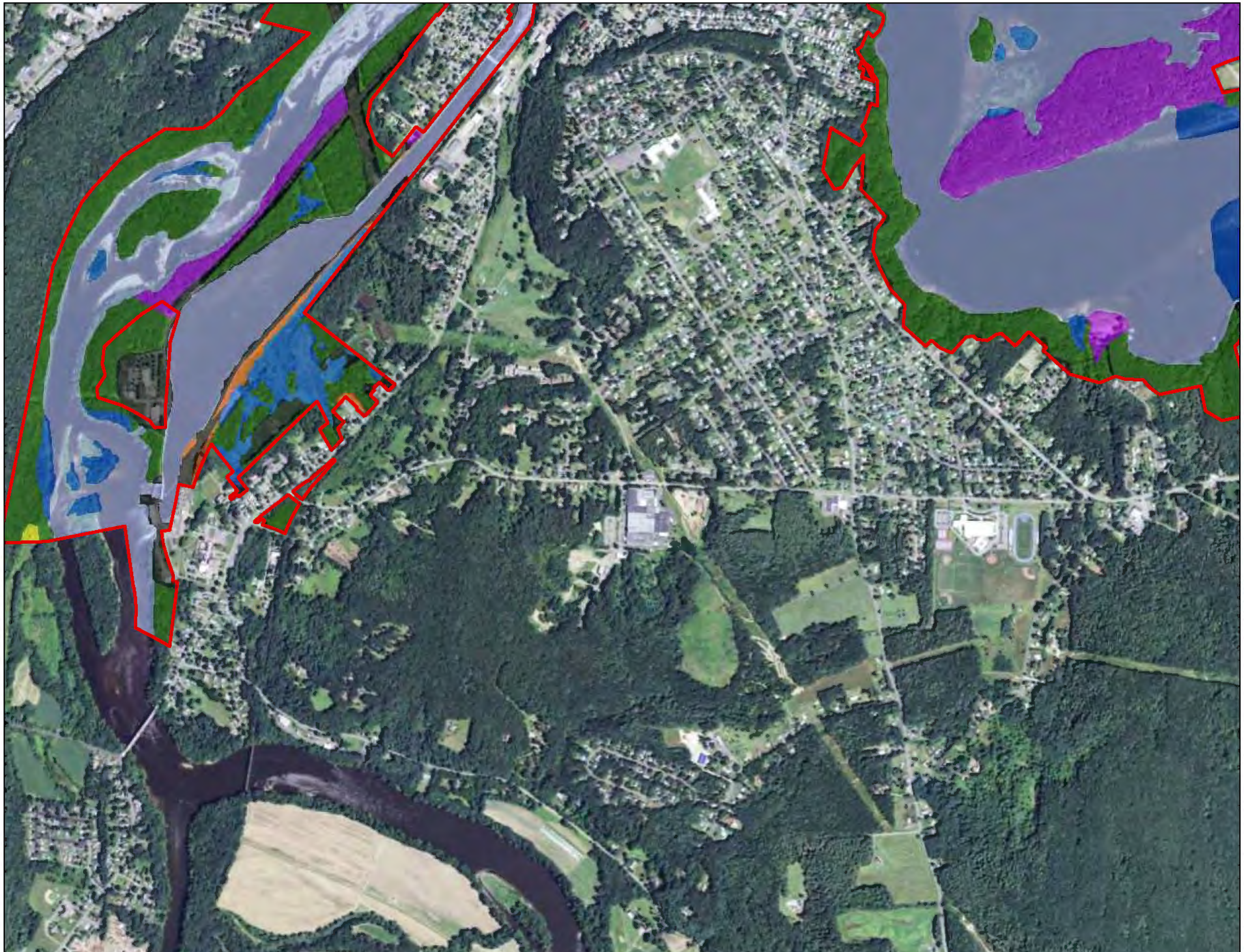

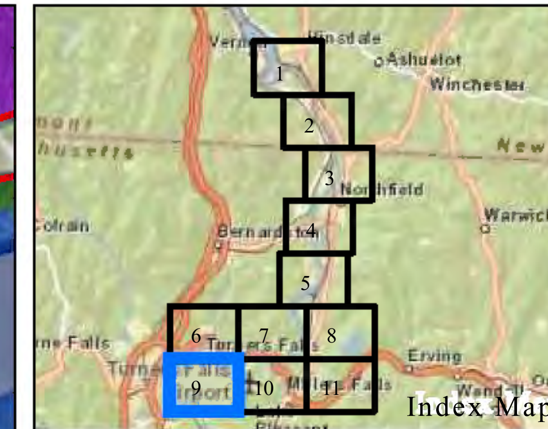

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 9

Legend

- Project Boundary Polygon

Land Use

- Agricultural - Crops
- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

N

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Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

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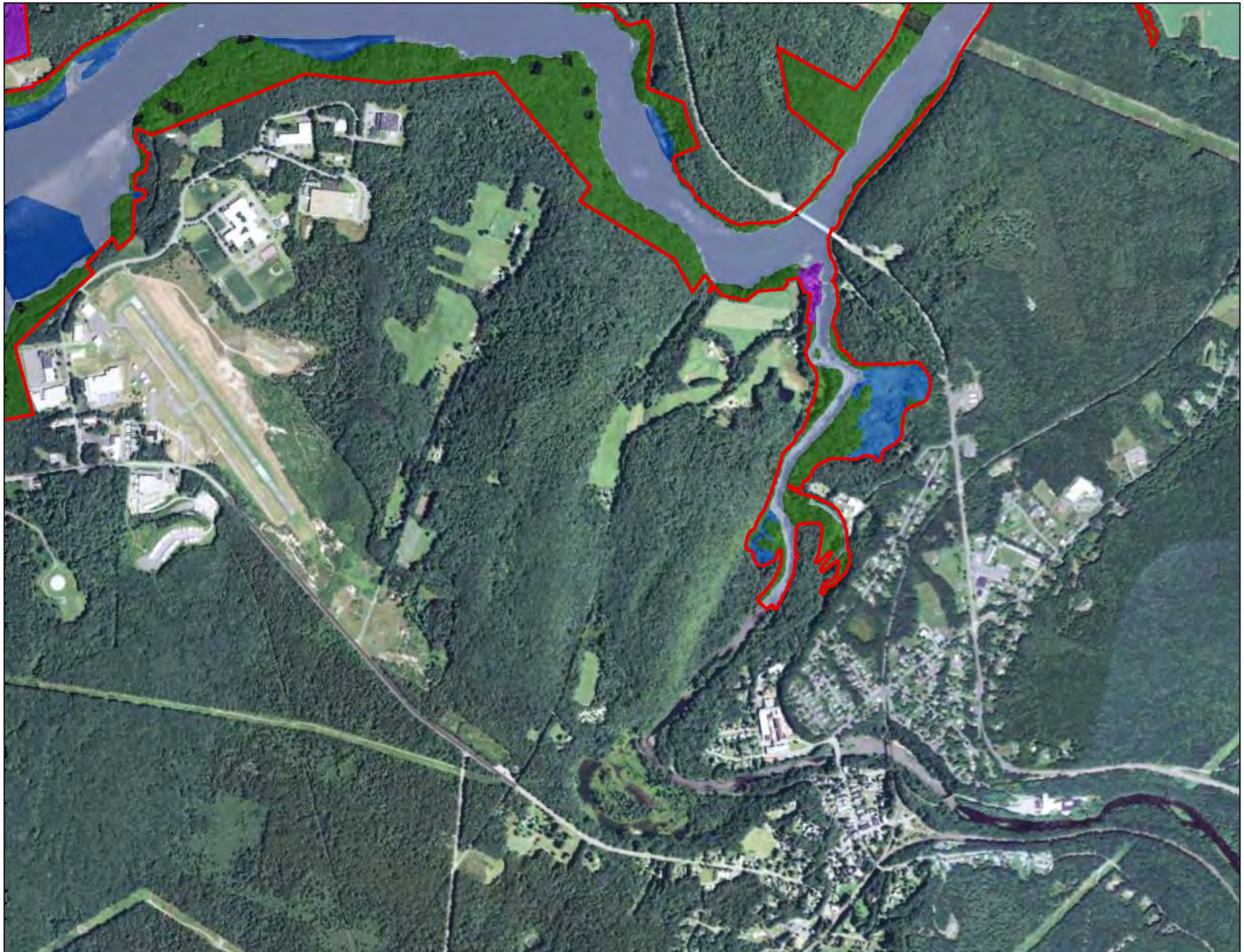
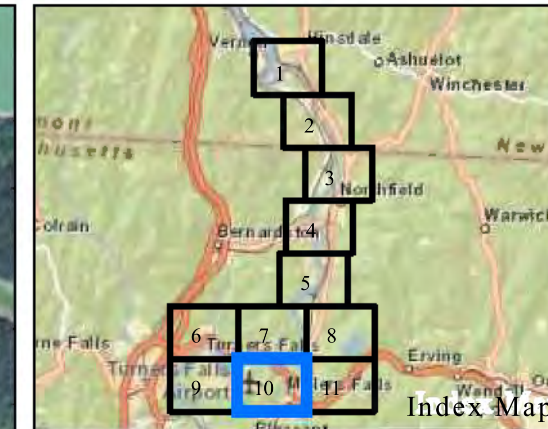
1 inch = 1,155 feet

FirstLight
GDF SUEZ





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

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 10

Legend

Project Boundary Polygon

Land Use

Agricultural - Crops

Developed

Forest

Open Water

Recreation

Wetland

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

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1 inch = 1,155 feet

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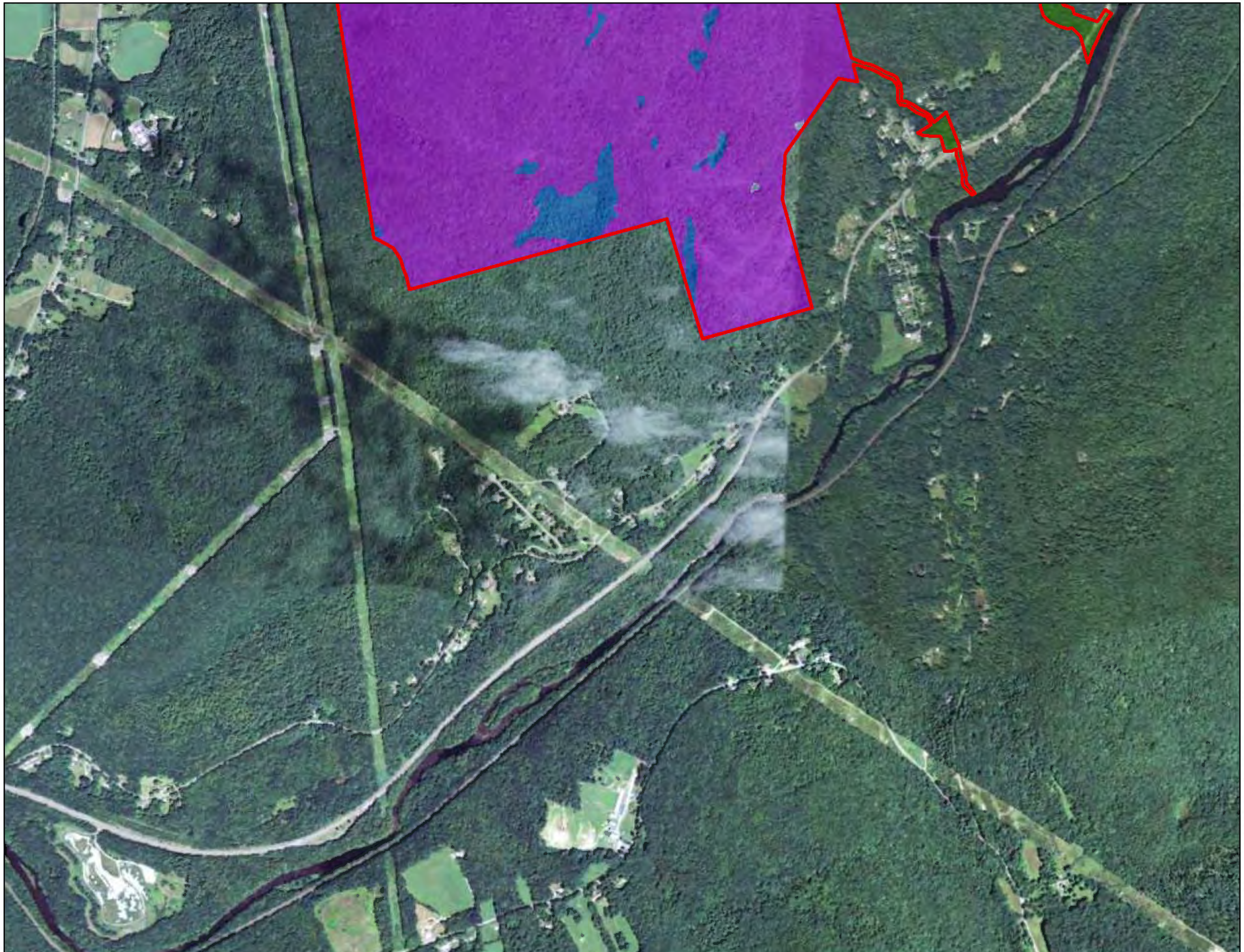

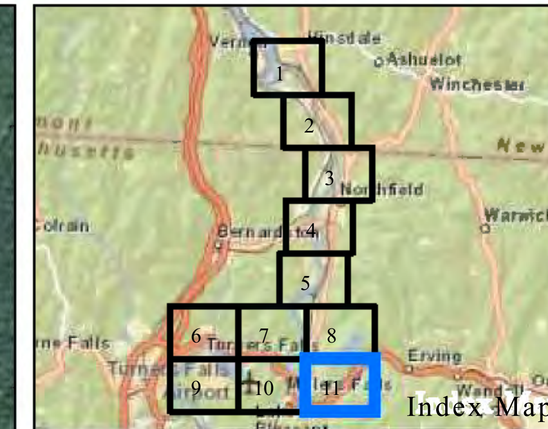

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Final License Application

Figure 3.3.7.1.2-1:
Land Use withing the Project Boundary
Map 11

Legend

- Project Boundary Polygon

Land Use

- Developed
- Forest
- Natural/Undeveloped
- Open Water
- Recreation
- Wetland

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp.,

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1 inch = 1,155 feet

FirstLight
GDF SUEZ

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

N

0 155 310 620
Feet

Figure 3.3.7.4-1:
Proposed Removal of the USGS Owned and Operated Conte Fish Lab

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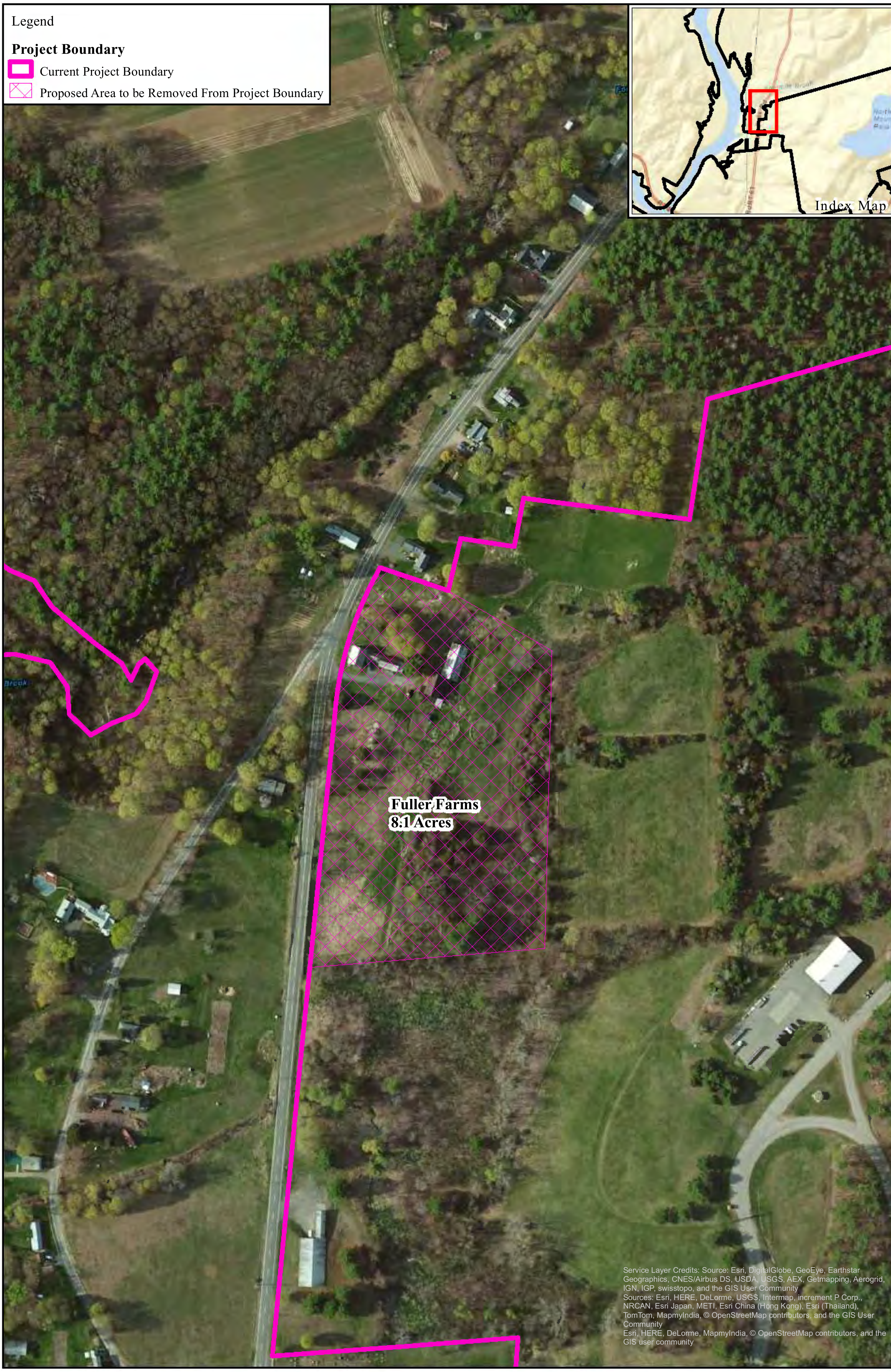

FirstLight GDF SUEZ

FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E

Figure 3.3.7.4-2:
Proposed Removal of the
8.1 Acre Fuller Farm Property

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3.3.8 Cultural Resources

Section 106 of the National Historic Preservation Act (NHPA) of 1966 (Section 106), as amended, requires the Commission to evaluate the potential effects of continued operation of the Project on properties listed in or eligible for listing in the National Register of Historic Places (NRHP) within the Project's Area of Potential Effects (APE). Properties listed in or eligible for listing in the NRHP are called historic properties. Section 106 also requires FERC to seek concurrence with the State Historic Preservation Offices (SHPO) on any finding of effects, and allow the Advisory Council on Historic Preservation an opportunity to comment before acting on a license application.

If Native American Traditional Cultural Properties (TCP) have been identified, Section 106 also requires the Commission to consult with interested Indian tribes that might attach religious or cultural significance to such properties.

3.3.8.1 Affected Environment

3.3.8.1.1 Area of Potential Effects

On November 27, 2013, FERC defined the APE for the Project in accordance with Section 106 and in consultation with the three SHPOs for the states included within the Project boundaries: the MHC, the NHDHR, and the Vermont Division for Historic Preservation (VDHP), along with the Narragansett Indian Tribe, and the Nolumbeka Project. The Project APE for both archaeological and historic architectural resources is defined as *"…all lands within the current FERC Project Boundary of the two projects in addition to any other lands outside the FERC Project Boundary where historic properties could be affected by project-related adverse effects. The Projects' APEs include lands within Franklin County, Massachusetts, Windham County, Vermont, and Cheshire County, New Hampshire. On lands adjacent to the project boundaries, the APEs would also include an additional 10 meters (33 feet) of lands inland from the top of banks of the Connecticut River and associated tributaries."* The APE for the Northfield Project is shown on Figure 3.3.8.1.1-1.

3.3.8.1.2 **Precontact and Historic Period Background**

Geographic Background. The Turners Falls Development and Northfield Mountain Pumped Storage Development are located on the Connecticut River in the states of MA, NH, and VT. The greater portion of the Turners Falls Development and Northfield Mountain Pumped Storage Development, including developed facilities and most of the lands within the Project boundary, are located in Franklin County, MA; specifically, in the towns of Erving, Gill, Greenfield, Montague, and Northfield. The northern reaches of the Turners Falls Development and Northfield Mountain Pumped Storage Development boundaries extend into the towns of Hinsdale, in Cheshire County, NH, and Vernon, in Windham County, VT.

Precontact Period Context (ca. 12,000 B.P. – ca. 500 B.P.)

The precontact period archaeological record of the Connecticut River Valley dates back more than 10,000 years (Johnson, 2007). Archaeologists have divided this record into three major periods known as the Paleoindian, Archaic, and Woodland periods. Further subdivisions within these periods are based on similarities in artifact forms and cultural adaptations over broad regions of the northeast. It is important to note that these divisions may be useful as archaeological constructs, and that their boundaries may represent changes perceived as culturally significant by archaeologists in the region.

Paleoindian Period (ca. 12,000-10,000 Years B.P.). The earliest recognized precontact period inhabitants in the Connecticut River Valley, and throughout North America, are referred to as Paleoindians. Paleoindians are believed to be the first people to migrate into North America and, in their pursuit of large game, rapidly colonized the continent (Martin, 1973). Throughout North America, the hallmark of Paleoindian people is the fluted spear point, which presumably was used to hunt down large game species, some of which are now extinct. These spear points are characterized by a lanceolate form and exhibit a long, groove-like flake struck from their base on both faces. In the northeast, Paleoindians are believed to have been highly mobile hunters and gatherers reliant mainly on caribou and their site locations tend to be associated with elevated landforms that may have provided prominent overlooks for migrating caribou herds (Spiess *et al*., 1998).

In the Connecticut River Valley, very little is known of the Paleoindian period. Only a few sites have been found in the region and these occur in a variety of settings. For example, the DEDIC/Sugarloaf site in Deerfield is situated on the surface of Lake Hitchcock bottom deposits and overlooks the modern floodplain (Ulrich, 1978); the Hadley Site is located on a low rise in a broad alluvial plain (Curran & Dincauze, 1977, p. 344-345); and the Hannemann Site is located on the sandy, well-drained Montague Plain near the Turners Falls airport (Hasenstab, 1987). The lack of Paleoindian sites is somewhat perplexing as the valley would have been a natural corridor for travel over great distances. Boisvert (1999) suggests Paleoindian occupation of northern New Hampshire often correlates with river valleys in order to provide ease of travel and communication with other regions. As suggested by Curran and Dincauze (1977), it might be that the environment of Lake Hitchcock was not favorable for Paleoindian occupation due to its limited resources and this is supported by the fact that the few resources recovered to date are found within the former margins of the lake. This would suggest that the environment became more favorable after drainage of the lake. The lack of Paleoindian sites may also reflect sampling biases, or the possibility that sites favored by Paleoindians have long since been destroyed by erosion processes and development. Regardless, the Paleoindian resources in the valley share a common trait with other Paleoindian sites of the northeast. This trait is the use of high quality cherts and other cryptocrystalline materials to manufacture stone tools.

The end of the Paleoindian period and subsequent transition into the Early Archaic period is poorly understood with no clearly defined correlation between the two periods. The beginning of the Archaic period within the Connecticut River Valley is marked only by the presence of bifurcate projectile points that are typically out of context. These points are best known in more southern regions and they suggest a different material culture than the preceding Paleoindian period.

Archaic Period (ca. 10,000-3,000 Years B.P.). The Archaic period represents the longest cultural period in the region, spanning around 7,000 years. This time frame is indicative of persistent cultural adaptations, as inferred from artifact assemblages, which lasted over several millennia. As noted earlier, Early Archaic period occupation is poorly represented in the valley and not well understood. The scant evidence comes from a few bifurcate points representative of the Early Archaic period recovered from the Riverside Archaeological District (Johnson & Krim, 2007; Nassaney, 1999). The lack of Early Archaic period remains may be due to the fact that sites dating to this period have been deeply buried in alluvial deposits and therefore not adequately sampled. Another possibility is that sites dating to the Early Archaic period have gone unrecognized due to the absence of chipped stone projectile points. Research in northern New England has revealed Early Archaic assemblages consisting of crudely fashioned flake and unifacial tools made on cobbles and locally available stone (Robinson, 1992). These Early Archaic assemblages are commonly found in stratified riverine settings and reveal an adaptation to aquatic resources, particularly beaver, muskrat, and fish. It is presumed that similar resources and settings would have been available in the Connecticut River Valley as well.

By the Middle Archaic period, sites are somewhat more numerous, but still relatively scarce within the Connecticut River Valley. Middle Archaic period sites are marked by an increase in chipped stone spear points, particularly those of the Neville and Stark variety. These points have been found in a variety of settings, including river and stream margins in both upland and lowland areas (Johnson, 2007). They are believed to have affiliations with forms in the mid-Atlantic region suggesting broad regional influences during the Middle Archaic period (Dincauze *et al.*, 1976). The variety of settings where Middle Archaic sites are found led some researchers to hypothesize the establishment of seasonal scheduling of subsistence activities and increased recognition of territories (e.g., Dincauze *et al*., 1977, Thomas, 1980).

By the Late Archaic period, sites are more frequent and larger in size, possibly suggesting an increase in population density (Nassaney, 1999). The sites also tend to occur in a wider variety of settings with large sites occurring where resources could be seasonally procured in abundance (e.g., Turners Falls) and smaller sites occurring in upland areas where specific resources were exploited. Quarrying of diabase and steatite from sources within the valley also becomes more widely recognized during the Late Archaic period and is believed to be part of a groundstone industry that likely emerged during the earlier Archaic period (Robinson, 1992; Johnson & Krim, 2007). The Late Archaic is divided into three major traditions that include the Laurentian, Small-Stemmed, and Susquehanna traditions. These traditions are largely inferred from different point styles that range from side-notched forms (e.g., Otter Creek and Brewerton), crudely fashioned stemmed forms made of local materials (Small-Stemmed Point), and broad-bladed forms (Susquehanna). As in most areas of the northeast, the Laurentian and Small-Stemmed Traditions tend to predate the Susquehanna Tradition. In particular, it is uncertain whether the various archaeological assemblages of the Late Archaic reflect local, long-term cultural adaptations or movement of people into the region with a different culture and way of life. The expansion of sites and variety of point styles during the Late Archaic period, particularly those of the Susquehanna, may relate to environmental changes that led to decreases in aquatic resources and increases in the habitat of terrestrial animals.

Woodland Period (ca. 3,000-500 Years B.P.). The introduction of pottery manufacture signals the beginning of what archaeologists call the Woodland period in the Connecticut River Valley. Woodland period sites are the best represented in the valley and occur in a variety of sizes and habitats, as well as show a diverse range of activities (Johnson, 2007). The Connecticut River Valley played a significant role in the development of the Woodland period due to its fertile bottomlands, which were favorable for horticulture, and its exposures of Lake Hitchcock bottom sediments, which provided a readily available source of clay for pottery manufacture. The period is divided into Early, Middle, and Late subdivisions.

During the Early Woodland period, adaptations established during the Late Archaic continue with most Early Woodland components found in similar settings to Late Archaic sites. Diagnostic tool forms during the Early Woodland include Vinette I pottery, Meadowood projectile points, and blocked end tube pipes suggestive of influence from Adena cultures in the Midwest. The first real evidence for mortuary activity containing Adena-like artifacts, also appears during this time and is believed to be representative of wide-spread exchange system recognized over a broad region of eastern North America (Johnson, 2007). The Middle Woodland period is defined largely by the presence of different pottery styles. Long established patterns of seasonal exploitation of resources, and concomitantly congregation of people, at favored locations such as Turners Falls, continue. However, by the end of the Middle Woodland period, horticulture became established as a part of the subsistence pattern. The emergence of horticulture certainly would have affected settlement patterns to some degree with occupation increasing in areas where fertile soils were prevalent. The Late Woodland period is marked by the continued development of horticulture, evolving pottery styles, and the presence of diagnostic triangular projectile points known as Levanna.

The picture that emerges from Woodland period sites is one showing a long-standing cultural adaptation to the diversified use of local resources. In addition, the nature of artifact forms present and certain types of stone recovered from Woodland period sites indicate trade and communication with people from far-off regions. By the end of the period, historical evidence suggests core settlement areas had developed in the lowlands of the valley with peripheral areas occupied during certain times of the years for hunting and gathering. The Woodland period ends with European contact around 500-450 years ago. At this time, referred to as the contact period, many of the artifacts attributable to precontact period inhabitants disappear from the archaeological record and trade goods, such as copper and beads, emerge in the record.

Historic Period Context (1500-1973)

Contact Period (1500 – 1620). The contact period (1500-1620) in the Connecticut Valley is defined by direct and indirect interaction between Native American populations and Europeans. It is unclear when initial contact between these populations took place in the region, but most likely occurred to the south of the study area in the early seventeenth century. Contact between these populations (direct and indirect) was intermittent and it is thought that little material culture of European origin was utilized by Native Americans.

Plantation Period (1620 – 1675). The Plantation period (1620-1675) witnessed the development of a number of European settlements including those in the town of Northfield. During this period, direct contact between Europeans and the Native American population increased in part due to mutual involvement in the fur trade. This contact led to widespread epidemics and resulted in the decimation of Native American populations and the abandonment of Native American settlements.

Colonial Period (1675-1775). Colonial settlement of the Project area (present-day towns of Gill, Greenfield, Montague, Erving and Northfield, MA; Vernon, VT; and Hinsdale, NH) in the seventeenth century was scattered and short-term and is for the most part poorly documented. Turners Falls gained its name from the historic “Falls Battle” of 1676, when Captain William Turner attacked a group of Pocumtucks and members of other tribes camped at the falls of the Connecticut River. More than 300 Indians died in the battle before they counter-attacked, killing Turner and 40 of his men (Jenkins, 1980, p. 8.1).

Considered a northern outpost of colonial settlement, the Vernon and Northfield areas were largely abandoned during King Philip's War and only lightly re-settled after the conclusion of Queen Anne's War in 1714. Confusion over the town boundaries of Northfield in relation to the New Hampshire colony to the north resulted in several inconclusive surveys that muddied settlement claims in the area for many years (NHDOT, 2007, p. 4). A 1753 decree by New Hampshire’s Royal Governor created two towns north of Northfield on either side of the Connecticut River, both named Hinsdale (Holmes *et al*., 1991, p. 56).

Federal Period (1775-1830). Vermont, contested among NY, NH and MA in the years before the Revolution, enjoyed a population boom in the late 1700s. In 1783, the province had a population of 10,000; by 1790, it had increased to 55,425. On March 4, 1791 Vermont gained statehood. In October 1802, the town on the Vermont side of the Connecticut River changed its name from Hinsdale to Vernon (Child, 1884. p. 304; Holmes et al., 1991, p. 56).

Turners Falls itself was not settled until 1792, when a canal and dam were proposed by the Proprietors of the Upper Locks and Canals of the Connecticut River to aid navigation around both Turners Falls and South Hadley to the south. When completed in 1798, the locks and canals formed a vital link in the 300-mile system of waterways from Wells River, VT to Hartford, CT (Jenkins, 1980, p. 8.1). The canal, designed by Benjamin Prescott of Northampton, was 2.5 miles long and 14 feet wide, with ten locks. In 1799, the Fifth Massachusetts Turnpike Company was established to either construct new roads or take over and improve existing ones in western MA.

Early Industrial Period (1830-1870). Railroads opened up the entire Connecticut River Valley area to sustained economic development beginning in the 1840s and remained the area’s transportation backbone for nearly a century. The first railroad line to reach the Turners Falls area of Montague was the Connecticut River Railroad, a north-south line between New Haven and Greenfield which began service in 1846 (Holmes *et al*., 1991, p. 24). This line was extended to Brattleboro, Vermont in 1851.

The present-day Village of Turners Falls in Montague dates only from 1866, when Colonel Alvah Crocker decided to create a planned industrial community on the model of Lowell or Holyoke (Jenkins, 1980, p. 8.1). Crocker and his associate Wendell T. Davis bought up the stock and water rights of the defunct Proprietors of the Upper Locks and Canals and eventually acquired 700 acres of land in the Turners Falls area (Abercrombie, 1925). Crocker and Davis founded the Turners Falls Company which embarked on building a dam and a new power canal that roughly paralleled the route of the old navigational canal, from which water was thereafter leased or sold to factories for power purposes. A wood-and-stone crib dam with a 30-foot fall at the Turners Falls rapids was completed in early 1867 (Jenkins, 1980, p. 8.2).

The new village received a huge boost in 1868, when the John Russell Manufacturing Company moved to Turners Falls. Its complex of two- and four-story buildings (no longer standing) running for nearly 2,000 feet along the power canal housed one of the largest cutlery factories in the world at the time (Jenkins, 1980, p. 8.2; Montague Bicentennial Committee, 1954, p. 12; Great Falls Discovery Center, 1996, p. 3).

Late Industrial Period (1870-1915). In 1871, the Montague Paper Company (partially owned by Alvah Crocker) built its complex on a site on either side of the power canal just below the dam bulkhead. The Keith Paper Company (later Hammermill Paper) Mill complex was completed in 1873. In 1874, the Turners Falls Cotton Mill was built at the southern end of the power canal (Holmes *et al*., 1991, p. 28).

The Riverside area of Gill remained sparsely populated until late 1867 when Amos Perry, David Wood, and Nathaniel Holmes bought water rights on the Connecticut River from the Turners Falls Company along with a small parcel of land in Riverside at the edge of the river for a grist- and saw-mill (Gill Historical Commission, 1999, p. 2). In 1872, Holmes, Wood and Perry incorporated as the Turners Falls Lumber Company to bring logs downriver to their saw-mill from VT, NH, and Canada. The company's saw-mill provided vast amounts of lumber for the development of Turners Falls across the river and lumber production soon surpassed the gristmill (Gill Historical Commission, 1999, p. 3).

By the early 1880s, Hinsdale possessed a well-developed industrial infrastructure, centered on several paper and cotton mills built along the Ashuelot River. High, Hancock, and Prospect Streets were laid out on the north side of town, reflecting the steep hillside on which the village is built. High Street, located above the heat and noise of the valley below, was soon lined with spacious architect-designed residences (NHDOT, 2007, p. 8).

On June 9, 1886, A.S. Clarke of the Clarke & Chapman Machine Company, made arrangements with the Turners Falls Company for a six-hour additional use of water for the purpose of generating electricity at night. In late 1886, an electric generating station opened at the Turners Falls gatehouse and in 1892, the gatehouse was expanded for greater water flow (Sanborn Map Company, 1895). The present Turners Falls gatehouse was built in 1903-1904 following demolition of the original 1866 gate house and was substantially enlarged in 1913-1914 (Turners Falls Power & Electric Company, 1914a, 1914b; Gregory, 2006, p. 12).

The Turners Falls Power Canal also was improved by widening it and increasing its depth (Sanborn Map, Company, 1895). By 1917, the canal was extended to its present length of approximately 2.5 miles (Turners Falls Power & Electric Company, 1917). Final work on the canal's excavation was completed that year when it reached its present depth of between 25-40 feet and between 100-920 feet (the latter at the Cabot forebay) in width (Jenkins, 1980, p. 8.4; Gregory, 2006, p. 13; Holmes *et al*., 1991, p. 28).

In 1892, the Boston & Maine Railroad acquired the entire Connecticut River Railroad, made up of the former 21-mile Ashuelot Railroad and the Cheshire Railroad, among others (Wallace *et al*., 2001, p. 36). In 1911, the railroad extended its line from Dole Junction, NH to Brattleboro, VT on the other side of the river. Known as the Fort Hill Branch of the Boston & Maine Railroad, the rail line at one time included eight bridges, a 2,800-foot causeway and numerous stone culverts and drains (Hostutler and Muzzey, 1994).

In 1904, the Central Railroad of Vermont, rebuffed in its offer to construct a combination rail/vehicular bridge, proceeded with plans to construct its own bridge across the Connecticut River in Northfield. The six-span, pin-connected, metal Pratt truss bridge was completed later that year. The bridge's current appearance with five spans now consisting of a series of Warren deck trusses is the result of a major reconstruction carried out by the American Bridge Company for the railroad after the bridge was severely damaged in the 1936 flood (Arts Council of Franklin County, 1978d).

By the beginning of the twentieth century, the Turners Falls Company had moved into the emerging hydro-electric market (Jenkins, 1980, p. 8.3). In 1904, Charles Hazelton, treasurer of the Turners Falls Company, proposed to his board of directors that that they make better use of the water power currently being wasted by widening and extending the power canal, and establishing a hydroelectric generating plant of 5,000 kilowatt capacity. (Bennett, 1990a, p. 5).

In 1905, the Turners Falls Company completed construction of Station No. 1, a 1,000-kilowatt unit built approximately 3,000 feet downstream of the Turners Falls gatehouse at the upstream end of the power canal (Turners Falls Company, 1904, 1907). As designed, the construction of Station No. 1 involved the installation of six small horizontal Francis-type units (WMECO, 1987, p. 2). The first generation of electricity from water power by the Turners Falls Company took place in 1906. By 1913, the station had grown to five units with a total capacity of 5,000 kW.

In 1908, Boston financier Phillip Cabot assumed the post of president of the Turners Falls Company, which was reorganized and renamed the Turners Falls Power & Electric Company, reflecting the company's new focus on hydroelectric power and its transmission. Cabot's ambitious plans called for the construction of a second powerhouse, named Cabot Station in his honor, replacing and raising the original Crocker-built dam with the present Gill and Montague (Turners Falls) Dams, and extending and widening the power canal and Gate House. Work began on dam construction in 1912 and was completed in 1915 along with the Cabot Station in 1917 and the newly improved power canal by the 1920s.

The Sixth Street Bridge was constructed across the power canal in 1912. It is a riveted, double-intersection Warren thru-truss, designed by the Eastern Bridge & Structural Company of Worcester MA, and erected by a crew of workers from the Turners Falls Company (Bennett, 1990a, p. 4). The Eastern Bridge & Structural Company also built footbridges at Fifth Street and to the Keith's Mill (Arts Council of Franklin County, 1978a, 1978b, and 1978c).

Modern Period (1915-Present). In 1915, the Eleventh Street Bridge was completed over the power canal. The bridge is a unique triple-barreled configuration of a double-intersection Warren thru-truss, with a pair of trusses on either side of the roadway, and lateral bracing between each pair, but none over the roadway. The Eleventh Street Bridge was also engineered by the Eastern Bridge & Structural Co. and is the only known example of this bridge type in MA (Arts Council of Franklin County, 1978e; Bennett, 1990a, p. 1).

In 1915, the Turners Falls Company completed construction of a new Turners Falls Dam to replace the original Crocker-built dam. That same year, construction began on the Cabot Station powerhouse located at the south end of the power canal. Cabot Station was named for Philip Cabot who was largely responsible for its construction, first as President of the Turners Falls Company after 1908, and then as founder and president of the Turners Falls Power & Electric Company (Arts Council of Franklin County, 1978c). Historically, Cabot Station represents the last major industrial development of the water resources at Turners Falls. When it was completed, Cabot Station was the largest hydroelectric facility in MA, and the principal source of power for the Turners Falls Power & Electric Company.

With the advent of the automobile in the early 1900s, the Massachusetts Highway Commission made plans to improve all the state's roads, including the section of highway from Greenfield to North Adams. Work was begun in September of 1912 and completed in November of 1914, at a cost of $350,000. At the opening ceremonies, October 24, 1914, the highway was officially dedicated as "The Mohawk Trail" after the Mohawk Indians of that region (Bennett, 1990b, p. 1).

The French King Bridge was conceived as part of a state-financed project to relocate a particularly hazardous seven-mile stretch of the old Mohawk Trail Highway (State Route 2) between Erving and Greenfield. After looking at several plans, the engineers decided to cross the Connecticut River with a bridge at the height of the hills on either side, about 135 feet above the water. Construction of the French King Bridge began in September of 1931, was completed at a cost of $385,000, and opened to travel on September 10, 1932. The bridge is one of four known steel deck-arch vehicular bridges in MA, and has the sixth-longest span of any vehicular bridge in the state (Bennett, 1990b, p. 6).

After extensive studies in the 1920s and 1930s, the Turners Falls Power & Electric Company and the Connecticut River Power Company of New Hampshire combined to form the Connecticut River Conservation Company. Its purpose was to "develop a system of reservoirs on the headwaters and tributaries of the Connecticut whereby the tremendous spring run-off might be stored for use during the period of low flow in the River." It was projected that five-billion cubic feet of storage water could be made available for power purposes, saving ten thousand tons of coal annually (Samartino, 1991, p. 26).

In 1942, the biggest merger was made when three pre-existing companies were merged into Western Massachusetts Electric Company (WMECO): Turners Falls Power & Electric Company, Pittsfield Electric Company, and United Electric Light Company. The several power companies continued to expand and to cooperate in transmission exchanges. Combined, nearly two dozen major hydroelectric stations along the Connecticut River were capable of producing collectively 700 thousand kilowatts of power. Studies to increase the generating capacity at the Turners Falls plants were well underway in 1961. In 1965, three Connecticut Valley power companies—WMECO, Connecticut Light & Power Company, and the Hartford Light Company—joined forces to form Northeast Utilities Service Company (NU) (WMECO, 1987, p. 4).

Construction of the Northfield Project began in 1968, with the major job being the drilling and dynamiting of a 2,500-foot tunnel, 565-foot ventilation shaft, 1130-foot pressure shaft, and the mile-long tailrace between the powerhouse and the river, as well as the 10-story-high underground powerhouse. Over 4.9 billion tons of rock were blasted to create the tunnels, shafts, and powerhouse (Samartino, 1991, p. 26). Four 250,000-kilowatt capacity turbine generators were placed in the powerhouse cavern 700 feet below the surface. Also built were a 300-acre reservoir, a rock-fill dam 144 feet high and 5600 feet long, and other dikes totaling 5600 feet. At the same time, the Turners Falls Dam downriver was raised, which created a 2,110 acre reservoir on the Connecticut River. The Northfield Mountain Pumped Storage Development began operation in early 1972. As part of the development, WMECO created the Northfield Recreation and Environmental Center (also known as the Northfield Mountain Tour and Trail Center or the Visitors Center), with exhibits on the area's geology, history, and ecology, along with facilities and trails for hiking, skiing, and snowshoeing (Samartino, 1991).

3.3.8.1.3 **Precontact and Historic Archaeological Resources**

In July and August 2014, FirstLight conducted an archaeological reconnaissance survey (Phase IA Study) within the Project APE (Sara *et al*., 2014a, 2014b, 2015). The purpose of the Phase IA archaeological reconnaissance was to identify archaeologically sensitive areas within the Project APE and provide recommendations where Phase IB archaeological surveys should occur based on identified sensitivity and Project-related effects, including Project-induced erosion. The study integrated background research with field investigations. The background research involved a review of state files at the MHC, NHDHR, and VDHP to identify known archaeological resources within a one-mile buffer of the Project APE and to review previous archaeological studies conducted in the region. In addition, numerous local repositories were consulted in order to provide a cultural context for the Project. The purpose of this research was to provide a framework for understanding the historic contexts of the region and to develop a sensitivity model for predicting the locations of potential archaeological resources. The field investigations consisted of walkover inspection and boat survey of the shoreline within the Project boundaries to assess current environmental conditions.

The field investigations segregated the Project APE into 65 segments (48 segments in MA, 10 in NH, and 7 in VT) based on geomorphic and topographic differences. These segments consist of floodplains, older river terraces, islands, and glacial and/or early postglacial landforms. Portions of all 65 segments are considered sensitive for archaeological resources. In addition to the 65 segments evaluated during the study, a separate archaeological sensitivity analysis was conducted for the Fuller Farm property in the Town of Northfield, MA.

In MA, background research identified 65 previously recorded precontact period and six historic period archaeological sites within the Project APE. Additionally, 70 precontact period and 25 historic period archaeological sites were identified within a one-mile distance of the Project boundary. Precontact period sites in the Project vicinity span the known human occupation of the region from the Paleoindian period to the Late Woodland and Contact period. In addition, historic period sites are located within or adjacent to the Project APE. These include domestic, transportation related (ferry and bridge crossings), and industrial related sites dating from the first European contact in the region in the seventeenth century to the present day.

As a result of the fieldwork in MA, the locations of two previously recorded precontact period sites were confirmed in the field based on the observation of surface artifacts, and four previously unrecorded historic period archaeological sites and one previously unrecorded precontact site were located within the Project APE. These newly identified archaeological sites include a precontact artifact scatter near the Ashuela Brook confluence with the Connecticut River, the remnants of historic Munns Ferry north of Kidds Island, the remnants of a small summer cottage on an upland ridge overlooking the Connecticut River, a historic surface scatter and related ground depression west of Cabot Camp, and a partial stacked-stone foundation and spring-related feature on a hillside west of the Route 2 Bridge (French King Bridge).

In addition, the sensitivity analysis for the Fuller Farm property in MA found it to be sensitive for the presence of archaeological resources.

In NH, background research did not identify any previously recorded sites within the Project APE, although there were three previously reported archaeological resources in Cheshire County, NH located within one mile but outside of the Project APE.

In VT, four sites (WD-1, WD-10, WD-124, and WD-125) are located within or directly adjacent to the Project APE. Site WD-1 is also located within the Project boundary for the Vernon Hydroelectric Project (Project No. 1904), which is currently undergoing relicensing. During field investigation, no newly identified archaeological sites were recorded in VT or NH during the Phase IA study.

Following background research and fieldwork, a total of 80 recorded archaeological sites have been recorded within the Project APE (70 precontact and 10 historic archaeological sites).

A sensitivity model was developed to categorize the sensitivity of landforms within the Project areas for precontact period archaeological resources. This model is based on analysis of environmental attributes associated with previously recorded archaeological site locations within a one-mile distance of the Project boundary and is intended to predict where precontact period archaeological resources may be located in the Project APE. The model found that modern floodplains and early Holocene river terraces in the northern half of the Project APE are considered to have the greatest sensitivity for precontact period archaeological resources with no preference for secondary tributaries of the Connecticut River. In its Phase IA study review letter of February 5, 2015 to FirstLight, the NHDHR commented that not many surveys have been conducted along the margins of the Connecticut River and cautioned that this should be taken into account when using the model's data set on informing archaeological sensitivity.

In addition to a sensitivity assessment, areas of shoreline in the Project APE were also evaluated for evidence of active erosion that may threaten culturally sensitive landforms although the causes of erosion were not examined in the Phase IA study. The causes of erosion within the impoundment are being examined as part of Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability;* a final report will be filed with FERC on October 14, 2016 or as directed by FERC in its process plan and schedule. The erosion classification was based on the criteria set forth in the 2013 FRR of the Project APE and included identification of the type, stage, indicators, and extent of erosion (FirstLight, 2014d). Indicators of active erosion such as exposed roots, creep, overhanging banks, and notching were noted along the shoreline during the course of the archaeological reconnaissance.

Erosion processes in the form of bank undercutting, slumping, exposed tree roots, and leaning shoreline trees were documented primarily in the Turners Falls Development APE along long stretches of low-lying floodplain shoreline from the Northfield Mountain Pumped Storage Development tailrace to the Vernon Dam. Little to no erosion was noted in the stable shorelines south of the French King Gorge, with the exception of Barton Island (in the TFI) and Rawson Island (in the bypass reach). No erosion processes were observed in the Northfield Mountain Pumped Storage Development APE.

3.3.8.1.4 **Historic Buildings and Structures**

Between November 2013 and July 2015, FirstLight conducted a historic architectural survey and NRHP evaluation of all buildings, structures, objects, sites, and districts 50 years or older within the Project APE (FirstLight, 2014c; FirstLight 2015j). The 2013-2015 historic architectural survey consisted of background research on previously identified architectural resources in the APE; preparation of a historic context of the APE from the colonial period to the modern period; a survey of all architectural resources 50 years or older within the APE; and evaluation of their NRHP eligibility, either as an individual resource or as a contributing resource in an NRHP-listed or -eligible historic district. The Northfield Mountain Pumped Storage Development, built between 1968 and 1972, also was surveyed as it will be 50 years old by the time the current license expires in 2018.

There are 31 previously identified resources within the Project APE. The Turners Falls Historic District, consisting of historic industrial, residential, and commercial buildings in Turners Falls, was listed in the NRHP in 1983 and contains 13 contributing resources located within the Project APE. Six historic resources in the APE—Cabot Power Station and Dam; Eleventh Street Bridge; East Mineral Road Bridge; Gill-Montague Bridge; French King Bridge; and Schell Memorial Bridge (all located in MA)—were previously determined eligible for the NRHP. (The Cabot Station Gantry Crane was determined NRHP-eligible in 1987, but has since been demolished after being recorded via the Historic American Engineering Record). Three previously surveyed resources—Central Vermont Railroad Bridge over the Connecticut River (MA); Boston & Maine Railroad-Fort Hill Branch Bridge over Ashuelot River (NH); and Boston & Maine Railroad-Fort Hill Branch Bridge Piers over the Connecticut River (NH)—were previously determined not eligible for NRHP listing. Eight previously surveyed resources in the Project APE—"The Patch" Historic District, Frederick Morgan House, Red Suspension Bridge, the Capt. Turner Monument, the Riverside Historic District and three individual resources, the Frank Smith House, Albert Smith House, and the Hunt-Sanderson House located within the Riverside Historic District—had not been previously evaluated for NRHP eligibility at the time of the 2013 – 2015 survey. There are no previously surveyed resources located within the VT section of the APE.

As a part of its field survey, FirstLight identified an additional 38 resources 50 years or older not previously surveyed within the APE. FirstLight evaluated these 38 resources and the eight previously surveyed resources not yet evaluated, for NRHP-eligibility according to the NRHP Criteria and standards for integrity. Of the eight previously surveyed resources, "The Patch" Historic District in Turners Falls and the Riverside Historic District in Gill (with the three previously surveyed contributing resources located within the Project APE) and the Hinsdale Historic District are eligible for the NRHP. Three previously surveyed resources—Red Suspension Bridge, Capt. Turner Monument, and Morgan House—are not eligible for NRHP listing.

Of the 38 newly surveyed resources, 13 resources are eligible for NRHP listing (all located within MA) and 24 (22 in MA and 2 in VT) are not eligible for the NRHP due to lack of architectural/historical significance and/or loss of integrity. One resource, the Mohawk Trail, is undetermined. In NH three newly surveyed resources (a highway bridge, a culvert, and a USGS gaging station) are contributing resources within the NRHP-eligible Hinsdale Historic District in Hinsdale. The Northfield Mountain Pumped Storage Development is considered NRHP-eligible under Criteria A and C in 2018.

The VT SHPO has concurred with FirstLight's recommendation that there are no NRHP-eligible architectural resources within the Project APE. The NH SHPO concurred that no additional survey or evaluation is required. By letter dated December 11, 2015 the MA SHPO commented that the 3.7.2 *Historic Architectural Resources Survey & National Register Evaluation Study Report Addendum* incorporates additional mapping and information requested by the MA Historical Commission and that it looks forward to reviewing FERC's determinations of eligibility and effect for historic properties within the APE.

3.3.8.1.5 **Traditional Cultural Properties**

To document TCPs in the Project APE, FirstLight contacted the Narragansett Indian Nation (NIT) and the Nolumbeka Project on several occasions in 2014 to initiate tribal consultation and documentation of TCPs within the Project APE. Despite several attempts to initiate interviews and field investigations with Tribal members to document TCPs within the Project APE, interviews and field investigations have not occurred as neither entity has yet agreed to meet with FirstLight's ethnographer. In response to an April 29, 2015 request of the Nolumbeka Project, by letter dated June 9, 2015, FirstLight agreed to walk the Wissatinnewag Property (located outside of the APE) with the Nolumbeka Project. To date, the Nolumbeka Project, however, has not contacted FirstLight's ethnographer to set up a site visit. Background research conducted in accordance with the RSP identified one NRHP-listed TCP in the Project vicinity. The TCP is located at the Turners Falls Municipal Airport, Franklin County, MA. Known as the Turners Falls Sacred Ceremonial Hill Site, it consists of four visible stone piles and an extended row of stacked stones. No NRHP-listed TCPs in the Project APE have otherwise been identified (FirstLight, 2015k).

3.3.8.2 Environmental Effects

The Licensee is proposing to remove an 8.1 acre parcel of land (the Fuller Farm property) from the Project boundary because it is not needed for continued operation of the Project. As noted above, the Fuller Farm property was found to be sensitive for the presence of archaeological resources and may require further studies (such as an intensive (locational) archaeological survey (Phase IB). The proposal to remove the 8.1 acre parcel is discussed in more detail in Section 3.3.7.4.

As set forth in Section 2.2.1, the Licensee is also proposing to remove a 20.1 acre parcel owned by USGS and on which USGS's Conte Lab is located. As noted in Section 3.3.7.4, the Phase IA Study identified several previously recorded archaeological resources on this parcel, which have not been investigated for NRHP eligibility. Nonetheless, because the parcel will remain under the ownership of USGS (a federal governmental entity), which is subject to Section 106 requirements, there will be no adverse effect as a result of removing the Conte Lab parcel from the Project.

The Licensee is not proposing any other changes to the Project or any changes in the operation of the Project that would affect any of the identified archaeological or architectural resources found within the Project APE.

To protect eligible cultural resources over the term of a new license, the Licensee has developed a Draft Historic Properties Management Plan (HPMP), which will be filed with FERC and sent to the MA, NH and VT SHPO's and Tribes as privileged. The purpose of the HPMP is to set forth specific actions and processes to manage historic properties within the Project APE. It is intended to serve as a guide for FirstLight's operating personnel when performing necessary activities and to prescribe site treatments designed to address ongoing and future effects to historic properties. The HPMP also describes a process of consultation with state and federal agencies. Measures included in the HPMP are: identification surveys and site NRHP evaluations, site management measures; training of staff; routine monitoring of known cultural resources; and periodic review and revision of the HPMP.

As reported in the Phase IA archaeological reconnaissance survey reports, based on the results of the sensitivity modeling and the observed erosion, 15.2 miles (24,425 meters) of shoreline in the Project APE are recommended for future Phase IB survey in the event that it is determined that the observed erosion is Project-induced, or that there are other Project-related effects. This includes 7.6 miles (12,200 m) of shoreline in MA, 4.3 miles (6,875 m) of shoreline in NH, and 3.3 miles (5,350 m) of shoreline in VT. The purpose of such field survey would be to ascertain the presence or absence of archaeological site(s) and if such resources have the potential to be adversely impacted by Project-induced erosion or other Project-related effects. The MHC has concurred that an intensive (locational) archaeological survey (Phase IB) should be conducted within the survey segments identified in the MA Phase IA report (Sara *et al*., 2015a). The NHDHR and VDHP have concurred with the recommendation for Phase IB archaeological survey within the segments identified for survey in New Hampshire and Vermont (Sara *et al*., 2015b). Provisions are included in the HPMP to provide for continuing archaeological surveys of these portions of the Project shorelines in the event that it is determine that the observed erosion is Project-induced, or that there are other Project-related effects, as well as for the Fuller Farm property.

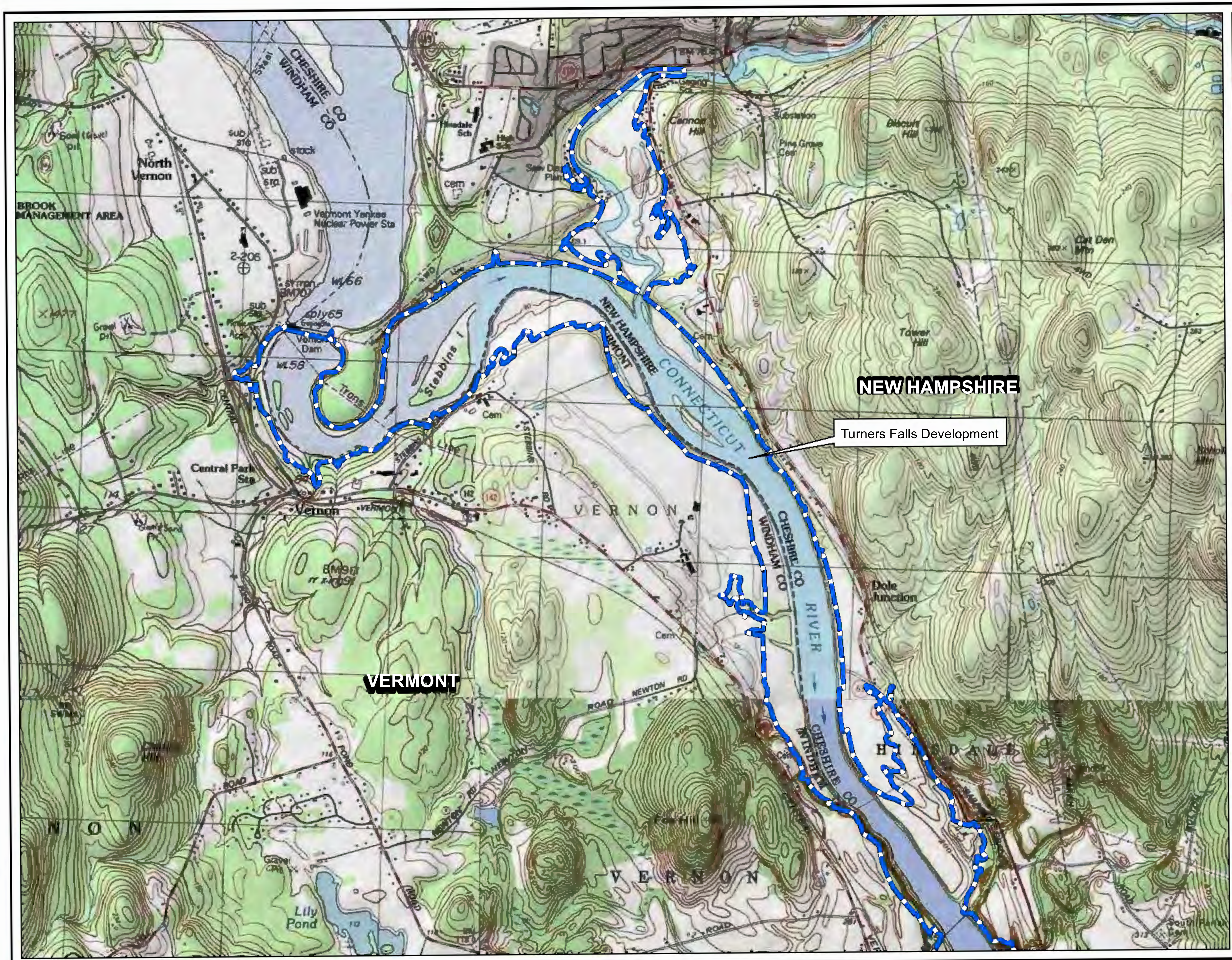
As noted in Section 3.3.8.1.4, there are 23 previously evaluated architectural resources and 16 newly evaluated architectural resources located in the Project APE (all located within MA), which are either listed (the Turner Falls Historic District) or eligible for NRHP listing. One of these resources is the Northfield Mountain Pumped Storage Development, which will be 50 years old in 2018. Provisions are included in the HPMP to provide for management measures to avoid adverse effects to these resources from any future Project modifications or activities.

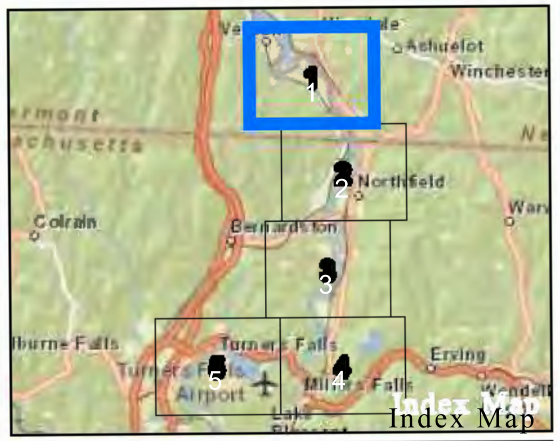
3.3.8.3 Proposed Environmental Measures

As described above, FirstLight's proposed Project includes one measure specifically related to the protection of cultural resources, which is the development and implementation of the HPMP. The HPMP will ensure that appropriate consultation occurs prior to any future activity that may affect the historic properties associated with the Project. The draft HPMP is being provided to the SHPOs for MA, VT, and NH, Tribes, and filed with FERC under separate cover as "privileged," because it contains confidential archaeological site location information. The HPMP addresses known NRHP-eligible historic properties as well as includes provisions to address any subsequently historic properties identified during the term of a new license.

3.3.8.4 Unavoidable Adverse Impacts

Continued operation of the Northfield Project will result in no unavoidable adverse impacts on historic properties. Implementation of the HPMP would assure that the effects of the Project on cultural resources will be taken into account. Therefore, pursuant to the National Historic Preservation Act, Section 106 (16 U.S.C. § 470f (2006) and 36 CFR § 800.5(b) (2008), the Project as proposed would not have any adverse effects on historic properties located at the Project.





FIRSTLIGHT HYDRO GENERATING COMPANY
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Final License Application
Exhibit E
Figure 3.3.8.1.1-1: Area of Potential Effects
Map 1

N

Legend

*Area of Potential Effects**

* Final Area of Potential Effect defined by Northfield Project Boundary

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0 1,000 2,000 4,000 Feet

1 inch = 2,000 feet

FirstLight
GDF SUEZ

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