Great River Hydro, LLC

LIHI Recertification Application

Fifteen Mile Falls Hydroelectric Project

LIHI Certification # 39

January 2022

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1.0 Introduction

The Fifteen Mile Falls Project (FERC License No. 2077) is owned and operated by Great River Hydro, LLC ("GRH" or "the Company") and spans a 26-mile reach in the upper Connecticut River between river miles (RM) 268.6 and 294.5 in the towns of Littleton and Monroe, in Grafton County New Hampshire, and the towns of Waterford and Barnet, in Essex and Caledonia counties Vermont. The project consists of three developments: Moore, Comerford, and McIndoe (see Figures 1 and 6).

On July 10, 2015 the Fifteen Mile Falls Project was recertified as low impact for a five-year term, effective December 15, 2013 and expiring December 15, 2018. On January 24, 2017 an additional three years was added to the certification term bringing the expiration date to December 14, 2021. The additional years were added after Condition 3 of the certification was satisfied. Following are the three conditions associated with the July 10, 2015 certification and the current status (completed or active) of each:

> Condition 1: Pertaining to the trap and truck operation for downstream passage of Atlantic salmon smolts stocked upstream of the Moore Dam, the facility owner shall remain in full compliance with its FERC license and the associated Settlement Agreement (SA) and Water Quality Certificate. If the licensee requests to amend the FERC license or the WQC, or reopen the SA, with regard to use of this operation, the facility owner shall notify LIHI within seven days, including a description of the proposed changes and schedules for pursuing them. LIHI shall also be provided a copy of any amendments, along with resource agency comments, to confirm continued compliance with LIHI's criterion.

In 2016, License Articles 409 and 410, related to the trap and truck operation described in Condition 1, was suspended by FERC (discussed below). The requirements under this condition were met via letter to LIHI dated January 28, 2016 (Appendix B, 6.1).

> Condition 2: As part of the required annual Compliance Statement to LIHI, the facility owner shall identify any violations of FERC operating requirements and will include copies of all agency and FERC notifications and reports of deviations of said operating requirements that have occurred in the previous year. This report shall be submitted by March 31 for the previous year's events. This report shall reference and include copies of all notifications made to the FERC during the previous year. Unless otherwise included in the FERC notifications themselves, the report to LIHI shall describe for each instance:
>
> 1. The cause of the event/deviation;
> 2. The date, duration and magnitude of the deviation;
> 3. Confirmation that the required 24-hour notices have been made to NHDES and VTDEC of such events (list the date of and to whom all notifications were sent);

4. Ways to minimize future repeat occurrences to the extent possible by the Licensee;
5. Any proposed mitigation measures and a schedule by which such measures will be implemented; and
6. Status or confirmation that the previously developed mitigation measures (for the previous year) have been implemented according to the proposed schedule.

The owner shall maintain a proactive approach to reducing the frequency and severity of such deviations to the extent reasonably possible. LIHI shall be informed of the capital improvement projects that are underway and planned for the future to minimize the occurrence of deviations or plant outages. The annual compliance report to LIHI will be used as confirmation that the facility owner is conducting the necessary actions to minimize such events and ensure compliance with LIHI's flow and water quality criteria. Condition satisfied 2018, extended term granted.

Condition 3: The facility owner shall provide LIHI with a description of the current status and use of funds from the Mitigation and Enhancement Fund that was part of the Settlement Agreement for the most recent FERC licensing. In particular, this description shall identify the lands and waters that are benefiting from the funds, the current fund balance, and continuing payment schedule, and be sufficient to determine if these funds are achieving the ecological and recreational equivalent of land protection of the buffer zone referred to in Question D.1. This information will be used by LIHI staff to determine if the Fifteen Mile Falls certification qualifies for three additional years in its term. The facility owner may or may not take advantage of this opportunity to request an extended term of their new certificate; if they do not provide this additional information, it will not affect the new five-year term.

GRH took advantage of this opportunity and the condition was satisfied in 2018 as indicated in LIHI letter dated January 23, 2018 (Appendix B, 6.2).

On May 15, 2016 LIHI was notified that TransCanada Hydro Northeast Inc. was converted to a limited liability company on April 7, 2017, becoming TransCanada Hydro Northeast LLC. On April 19, 2017, the name of the company was changed from TransCanada Hydro Northeast LLC to Great River Hydro, LLC.

Since the December 2013 effective date of the current LIHI certification, the following changes have been made to the project:

- On June 20, 2013, FERC issued an order certifying incremental hydropower generation for production tax credit after generator rewinds and Phase 2 runner replacements at Comerford Units 2, 3, and 4 resulted in an 0.57% improved efficiency of the three development Project. An as-build Exhibit A and photos of new nameplates for the rehabilitated units (and two units at Moore that were rehabilitated earlier, in 2003 and 2004) were filed with FERC on November 9, 2017, and December 7, 2017. On December

13, 2017, FERC issued an order amending the license to reflect the new nameplate capacity, revise annual charges, and approve the as-built Exhibit A.

- On May 2, 2016, FERC issued an order suspending license Articles 409, 410, and 413. These Articles required the Company to implement requirements for the downstream passage of Atlantic Salmon smolts at the McIndoe (Article 409), Comerford and Moore (Article 410) developments and monitor effectiveness of both upstream and downstream passage modifications (Article 413). This was in response to the Company's December 31, 2015, March 3, 2016, and March 8, 2016 filings requesting suspension or elimination of Articles 409, 410 and 413 due to U.S. Fish and Wildlife Service (USFWS) discontinuing the Atlantic Salmon stocking program, and forwarding supporting documentation from the Connecticut River Atlantic Salmon Commission (CRASC) including notification that all surviving smolts from the final stocking of salmon fry in the upper Connecticut basin in 2013 migrated out of the basin by 2015. The Company consulted with the USFWS, New Hampshire Fish and Game Department (NHFG) and Vermont Division of Fish and Wildlife (VTFW) on this issue and received concurrence from NHFG and VTFW with the Company's approach as documented in its December 31, 2015 filing.

- On February 9, 2016 FERC issued an order amending license Article 405 by approving amended Plan for the Long-Term Monitoring of Mercury in Fish Tissue at Moore and Comerford Reservoirs, dated June 30, 2015. The company filed the amended plan in accordance with provisions of the Article and after consulting with the Vermont Department of Environmental Conservation (VTDEC), New Hampshire Department of Environmental Services (NHDES), and USFWS. The amended plan reduces the number of species and individuals collected from the two reservoirs for mercury testing but maintains the 5-year collection interval.

- Revised Exhibit F drawings were filed with FERC on January 7, 2019, reflecting upgrades to the McIndoe switch yard/transformer yard completed in 2017. On August 1, 2019 FERC issued an order approving the drawings.

- On January 21, 2020 Great River Hydro filed a non-capacity license amendment application to install a minimum flow unit (4.7 MW) at the Moore Development. The new unit (Unit 5) will provide the required minimum flow of 320 cubic feet per second (cfs), or inflow if less, more efficiently than current operation. Structural modifications include: (1) a new modified intake with an accompanying trashrack and headgate providing flow to a new penstock installed on the upstream face of the dam in the original additional intake location adjacent to the existing Unit 1 intake; (2) a 7-foot-diameter steel pipe exiting the downstream face of the dam on the Vermont side of the existing transmission substation (owned by New England Power Co., d.b.a. National Grid); (3) a new 42 foot by 30 foot reinforced concrete powerhouse constructed on the Vermont side of the existing powerhouse; (4) a dissolved oxygen enhancement system consisting of a pipe with aeration devices that discharge water into the new powerhouse tailrace, and; (5) a new tailrace channel extending into the existing tailrace bound by concrete or sheet pile retaining walls on either side. With the proposed modifications the maximum hydraulic capacity would be increased by a maximum of 430 cfs, while the installed capacity would be increased from the current 154.8 MW to 159.5 MW. No changes are proposed to the existing operating regime except that the new unit will be the priority unit to provide minimum flow. FERC noticed the application accepted for filing and solicited comments, motions to intervene and protests on April 27, 2020. In consultation with the Vermont Department of Environmental Conservation (VTDEC) and the New Hampshire Department of Environmental Services (NHDES), Great River Hydro developed a dissolved oxygen monitoring plan that was finalized on August 26, 2021. In letters dated August 27, 2021 and August 31, 2021 the VTDEC and NHDES, respectively, waived Section 401 water quality certification authority. A final agreement between GRH and NHDES for the Moore Minimum Flow Project became effective on August 31, 2021. These documents are included in GRH's September 3, 2021 filing.

- On May 20, 2020 FERC approved GRH's intent to convey an easement to New England Power Company, dba National Grid, for the purpose of modifying the existing non-project switching station at the Comerford Development. As more specifically described in GRH's May 1, 2020 filing, National Grid proposes to reconfigure the existing non-project switchyard in order to improve electric reliability. A new switchyard would be constructed next to the existing switchyard and the existing switchyard would be restored to grass. Both the existing and proposed switchyards are located within the project boundary. In order to accommodate the new switchyard, GRH proposes to issue new easements and amend existing easements to reflect the new switchyard configurations.

Figure 1. Overview of Fifteen Mile Falls Project Development Locations within the Upper Connecticut River Watershed

2.0 Project Description

The Connecticut River originates at the mouth of the Fourth Connecticut Lake in Pittsburg, New Hampshire near the Canadian border at an elevation of 2,670 feet above mean sea level (msl), then widens as it delineates 255 miles of the border between New Hampshire and Vermont making its way southward a total of 410 miles to its mouth on Long Island Sound. The watershed spans portions of the Province of Quebec, New Hampshire, Vermont, Massachusetts, and Connecticut. Watershed topography moderates from mountains with elevations of more than 3,000 feet msl in the northern portion where the Project is located, to hilly and rolling country with elevations rarely above 2,000 feet msl, to a plateau with elevations below 700 feet, and finally to an outwash zone of tidal marshes, coves, and meadowlands. The majority of the Connecticut River bordering Vermont and New Hampshire conforms to the regional topography and flows roughly north-south. Slicing against, rather than with regional topography apparently led to the development of a deep, narrow, pre-glacial gorge, carved through bedrock, known as Fifteen Mile Falls.

The Fifteen Mile Falls Project spans a 26-mile reach of the upper Connecticut River, including three reservoirs and about a 1.5-mile riverine reach between the Comerford and McIndoe reservoirs. The Project has a total installed capacity of 333.2 MW and all dam and generation operations are controlled remotely from the Renewable Operations Center in Wilder, Vermont.

To relicense the Fifteen Mile Falls Project, the then licensee US Generating Company, New England, Inc. (USGenNE) elected to use an Alternative Licensing Process (ALP). Pursuant to the ALP, USGenNE and a collaborative team, consisting of representatives of USGenNE, New Hampshire Department of Environmental Services, New Hampshire Fish and Game Department, Vermont Agency of Natural Resources, U.S. Fish and Wildlife Service, Environmental Protection Agency, National Park Service, regional planning agencies, and non-governmental organizations, developed an Applicant-Prepared Environmental Assessment and license application. As a result of the ALP, USGenNE and the stakeholders reached a Settlement Agreement (Appendix B, 6.3) on proposed operations and environmental measures.

The current License for the Fifteen Mile Falls Project includes terms and conditions applicable to the entire Project, stipulated in the Settlement Agreement filed with the License application on July 29, 1999. The Settlement Agreement addresses issues pertaining to project operations, reservoir levels, minimum flows, fish and wildlife protection and enhancement measures, and land protection. The process of reaching this agreement included examination of the power and non-power tradeoffs and effects of a variety of operational scenarios. This negotiation process, after careful consideration of alternatives, resulted in a balancing of power and non-power interests associated with the Project through the Settlement Agreement. The FERC License conditions for the Project consist of the operational and environmental measures defined by the Settlement Agreement. The Settlement Agreement demonstrated the ability of diverse interests to come together in good faith to balance environmental quality, recreation, energy production, land preservation and other purposes. The agreement ensures that the Project will be managed over the License term to improve resource protection while recognizing the value of hydropower storage and release as a critical renewable energy resource.

The three developments from upstream to downstream are described below, photographs are provided in Appendix B, 6.4.

The Moore development is located at River Mile (RM) 283 and consists of: (1) an 11-mile-long reservoir with a surface area of 3,490 acres and 223,722 acre-feet of gross storage at a normal maximum operating level of 815 feet msl; (2) an earth and concrete gravity dam with an overall length of 2,920 feet and a height of 178 feet; (3) a 373-foot-long concrete spillway with a 15-footwide by 20-foot-high sluice gate, four 50-foot bays of 17-foot-high stanchions, and three bays of 36 foot-wide by 30-foot-high Tainter gates; (4) four steel penstocks each 296 feet long; (5) one steel penstock 335 feet long; (6) a primary powerhouse with four Francis type turbine-generator units; (7) an adjacent secondary powerhouse with one Francis type turbine-generator unit. Under a design head of 150 feet, turbine units 1-4 are each rated at 56,400 horsepower, equal to 42,300 kW; and unit 5 is rated at 6,511 horsepower, equal to 4,930 kW. The combined rated discharge of the five units is 13,720 cfs. Units 1 and 4 generators are rated at 39,000 kilovolt ampere (kVA) and a 0.9 power factor, yielding rated capacities of 35,100 kW. Unit 2 and 3 generators were recently rewound and are now rated at 53,000 kVA and a 0.9 power factor, yielding rated capacities of 47,700 kilowatts kW. The Moore Unit 5 brushless synchronous generator is rated at 5,222 kVA at a 0.9 power factor, yielding a rated capacity of 4,700 kW. The authorized capacity, considering the lessor of the nameplate ratings of the five turbines and generators, is therefore 159,500 kilowatts (kW).

The Comerford development is located at RM 275 and consists of: (1) a 7-mile-long reservoir with a surface area of 1,093 acres and 32,270 acre-feet of gross storage at a normal maximum operating level of 650 feet msl; (2) an earth and concrete gravity dam with an overall length of 2,253 feet and a height of 170 feet; (3) an 850-foot-long concrete spillway with six 7-foot-wide by 9-foot-high sluice gates, four bays of 8-foot-high flashboards and seven 10-foot-high stanchion bays; (4) four steel penstocks each 150 feet long; and (5) a powerhouse with four Francis type turbine-generator units. Unit 1 turbine is rated at 22,000 kW under a design head of 172 feet and Units 2-4 each are rated at 49,600 kW under a design head of 172 feet. The combined rated discharge of the four units is 12,990 cfs. Unit 1 generator is rated at 39,000 kVA and a 0.9 power factor, yielding rated capacities of 35,100 kW. Unit 2-4 generators, having been recently rewound, are rated at 54,000 kVA and a 0.9 power factor, yielding rated capacities of 48,600 kW. The overall rated plant generator capacity is 180,900 kW. Maximum station output at full load is 162,960 kW under a net head of 174 feet and combined turbine discharge of 13,300 cfs.

The McIndoe Development is located at RM 268 and consists of: (1) a 5-mile-long reservoir with a surface area of 465 acres and 4,500 acre-feet of gross storage at a normal maximum operating level of 451 feet msl; (2) a concrete gravity dam with an overall length of 730 feet and a height of 25 feet; (3) a 520-foot-long concrete spillway with a 12-foot-wide by 13-

foothigh skimmer gate, three 24-foot-wide by 25-foot-high Tainter gates, a 300-foot-long spillway flashboard section with 3-foot-high flashboards, and two 50-foot-wide by 14- foot-high stanchion bays; and (4) a powerhouse with four Kaplan type turbine-generator units. The turbines have a combined power rating of 2,850 kW each under a design head of 29 feet. The combined rated discharge of the four units is 5,800 cfs. Each generator is rated at 2,640 kW, yielding an overall rated capacity for the station of 10,560 kW. Maximum output at full load is 11,000 kW, under a net head of 23 feet and a maximum turbine discharge of 6,180 cfs.

For this reapplication, the Project area has been divided into 6 Zones of Effect (ZoE) as described below and mapped in Figures 2 through 4.

- Zone 1 – Moore impoundment – from RM 294 to the Moore Dam (RM 283).
- Zone 2 – Moore tailrace and Comerford impoundment – from Moore Dam to Comerford Dam (RM 275).
- Zone 3 – Comerford tailrace – approximately 1,200 ft below the Comerford Dam.
- Zone 4 – Comerford downstream reach – from the Comerford tailrace (approximately RM 275) to the McIndoe impoundment (RM 273).
- Zone 5 – McIndoe impoundment – from RM 273 to the McIndoe Dam (RM 268).
- Zone 6 – McIndoe tailrace – approximately 1,200 ft below the McIndoe dam.

The Moore development is a seasonal storage development generally operated in a daily peaking mode for generation purposes as well as providing water for downstream minimum flow requirements at Comerford. Seasonally, the reservoir is filled close to a maximum of 809 feet msl after the spring freshet and operated throughout the summer for generation and flow augmentation purposes. Over the winter period, the reservoir is drawn down to a target elevation of 769 feet msl prior to the onset of the spring freshet which annually refills the reservoir. For spring fish spawning a reservoir elevation of at least 802 feet msl is achieved with a target elevation of 804 feet msl by May 21 of each year. For the period May 21 through June 30 the reservoir is not drawn down more than 2 feet below any elevation previously attained in the same period. From June 30 to May 21, reservoir operations follow historic patterns and ranges as provided in Attachment 1 of the Settlement Agreement. Year-round, a minimum flow of 320 cfs or inflow is released below Moore station into the Comerford headpond, which extends upstream to the Moore Dam. On a daily average basis Moore releases water to satisfy the more substantial, seasonally adjusted, guaranteed minimum flow at Comerford. Flows exceeding station capacity are passed via spillway gates, typically when storage is no longer available or retained to capture peak spring freshet inflows. No changes are proposed to this operating regime with installation of the new minimum flow unit except that the new unit will be the priority unit to provide minimum flow.

The Comerford development is also a seasonal storage development operated in a daily peaking mode, essentially passing discharge from the Moore station with the exception of storing a portion of inflow from Moore to provide hourly minimum flow. Comerford typically operates in the vicinity of elevation 647 feet msl within a seasonally dependent 2-foot range between elevation 646 and 648 feet msl, and maximum operating limit of 650 feet msl. A winter drawdown is scheduled to provide reservoir storage prior to the spring freshet to capture local spring runoff and any extra flow passed as spill from Moore. The target drawdown level is 640 feet msl by mid to late February, with an additional capability to reach 610 feet msl, if necessary. For spring fish spawning a reservoir elevation of at least 645 feet msl is achieved, with a target elevation of 647 feet msl by May 21 for each year. For the period May 21 through June 30 the reservoir is not drawn down more than 2 feet below any elevation previously attained in the same period, From June 30 to May 21, reservoir operations follow historic patterns and ranges as provided in Attachment 2 of the Settlement Agreement. Seasonal minimum flows released below Comerford station are 818 cfs from June 1 through September 30, 1,145 cfs from October 1 through March 31, and 1,635 cfs from April 1 through May 31.

The Mclndoes development operates on a daily cycle and is used primarily to smooth the discharge from the Fifteen Mile Falls Project by discharging at a more constant rate throughout each day than the two upstream Developments. This entails daily cycling of the headpond. The minimum elevation at the beginning of each day is determined by scheduled generation at Comerford upstream and predicted inflow. This determines the Mclndoes generation schedule to build the headpond throughout the day and draw it back down over night. The maximum operating elevation is 451 feet msl and minimum operating elevation is 447.5 feet msl. The reservoir may surcharge above 451 feet msl if inflow exceeds discharge capability of 30,600 cfs. For spring fish spawning and incubation, minimum flow of 4,420 cfs or inflow is released below McIndoe station from April 1 through May 31. Seasonal minimum flows are 1,105 cfs or inflow from June 1 through September 30, and 2,210 cfs or inflow from October 1 through March 31. From June 1 through March 31, inflow is defined as the sum of the applicable Comerford minimum flow and the prorated Passumpsic gage. The downstream Dodge Falls Project's (FERC No. 8011) impoundment backs up to the McIndoe tailrace.

If Moore and Comerford reservoirs are in danger of not filling, minimum flow from Comerford can be reduced to no less than 50 percent of the Dalton gage flow, and Mclndoes minimum flow would be the sum of prorated Passumpsic gage flow plus no less than 50 percent of the Dalton gage flow. Spring spawning flow can be reduced to 2,210 cfs if flows in excess of 50,000 cfs at Bellows Falls or in excess of 10,000 cfs at Wilder are expected. Finally, maximum flows cannot exceed 6,180 cfs for more than 7 percent of the hours during the period June 1 through February 28, unless Moore and Comerford reservoirs are both at their maximum operating limits or stream flow (sum of the prorated Passumpsic and Dalton gages flows) exceeds 8,000 cfs during the months of March, April, and May. (FERC Order dated July 24, 2003 changed the maximum station discharge at McIndoe from 5,800 cfs to 6,180 cfs.)

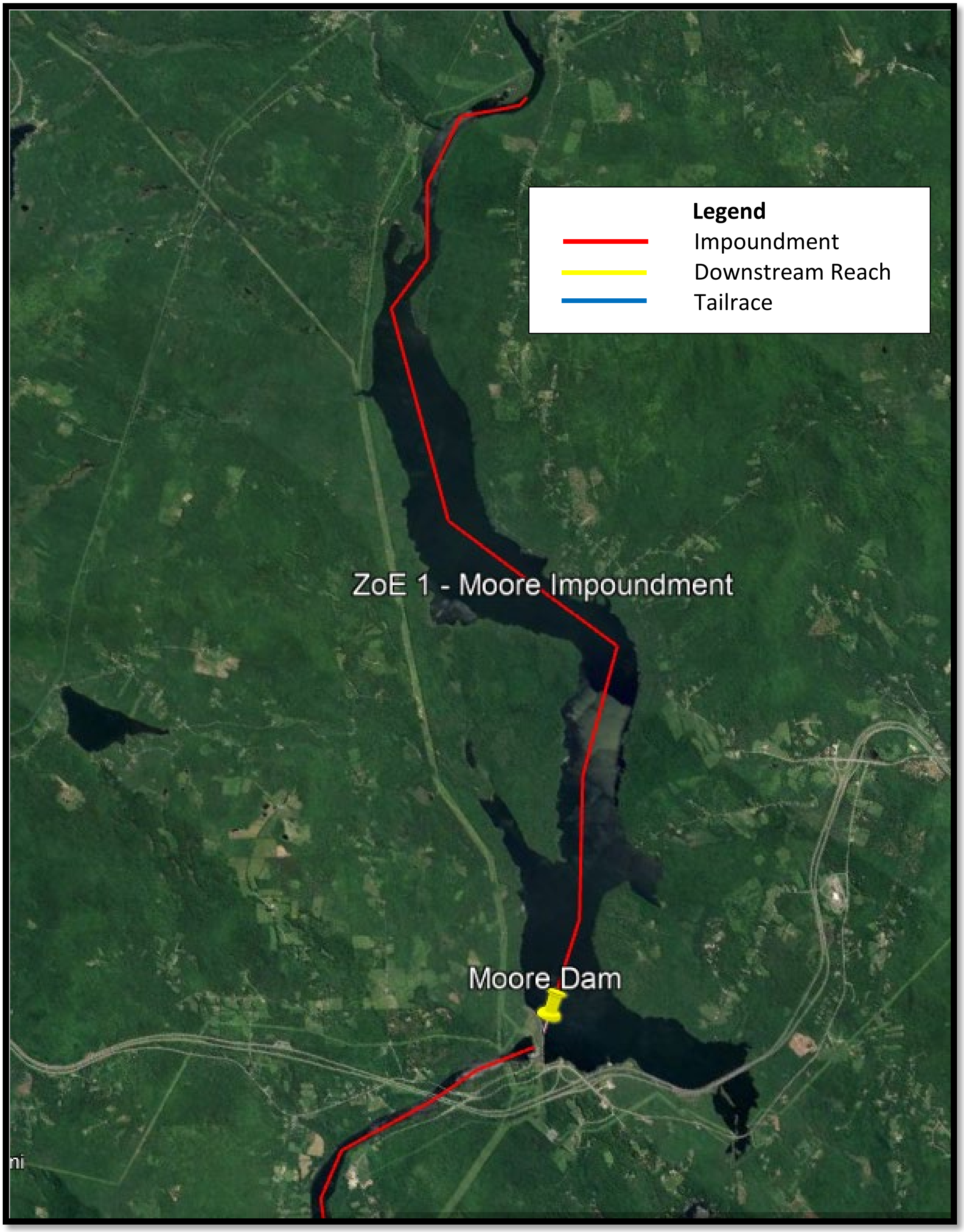


Figure 2. Moore Development

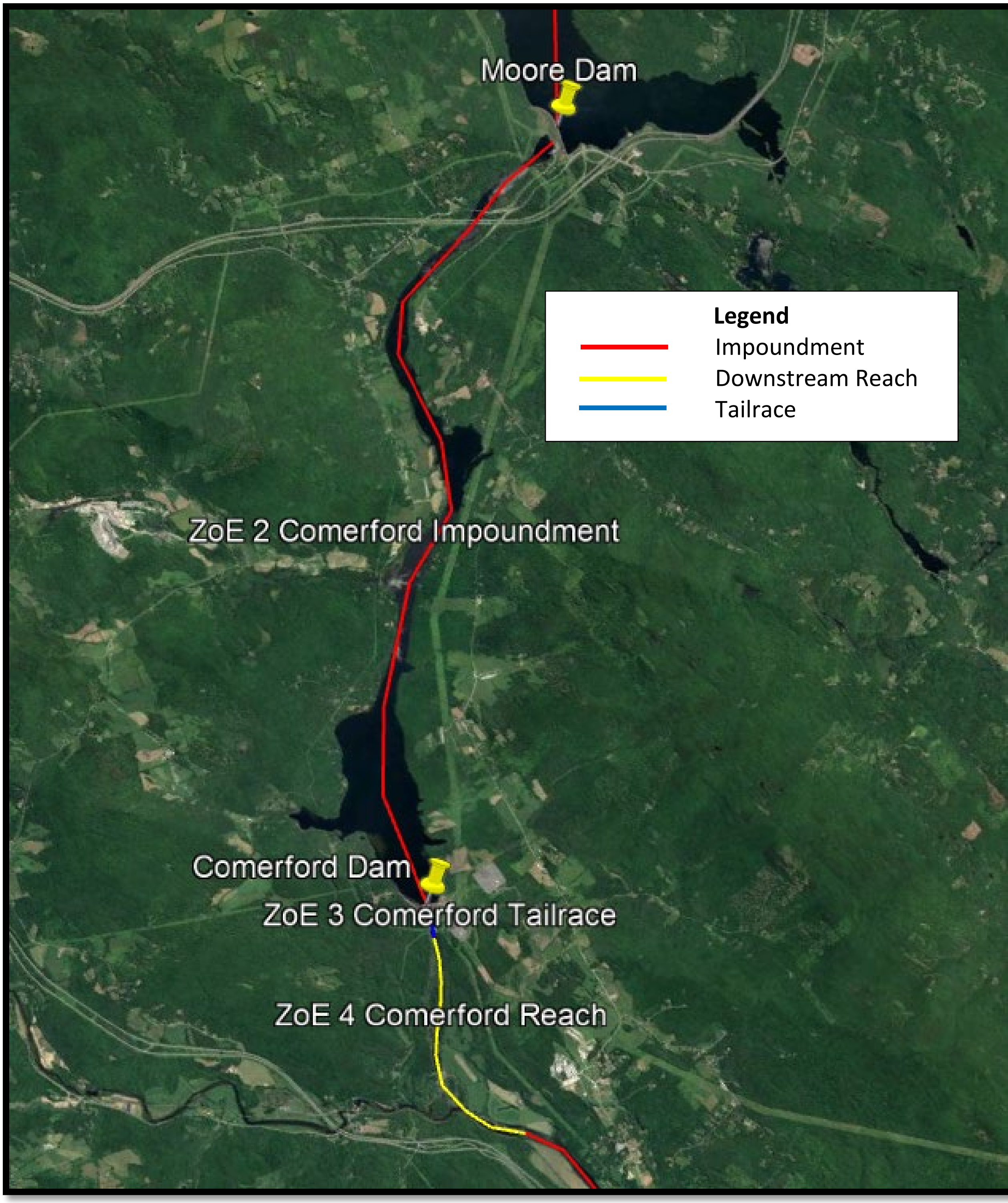


Figure 3. Comerford Development

Figure 4. McIndoe Falls Development

Facility Information (Table B-1.1 in LIHI's Certification Handbook, 2nd Edition) required for this application is provided in two tables. Table 1, provided below, includes information common to all three developments and Table 2, included as a separate Excel spreadsheet, provides facility specific information.

Table 1. Facility information common to all Developments.

Item	***Information Requested***	***Response (include references to further details)***
Name of the Facility	Facility name (use FERC project name or other legal name)	Fifteen Mile Falls Project (P-2077)
Location	River name (USGS proper name)	Connecticut River
	Watershed name (select region, click on the area of interest until the 8-digit HUC number appears. Then identify watershed name and HUC-8 number from the map at: https://water.usgs.gov/wsc/map_index.html)	Upper Connecticut HUC 01080101
	Nearest town(s), county(ies), and state(s) to dam	See Table 1b.
	River mile of dam	
	Geographic latitude of dam	
	Geographic longitude of dam	
Facility Owner	Application contact names (Complete the Contact Form in Section B-4 also):	John Ragonese, FERC License Manager Jennifer Griffin, FERC License Specialist
	Facility owner company and authorized owner representative name. **For recertifications: If ownership has changed since last certification, provide the date of the change.**	Great River Hydro, LLC John Ragonese, FERC License Manager Ownership transferred from TransCanada to GRH on April 19, 2017
	FERC licensee company name (if different from owner)	N/A
Regulatory Status	FERC Project Number (e.g., P-xxxxx), issuance and expiration dates, or date of exemption	P-2077 Issued – April 8, 2002 Expires – April 8, 2042
	FERC license type (major, minor, exemption) or special classification (e.g., "qualified conduit", "non-jurisdictional")	Major

Item	*Information Requested*	*Response (include references to further details)*
	Water Quality Certificate identifier, issuance date, and issuing agency name. Include information on amendments.	WQC, April 16, 2001, NHDES, conditions section included in License. WQC Waiver, July 13, 2001, VANR. WQC Waiver, August 31, 2021, NHDES WQC Waiver, August 27, 2021, VTDEC (attachment 4)
	Hyperlinks to key electronic records on FERC e-library website or other publicly accessible data repositories[1]	FERC License and WQC conditions. Settlement Agreement included as Exhibit B, 6.3. License amendment application for the Moore minimum flow unit

Table 2. Development Information

See Excel file included with this submittal

[1] For example, the FERC license or exemption, recent FERC Orders, Water Quality Certificates, Endangered Species Act documents, Special Use Permits from the U.S. Forest Service, 3rd-party agreements about water or land management, grants of right-of-way, U.S. Army Corps of Engineers permits, and other regulatory documents. If extensive, the list of hyperlinks can be provided separately in the application.

3.0 Standards Matrices

Table 3. Matrix of Alternative Standards for all Zones of Effect.

	Criterion							
	A	B	C	D	E	F	G	H
Zone No., Zone Name, and Standard Selected (including PLUS if selected)	**Ecological Flows**	**Water Quality**	**Upstream Fish Passage**	**Downstream Fish Passage**	**Shoreline and Watershed Protection**	**Threatened and Endangered Species**	**Cultural and Historic Resources**	**Recreational Resources**
1: Moore impoundment	1	2	1	2	2+	2	2	2
2: Moore tailrace and Comerford impoundment	2	2+	1	2	2+	2	2	2
3: Comerford tailrace	2	2	1	1	2+	2	2	2
4: Comerford downstream reach	2	2	1	1	2+	2	2	2
5: McIndoe impoundment	1	2	1	2	2+	2	2	2
6: McIndoe tailrace	2	2	1	1	2+	2	2	2

4.0 Supporting Information

4.1 Ecological Flow Regimes

The Project operates in compliance with flow conditions and reservoir elevations for fish and wildlife protection, mitigation and enhancement for reaches below all tailraces and the Comerford downstream reach. Flows and reservoir elevations are monitored continuously. Hourly flow and elevation data for each month at each Project development are reported annually to FERC and the Resource agencies. Temporary flow deficiencies occur infrequently. Most have been caused by emergency situations, mechanical equipment or instrumentation failure, or low inflows. In all but one case, these deficiencies were of short duration; in all cases corrective and preventative actions were taken immediately to avoid recurrence; and all incidents were reported to FERC and the resource agencies (Appendix B, 6.5). The single longer event resulted in FERC issuing a violation with no enforcement action taken. The event was a minimum flow reduction at the McIndoe development that occurred on February 3, 2016 when one of two units running was shut down for 3.5 hours. With only one unit running, total station discharge fell below required calculated inflow (approximately 1,895 cfs at the time) by as much as 551 cfs in the first hour, and as little as 40 cfs in the last hour of the deviation. However, due to the backwater effects of the downstream Dodge Falls impoundment, the deviation only resulted in a tailrace elevation change of approximately 0.2 feet. The Company investigated the incident and determined the cause to be operator error. Following the investigation GRH undertook an internal assessment of its compliance alarm system and notification procedures within the control room. As a result, a $46,000 project was undertaken to install audible and visual alarm indication and notification enhancements for all of its hydroelectric developments to reduce the likelihood of such an operator error in the future and improve overall attentiveness to license compliance alarms. Further action following the internal investigation resulted in termination of the employee.

Current ecological flow regimes were established in the April 8, 2002 FERC Order issuing a new 40-year license. The flows were based on instream flow studies and modeling, both quantitative and qualitative, designed to identify basin-specific seasonal and annual aquatic base flows where appropriate. Below Moore and McIndoe dams, flows are specified as "or inflow if less" while guaranteed minimum flows from reservoir storage is stipulated below Comerford dam. Management of the developments is described in the Fifteen Mile Falls Reservoir and Minimum Flow Operations and Monitoring Plan ("Ops Plan") filed March 7, 2002, approved July 24, 2003. The Ops Plan was prepared in consultation with NHDES, NHFGD, USFWS, and VTDEC. The purpose of the plan is to addresses how storage at the Fifteen Mile Falls Project will be used to provide required seasonal minimum flows and protect littoral spawning habitat and submerged aquatic vegetation at the project developments, while minimizing the effects on the environment and public use.

To inform settlement discussions, the then licensee USGenNE conducted studies and collected information in cooperation with many stakeholders, resource agencies, and NGOs, concerning the characteristics of the riverine aquatic habitats associated with the Project. These study results influenced the content of the Settlement Agreement and were reported in four reports: (1) Draft Riverine Habitat Mapping Report (Gomez and Sullivan 1997a); (2) Demonstration Flow Study for the Nine Islands Reach of the Connecticut River (Gomez and Sullivan 1997b); (3) Flow Effects on Riverine Habitat in the Main Stem of the Connecticut River (Gomez and Sullivan 1998); and (4) Final Riverine Habitat Report (USGenNE 1999). The studies examined the effects of proposed project flow releases or operations on five different stream habitat reaches: the mainstem of the Connecticut River from the tailrace of the Comerford Development to the upstream end of the Mclndoes Development impoundment; the mainstem of the Connecticut River stream habitat downstream of the East Ryegate Dam; and the riverine portion of the Upper Moore impoundment. The tailrace areas of the Moore and Mclndoes Developments were not included in the study because the discharges from both these developments enter impoundments formed by the downstream Comerford development and Ryegate project, respectively, and these areas are primarily pool habitat with very little to no riverine habitat.

The studies suggested the implemented operations, such as limiting water level fluctuations and drawdown in the reservoirs, would better mimic natural flow patterns, and would benefit many species of fish and invertebrates that utilize the reservoir littoral zone for spawning and other life stages. Smallmouth bass populations respond positively to stable water levels during spawning and fry development stages, as do other phytophilic species such as northern pike, pickerel, and yellow perch. Based on a smallmouth bass survey conducted at the project (Acres 1998), and the elevation of nests observed, the 2-foot reservoir drawdown limit was proposed during the spawning season (May 21 through June 30) at the Moore and Comerford Developments to help protect bass nests from desiccation.

These studies suggested that minimum flow releases, identified in the Settlement Agreement, would work to "mask" or dampen the range of flow fluctuations downstream of the powerhouses. The minimum flow releases would also create more natural streamflow conditions and benefit aquatic macroinvertebrates and fishes by providing more stable habitat conditions in areas where suitable habitat conditions exist. Aquatic biota would no longer be exposed to existing flow fluctuations that result from intermittent periods of high flows and nearly dewatered conditions. With the proposed minimum flows, macroinvertebrate production and fish utilization would be expected to increase in reaches receiving the minimum flows and where suitable habitat exists.

In addition to minimum flow release effects on aquatic riverine habitat, the Mclndoes impoundment elevation limit was also important because the lower impoundment elevation limit selected during settlement negotiations would create additional riverine habitat at the upstream end of the Mclndoes impoundment as well as expand emergent and submergent wetlands. The minimum flow requirements for the spring for the Mclndoes Development identified in the Settlement Agreement were also analyzed and suggested improved spawning and egg incubation flows for walleye.

Final minimum flows identified in the Settlement Agreement were based on agency recommendations during settlement discussions, the basis for which were seasonal New England aquatic base flows (NEABF) recommended by the USFWS. Those recommended flows by volume (cfs) and NEABF (drainage area) are:

Comerford minimum flows, guaranteed from storage:

- 818 cfs from June 1 through September 30 or 0.5 cfs/square mile of drainage area
- 1,145 cfs from October 1 through March 31 or 0.75 cfs/square mile of drainage area
- 1,635 cfs from April 1 through May 31 or 1.0 cfs/square mile of drainage area.

It should be noted there are extended periods when the minimum flows significantly exceed actual flows in the basin, suggesting the NEABF flows exceed site-specific flows.

McIndoes minimum are similar to Comerford relative to NEABF, but include an "or inflow" caveat and higher flows in the winter and spring (providing higher flows below the overall FMF Project):

- 1,105 cfs or inflow from June 1 through September 30 or 0.5 cfs/square mile of drainage area
- 2,210 cfs or inflow from October 1 through March 31 or 1.0 cfs/square mile of drainage area
- 4,420 cfs or inflow from April 1 through May 31 or 2.0 cfs/square mile of drainage area for spring fish spawning and incubation.

Moore minimum flow was set by agreement among parties to represent a year-round low flow minimum due in part to a number of factors including:

- Lack of riverine habitat below the Moore Dam (backwatered by Comerford Reservoir).
- Habitat below Moore is adequately protected by its required minimum flow and the impoundment operation at Comerford.
- Daily averaged flow would be equal to or greater than the minimum flow downstream at Comerford due to the guaranteed minimum flow from storage requirement at Moore.

The Project impoundments meet Standard 1 for Criteria A, Ecological Flow Regime:

- ZoE 1 – Moore impoundment
- ZoE 5 – McIndoe impoundment

Criterion	*Standard*	*Instructions*
A	1	Not Applicable / De Minimis Effect: • Confirm the location of the powerhouse relative to dam/diversion structures and demonstrate that there are no bypassed reaches at the facility. • For run-of-river facilities, provide details on operations and demonstrate that flows, water levels, and operation are monitored to ensure such an operational mode is maintained. If deviations from required flows have occurred, discuss them and the measures taken to minimize reoccurrence. • In a conduit facility, identify the source waters, location of discharge points, and receiving waters for the conduit system within which the hydropower facility is located. This standard cannot be used for conduits that discharge to a natural waterbody. • For impoundment zones only, explain water management (e.g., fluctuations, ramping, refill rates) and how fish and wildlife habitat within the zone is evaluated and managed. ***NOTE:*** this is required information, but it will not be used to determine whether the Ecological Flows criterion has been satisfied. All impoundment zones can apply Criterion A-1 to pass this criterion.

Because the Comerford impoundment backs up to the Moore dam, with no riverine reach between, the two are combined in one Zone of Effect. Of the Project's three impoundments the larger two, Moore and Comerford, are used for seasonal storage (Moore to a much greater extent than Comerford) and McIndoe to capture peaking discharge from the upstream stations to the extent possible and re-regulate the discharge at lower flow rates. The Ops Plan addresses applicable reservoir storage requirements, guaranteed minimum flows and a schedule of implementation addressing agency input. The monitoring section includes a schedule of implementation, and provisions for providing near real-time flow data, head- flow-power rating curves to the NH Department of Environmental Services and the Vermont Department of Environmental Conservation (the State Agencies). Additionally, the plan addresses annual data reporting and analysis requirements to both the Commission and the State Agencies.

The Moore reservoir, with a drainage area of 1,600 square miles and depth of approximately 180 feet, is managed as a seasonal storage reservoir for peaking generation. The principal source of water is the Connecticut River, with only a few small streams entering the reservoir from the surrounding slopes. The total impounded storage is 223,722 acre-feet, of which 114,176 acre-feet represents the available usable storage within a 40-foot drawdown range. The inflow is a mix of 89 percent natural and 11 percent regulated inflow from the various upstream mainstem tributaries. Maximum reservoir elevation is 809 feet msl and minimum elevation for winter drawdown is 769 feet msl. For spring fish spawning, particularly littoral species, the reservoir is brought up to an elevation of at least 802 feet msl, with a target of 804 feet msl, by May 21 of each year and through June 30 the reservoir is not drawn down more than 2 feet below any elevation previously attained in the same period. This stabilized elevation provides greater protection of the aquatic ecosystem and ensures that nests and eggs of littoral species, typically found below two feet from the water surface are not dewatered during these critical life stages when they're not as mobile as later life stages. Moore reservoir operations follow historic patterns and ranges outside of this period. Moore reservoir is drawn down in winter to create storage capacity for spring runoff and snowmelt, and to supplement flow downstream in the summer. No changes to reservoir management are proposed with installation of the new minimum flow unit.

The Comerford reservoir, with a drainage area of 1,635 square miles (2% larger than Moore) and depth of approximately 160 feet, is also managed as a seasonal storage reservoir for peaking generation. Inflow is almost entirely from the Moore development. The Comerford reservoir has a surface area of approximately 1,093 acres at a normal maximum operating level of 650 feet msl. The total impounded storage is 32,270 acre-feet which represents the available usable storage within a maximum 40-foot drawdown range, although only a small portion of that is typically used during normal operation. Maximum reservoir elevation is 650 feet msl and minimum elevation for winter drawdown is 624 feet msl. For spring fish spawning, particularly littoral species, the reservoir is brought up to an elevation of at least 645 feet msl, with a target of 640 feet msl, by May 21 of each year and through June 30 the reservoir is not drawn down more than 2 feet below any elevation previously attained in the same period. This stabilized elevation provides greater protection of the aquatic ecosystem and ensures that nests and eggs of littoral species, typically found below two feet from the water surface are not dewatered during these critical life stages when they're not as mobile as later life stages. Reservoir operations follow historic patterns and ranges outside of this period. Comerford reservoir is drawn down in winter to create storage capacity for spring runoff and snowmelt, and to supplement flow downstream in the summer.

The McIndoe reservoir has a depth generally between 15 to 30 feet, and a surface area of 543 acres at a normal maximum operating level of 454 feet msl. The total impounded storage is 5,988 acre-feet, of which 4,080 acre-feet represents the available storage within a 10-foot drawdown range, of which 3.5 feet can be used for normal operation. Reservoir elevation stabilization provides for the enhancement of available salmonid habitat in the Mclndoes impoundment by facilitating the use of near shore habitat and extensive submerged aquatic vegetative cover in the reservoir, in addition to protecting less mobile littoral species and life stages from desiccation. The Mclndoes reservoir has a drainage area of 2,210 square miles, which is 575 square miles larger than the drainage area for the Comerford reservoir. Approximately 485 square miles (84 percent) of these 575 square miles are contributed by the watershed of the Passumpsic River. The remaining inflow is contributed by small streams, such as the Stevens River, and sidehill runoff. Maximum reservoir elevation is 451.0 feet msl and minimum reservoir elevation is 447.5 msl. Reservoir elevation may exceed 451.0 feet msl if the inflow to the McIndoe reservoir exceeds the discharge capacity of the McIndoe dam.

Reservoir elevations can be temporarily modified if required by operation emergencies beyond the licensee's control, or for short periods upon agreement between the licensee and the state resource agencies. If such an emergency occurs, the licensee notifies NHDES and VTDEC within 24 hours and a written report is provided within 10 days that describes the emergency event and duration, reason for the occurrence, proposals to avoid future occurrences, and mitigative measures. An extension of the 10-day filing deadline may be granted in writing by the NHDES for good cause.

The Project downstream and tailrace reaches meet Standard 2 for Criterion A, Ecological Flows:

- ZoE 2 – Moore tailrace and Comerford impoundment
- ZoE 3 – Comerford tailrace
- ZoE 4 – Comerford downstream
- ZoE 6 – McIndoe tailrace

Criterion	***Standard***	***Instructions***
A	2	<u>Agency Recommendation:</u> • Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally protective). • Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement. • Explain how the recommendation relates to agency management goals and objectives for fish and wildlife. • Explain how the recommendation provides fish and wildlife protection, mitigation and enhancement (including in-stream flows, ramping and peaking rate conditions, and seasonal and episodic instream flow variations).

Ecological flows are specified in the Fifteen Mile Falls Project license which includes, by reference, the Fifteen Mile Falls Settlement Agreement, an agreement signed by the Governors of Vermont and New Hampshire, various State and Federal fishery agencies, state 401 WQ Certification agencies, National Park Service, EPA, and local, regional and national NGO's. The Ops Plan outlines methods to establish, maintain, verify, and report on reservoir levels, inflows, and minimum flows at the developments. Operations data, including inflow, outflow (generation, spill) and reservoir elevation, is filed with NHDES, VTDEC, USFWS, and FERC annually.

The process of reaching the settlement agreement included examination of the power and non-power tradeoffs and effects of a wide variety of different operational scenarios, based on computer modeling of the Connecticut River from the headwater storage lakes to downstream of the project. Various management scenarios involving combinations of various changes in project operations were evaluated. The operational changes included combinations of the following: various seasonally adjusted minimum flow levels below the project dams and the Connecticut Lake dams, reduced impoundment operating ranges, reduced winter drawdown, and stable or rising reservoir elevations in the spring to protect littoral spawning habitat. The various operating scenarios were evaluated and all operational characteristics including reservoir and minimum flows were established for the purpose of benefiting aquatic biota, particularly resident fish species, and maintaining state water quality standards.

At the Moore development a minimum flow of 320 cfs or inflow is passed to the Comerford impoundment immediately downstream of Moore Dam on a continuous, instantaneous basis, improving dissolved oxygen conditions in this reach, particularly during low flow periods. Comerford maintains seasonal minimum flows, guaranteed from storage, below the dam. Due to the guaranteed nature of the minimum flow below Comerford, upstream storage is used to augment downstream natural flow during low flow periods, supporting operation of the downstream hydro developments. The seasonal minimum flows below Comerford are: 818 cfs from June 1 through September 30; 1,145 cfs from October 1 through March 31; and 1,635 cfs from April 1 through May 31.

Water quality studies were conducted in the late 1990's for relicensing of the Project. In the tailrace of Moore Reservoir, DO levels measured for three days (during which no minimum flows were provided during non-generation periods) in the summer of 1996 decreased to approximately 50 percent saturation and to concentrations of just below 5 mg/l (Normandeau 1997). During two weeks of continuous monitoring in the summer of 1998 under conditions of minimum flow (as per the Settlement Agreement) and power generation, DO concentrations in the tailrace of the reservoir and half a mile downstream generally met both NH and proposed (at the time) VT regulatory standards for DO. The DO at both monitoring locations during normal generation was typically well above 75 percent saturation and above 6 mg/l, except during two of the monitored days when the level dipped briefly (for less than 1 hour) to approximately 72 percent saturation while the mg/l remained at or above 6 mg/l (Normandeau 1999). In the tailrace of the Comerford reservoir, DO levels measured during no-flow conditions during three days in the summer of 1996 decreased to approximately 60 percent saturation and to concentrations just above 5 mg/l (Normandeau 1997). During two weeks of continuous monitoring in the summer of 1998 under conditions of minimum flow (as per the Settlement Agreement) and power generation, DO concentrations in the tailrace of the reservoir and half a mile downstream generally met both NH and proposed (at the time) VT water quality standards for DO. The DO at both monitoring locations was typically well above 75 percent saturation except during a few occasions when the level dipped briefly to between 62 and 75 percent saturation. The DO concentrations, however, remained above 5 mg/l (Normandeau 1999).

Minimum flow at Moore and seasonal minimum flows at Comerford were established to enhance and protect salmonid habitat in the tailraces of the Moore and Comerford dams, and in the McIndoes Development, ensuring water quality sufficient to sustain a rainbow and brown trout fishery.

McIndoe has both minimum and maximum flow restrictions. Volumetric seasonal minimum flows carry an "or inflow, whichever is less" caveat and are: 1,105 cfs from June 1 through September 30; 2,210 cfs from October 1 through March 31; and 4,420 from April 1 through May 31. Inflow is defined as the sum of Comerford's minimum flow plus a prorated flow from the Passumpsic river. The prorated flow is defined as 1.3 times the Passumpsic gage No. 01135500 to reflect the 4 miles of additional drainage area between the gage and the confluence with the Connecticut River. These seasonal flows were developed to enhance available coldwater fisheries habitat downstream of the Mclndoes Development by releasing minimum flows and spring spawning and incubation flows.

In the tailrace of the Mclndoes reservoir, DO levels measured during no-flow conditions on August 20, 1996, decreased from approximately 85 to 50 percent saturation, and to concentrations of 4.5 mg/l (Normandeau 1997). During monitoring in 1997 under minimum flow conditions (as per the Settlement Agreement), the DO levels in the tailrace of the reservoir and half a mile downstream met both New Hampshire and Vermont regulatory standards for DO at all times with DO levels at both monitoring locations well above 75 percent saturation, and above 6 mg/l (Normandeau 1997).

Maximum discharge from the McIndoe development cannot exceed maximum station discharge capacity of 5,800 cfs for more than 7 percent of the hours during the period June 1 through February 28. The restriction does not apply to periods when the Moore and Comerford reservoirs are near their maximum operating elevations, or when the sum of the flow at the Dalton gauge, above the Moore impoundment, and the prorated Passumpsic gage exceeds 8,000 cfs or include flows required for downstream fish passage in the 5,800 cfs limit.

Minimum flows can be temporarily modified if required by operation emergencies beyond the licensee control, or for short periods upon agreement between the licensee and the state resource agencies. If such an emergency occurs, the licensee notifies NHDES and VTDEC within 24 hours and a written report is provided within 10 days that describes the emergency event and duration, reason for the occurrence, proposals to avoid future occurrences, and mitigative measures. An extension of the 10-day filing deadline may be granted in writing by the NHDES for good cause.

4.2 Water Quality

All Zones of Effect meet Standard 2 for Criterion B, Water Quality. The Project is in compliance with all conditions of the Clean Water Act Section 401 water quality certification.

Criterion	***Standard***	***Instructions***
B	2	Agency Recommendation: • If facility is located on a Water Quality Limited river reach, provide a link to the state's most recent impaired waters list and indicate the page(s) therein that apply to facility waters. If possible, provide an agency letter stating that the facility is not a cause of such limitation. • Provide a copy of the most recent Water Quality Certificate and any subsequent amendments, including the date(s) of issuance. If more than 10 years old, provide documentation that the certification terms and conditions remain valid and in effect for the facility (e.g., a letter from the agency). • Identify any other agency recommendations related to water quality and explain their scientific or technical basis. • Describe all compliance activities related to water quality and any agency recommendations for the facility, including on-going monitoring, and how those are integrated into facility operations.

The boundary between New Hampshire and Vermont is the low water mark of the Connecticut River on the western (Vermont) side, as it existed before the creation of the reservoirs. Project facilities and reservoirs are located in both states, and the discharge affects waters of both states. Consequently, under the provisions of Section 401 of the Clean Water Act, the Project is subject to the water quality standards of both states. New Hampshire issued a water quality certification (WQC) on April 16, 2001. In letter dated July 9, 2001 Vermont concurred with the conclusions and conditions of the New Hampshire certificate stating: "Vermont and New Hampshire jointly reviewed the project with an understanding that a single certification would be issued by the State of New Hampshire with conditions sufficient to assure that the project would conform to the water quality standards of both states." "Vermont supports the certification and affirms that the conditions of the certification are sufficient to provide reasonable assurance that the project will not cause a violation of Vermont Water Quality Standards and will comply with other appropriate requirements of Vermont law." The specific conditions of the WQC (Section E) are included as Appendix A to the license and conditions related to water quality, flow and reservoir management, and aquatic and terrestrial resource are included as License Articles and therefore remain in effect and are FERC compliance obligations. We have no Notices or Letter Notifications of Non-Compliance from either New Hampshire, Vermont or the FERC.

As discussed above, Great River Hydro filed a non-capacity amendment to the License for a new unit at the Moore Development to provide required minimum flow more efficiently than current operation. As part of the project, a dissolved oxygen enhancement system consisting of a pipe with aeration devices that discharge water into the new powerhouse tailrace was included to offset potential loss of the DO enhancement currently provided by the entrained air through the vacuum pressure prevention system that is opened while passing minimum flow inefficiently through large units. When in operation the new system should ensure NH and VT water quality standards for DO are met. After consultation and mutual development of a dissolved oxygen monitoring plan the VTDEC and NHDES, respectively, waived Section 401 water quality certification authority, with NHDES indicating that neither an amendment to the 2001 certification, nor a new certification, is necessary (see GRH's September 3, 2021 filing).

New Hampshire's surface water quality regulations (Env-Wq 1702.17) identify six designated uses for New Hampshire surface waters. Five apply to all surface waters of the State and an additional designation also applies to all tidal surface waters (NHDES CALM 2020 Table 3-4). The five designated uses pertinent to the Fifteen Mile Falls Project are: aquatic life integrity, fish consumption, potential drinking water supply, swimming and other recreation in and on the water, and wildlife. The designated use of "swimming and other recreation in and on the water", is further assessed for primary contact recreation (i.e. swimming) and secondary contact recreation (i.e. boating).

Some areas within the Project are identified by New Hampshire in its Clean Water Act Section 303(d) List of Impaired Waters, however no Project facilities are identified as causing these water quality impairments (see Assessment Unit ID NHLAK801030202-01, NHRIV801030203-01, and NHRIV801030205-02 on the 303(d) list). The Moore reservoir is impaired for dissolved oxygen saturation, and the Moore and Comerford tailraces are impaired for pH (acidity). The sources of impairment are classified as "unknown". Baseline relicensing studies to characterize water quality in the Fifteen Mile Falls reservoirs confirmed late August stratification and the presence of low DO levels in the deeper waters of the Moore Reservoir. The studies concluded that the Moore Reservoir was meso/eutrophic, reflecting nutrient input from a source further upstream in the watershed and that: 1) Moore Reservoir was prone to stratification, exhibiting the highest DO levels in the photic zone and some oxygen depletion at depth; 2) the introduction of air into discharges from the Moore powerhouse would optimize DO levels below the powerhouse; 3) project operations did not appear to influence Moore Reservoir temperature and DO profiles (Normandeau 1997, 1999, Louis Berger 2000).

Low pH, or acidic conditions are common in New Hampshire where 70% or 3,821 miles of assessed rivers and streams are categorized as impaired for unbalanced acidity (pH levels), as are 88% or 140,736 acres of assessed lakes and reservoirs (EPA 2021). Acidity in waterways is influenced by rock and soils, as well as human sources such as industrial and car emissions, mining, and agricultural runoff.

As specified in the Vermont Water Quality Standards and summarized in Tactical Basin Plans for Basin 16 (Moore and Comerford reservoirs) and Basin 14 (McIndoe Falls reservoir) all surface waters are managed to support designated uses that include: swimming, boating, fishing, aquatic biota, aquatic habitat, aesthetics, public water source, and irrigation. All waters at or below 2,500 feet altitude, National Geodetic Vertical Datum (NGVD), are designated Class B(2) for all uses, unless specifically designated as Class A(1), A(2), or B(1) for any use. The Project waters are all below 2,500 feet NGVD and have not been otherwise specifically designated for any use (see Chapter 2 of each Tactical Basin Plan). Additionally, the Project waters are designated cold-water fish habitat by default because they are not specifically designated warm-water fish habitat.

No Project areas are identified in Vermont's 303(d) list. However, in New Hampshire and Vermont all fresh waters are identified as impaired for mercury and both states follow the Northeast Regional Mercury TMDL strategy. Mercury occurs naturally in rocks and coal. Most of the mercury in the environment is released into the air, but it reaches waterbodies through atmospheric deposition. Airborne mercury is converted in water by bacteria into a toxic form called methyl-mercury which accumulates in the food-chain. Mercury can build up in fish, which then poses health risks to people and animals that eat fish. Every 5 years Great River Hydro collects fish from the Moore and Comerford reservoirs for analysis of mercury. The results are provided to Vermont and New Hampshire for updating their fish consumption advisories. The most recent report was filed with FERC and the states on August 2, 2019.

New Hampshire water quality standards are found here. All surface waters of the State are either classified as Class A or B, with the majority of waters being Class B (NHDES 2020). The reaches of the Connecticut River affected by the Project have been designated by the New Hampshire legislature as Class B waters. Class B waters are of the second highest quality, these waters are considered acceptable for fishing, swimming and other recreational purposes, and, after adequate treatment, for use as water supplies.

Vermont water quality standards are found here. The reaches of the Connecticut River affected by the Project have been designated by the Vermont Water Resources Board as Class B waters. Class B waters are managed to achieve and maintain a high level of quality compatible with certain beneficial values and uses. Values are high quality habitat for aquatic biota, fish and wildlife and a water quality that consistently exhibits good aesthetic value; uses are public water supply with filtration and disinfection, irrigation and other agricultural uses, swimming, and recreation, including fishing.

The Moore tailrace and Comerford impoundment (ZoE 2) meets Standard Plus for Criterion B, Water Quality.

Criterion	***Standard***	***Instructions***
B	PLUS	Bonus Activities: • Describe any advanced technologies or methods that have been deployed at the facility to enhance ambient water quality and how its performance is being monitored. • If adaptive management is being applied, describe the management objectives, the monitoring program in place to evaluate performance against those objectives, and the management actions that will be taken in response to monitoring results.

Great River Hydro intends to operate a DO enhancement system at the Moore development to ensure water quality standards are met when the new minimum flow unit (Moore Unit 5) comes online. Confidential design drawings of the new unit and DO enhancement system are provided as Appendix B, 6.6 (not for public distribution). Article 404 of the 2002 license required the development of a Water Quality Monitoring and Enhancement Plan (WQ Plan) with the purpose of ensuring that streamflow below the Moore and Comerford developments, as measured immediately downstream of the respective tailraces, met DO water quality requirements. Five years of monitoring under the WQ Plan showed that discharge through Moore generating units greatly improved DO levels compared with levels detected in the water drawn from the reservoir through the deep-water intake. These studies suggest aeration was due to air entering the scroll case through vacuum breaking air valves that prevent negative pressure build up around the turbine and inside the scroll case. Because the purpose and design of Moore Unit 5 is to more efficiently use minimum flow to generate electricity, it is not expected to entrain air to the extent the larger units do and therefore significant increases in DO as water passes though the turbine is not anticipated. Therefore, the scope of the proposed Moore Unit 5 development also includes a mitigation plan to ensure that the minimum flow discharge meets applicable State water quality standards for both NH and VT.

The DO enhancement system will consist of an on-land oxygen storage and supply area, piping, and valves conveying flow from the new turbine penstock, as well as underwater anchored equipment installation where the oxygen and water are mixed. Adequate oxygen and enhancing flow supply will be determined by measuring water quality at a designated downstream location. Oxygen concentration will be measured upstream of the injectors on the pipe tap from the penstock. Algorithms for oxygen supply rate based on incoming concentration and turbine flow, and automation may be implemented to facilitate ease of operations. The system will be of modular design such that additional components may be installed in the future at the owner's determination of need for increased capacity.

Great River Hydro will continue to operate the Moore Development and FMF Project as required by the 2002 FERC license and WQC, and as specified in the Reservoir and Minimum Flow Operations and Monitoring Plan, as revised to reflect the new Moore Unit 5 (see Attachment 3 of GRH's January 21, 2020 license amendment application). Great River Hydro will conduct water quality monitoring during the late summer critical stress period in the tailrace below the Moore Station for a minimum of two years after the Moore Unit 5 is operational. A monitoring plan, using the continuous monitoring system, will be developed in consultation with the NHDES and VTDEC.

4.3 Upstream Fish Passage

All Zones of Effect meet Standard 1 for Criterion C, Upstream Fish Passage.

Criterion	***Standard***	***Instructions***
C	1	<u>Not Applicable / De Minimis Effect:</u> • Explain why the facility does not impose a barrier to upstream fish passage in the designated zone. Typically, impoundment zones will qualify for this standard since once above a dam and in an impoundment, there is no facility barrier to further upstream movement. • Document available fish distribution data and the lack of migratory fish species in the vicinity. • If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.

Migratory species in the Connecticut River with historic reach to the Project area include Atlantic salmon and American eel. Migratory species in the Connecticut River Basin are managed by the Connecticut River Atlantic Salmon Commission (CRASC). It was established in 1983 by Congress "to promote the restoration of anadromous Atlantic salmon in the Connecticut River Basin by the development of a joint interstate program for stocking, protection, management, re-search, and regulation" with the purpose of restoring Atlantic salmon to the Connecticut River in numbers as near as possible to their historical abundance. Agency representation includes: USFWS, National Marine Fisheries Service, Connecticut Department of Environmental Protection, Massachusetts Department of Fish and Wildlife, New Hampshire Department of Fish and Game, and Vermont Department of Fish and Wildlife. The CRASC expanded their mission to include all diadromous species in the Connecticut River Basin.

European colonization brought decline to the native salmon population as water-power dams were erected throughout the lower basin, and by the late 1700's salmon were extirpated from the Connecticut River. Restoration efforts began in the late 1860's with minimal success but were rejuvenated in the late 1960's with the availability of federal funding. Restoration efforts included fry and smolt stocking in mainstem tributaries and the construction of upstream and downstream fish passage facilities at the first four dams on the mainstem Connecticut River including GRH's Vernon, Bellows Falls, and Wilder Projects. Further upstream migration is impeded by the Dodge Falls Project, located between the Wilder Project and McIndoe Development. In 2013, the USFWS formally announced that its Atlantic salmon stocking efforts in the Connecticut River basin had not achieved restoration levels and that stocking efforts to restore Atlantic salmon to the Connecticut River would be discontinued.

The FMF 2002 FERC license includes requirements to transport up-migrating adult salmon past McIndoe and Comerford (Articles 411 and 412) after notification that 20 adult Atlantic salmon reached the East Ryegate Dam at the Dodge Falls Project in two consecutive years, and the New Hampshire Fish and Game Department (NHFG), the Vermont Department of Fish and Wildlife (VTFW), the USFWS, and the CRASC determined that upstream fish passage is justified. While some wild salmon continue to enter the Connecticut River after the restoration effort was abandoned, the numbers are low and very few migrate farther than the Connecticut state line. The trigger condition associated with upstream salmon passage at the Fifteen Mile Falls Project has not been met and is not expected to be met any time soon.

American eel enter the Connecticut River as juveniles and move upstream and into tributaries. They have few habitat preferences and can move around most obstructions, allowing them to inhabit most aquatic habitats. Historical records indicate eels were found upstream of the Fifteen Mile Falls Project in the Connecticut Lakes. Recent studies show few eels moving farther then the Vernon and Bellows Falls dams (NHFG 2015, Figure 5).

In accordance with Article 414 of the Fifteen Mile Falls license, the company filed an American Eel Passage Plan. In accordance with the Settlement Agreement and the WQC, and with the support of the resource agencies, the American Eel Passage Plan describes a plan for developing a specific study for providing upstream and downstream American eel passage past the project within one year of notification by the USFWS, VTFW and NHFG that eel passage is needed at the project. Such notification has not been issued.

The Project waters primarily support a warmwater/coolwater fish community; however, a coldwater fishery for salmonids also exists in the project area, supported by a stocking program, with some wild trout production in the tributaries to the project reservoirs. New Hampshire stocks brown, rainbow and brook trout in Moore reservoir, and brown and rainbow trout in the Connecticut River upstream of the reservoir. Vermont stocks brown and rainbow trout in the Passumpsic River, a tributary to the McIndoe impoundment. The dominant warmwater species include smallmouth bass, rock bass, white sucker and fallfish; cool-water species include yellow perch, northern pike, and chain pickerel (PG&E 1999).

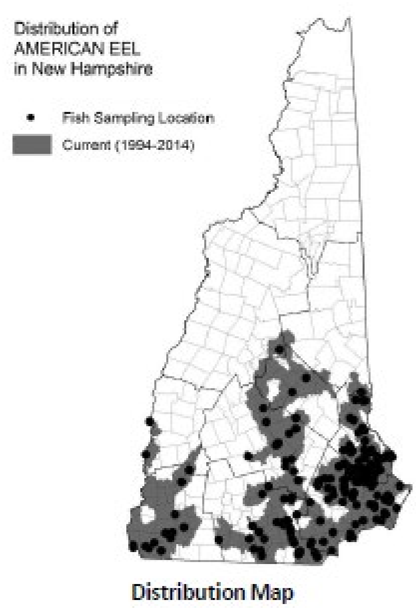


Figure 5. Distribution of American eel in New Hampshire.

Source: New Hampshire Wildlife Action Plan (NHFG 2015)

4.4 Downstream Fish Passage

The following downstream and tailrace Zones of Effect meet Standard 1 for Criterion C, Downstream Fish Passage:

- Zone 3 – Comerford tailrace
- Zone 4 – Comerford downstream reach
- Zone 6 – McIndoe tailrace

The following impoundment Zones of Effect meet Standard 2 for Criterion C, Downstream Fish Passage:

- Zone 1 – Moore impoundment
- Zone 2 – Moore tailrace and Comerford impoundment
- Zone 5 – McIndoe impoundment

Criterion	***Standard***	***Instructions***
D	1	Not Applicable / De Minimis Effect: • Explain why the facility does not impose a barrier to downstream fish passage in the designated zone, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines). Typically, tailwater/downstream zones will qualify for this standard since below a dam and powerhouse there is no facility barrier to further downstream movement. Bypassed reach zones must demonstrate that flows in the reach are adequate to support safe, effective and timely downstream migration. • For riverine fish populations that are known to move downstream, explain why the facility does not contribute adversely to the sustainability of these populations or to their access to habitat necessary for successful completion of their life cycles. • Document available fish distribution data and the lack of migratory fish species in the vicinity. • If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this.
D	2	Agency Recommendation: • Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent). • Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is part of a Settlement Agreement or not. • Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.

The 2002 FERC license included downstream passage (Articles 409 and 410) and monitoring (Article 413) requirements for juvenile Atlantic salmon (smolts) at the Moore, Comerford and McIndoe developments. Downstream passage was implemented and continued through 2015, before FERC suspended the downstream passage requirements (see Section 1 for document links).

After USFWS officially discontinued Atlantic salmon stocking efforts in the Connecticut River basin, the former licensee, TransCanada, filed license amendment requests with the Commission on December 31, 2015, March 3, 2016, and March 8, 2016 to suspend or remove License Articles 409, 410 and 413 associated with downstream passage of Atlantic salmon at the Fifteen Mile Falls Project developments. In its filing, TransCanada included correspondence from NHFG and VTFW supporting suspension of the requirement to provide downstream passage for Atlantic salmon smolts at the Fifteen Mile Falls developments. On May 2, 2016 the Commission issued Order Suspending License Article 409, 410, and 413 for the Fifteen Mile Falls Project. No other anadromous species occupy the Fifteen Mile Falls project area.

From 2004 through 2015 downstream passage of Atlantic salmon smolts past the Moore and Comerford dams was via a fish trap installed in the sluice gate of the Moore dam. The trap was non-selective and a range of resident species was collected each year along with salmon smolts. As reported annually to the FERC, USFWS, VTFW, and NHFG, the collected salmon were transported downstream below the Fifteen Mile Falls Project and all resident species collected in the trap returned to Moore reservoir per agency direction. Downstream transportation of resident species was not a condition of the Fifteen Mile Falls License, Settlement Agreement or WQC.

4.5 Watershed and Shoreline Protection

All Zones of Effect meet Standard 2 and Plus for Criterion E, Watershed and Shoreline Protection.

Criterion	***Standard***	***Instructions***
E	2	Agency Recommendation: • Provide copies or links to any agency recommendations or management plans that are in effect related to protection, mitigation, or enhancement of shoreline surrounding the facility (e.g., Shoreline Management Plans). • Provide documentation that indicates the facility is in full compliance with any agency recommendations or management plans that are in effect.

Criterion	*Standard*	*Instructions*
E	PLUS	Bonus Activities: • Provide documentation that the facility has a formal conservation plan protecting a buffer zone of 50% or more of the undeveloped shoreline that the facility owns around its reservoirs and river corridors • In lieu of a formal conservation plan, provide documentation that the facility has established a watershed enhancement fund for ecological land management that will achieve the equivalent land protection value of an ecologically effective buffer zone of 50% or more around undeveloped shoreline.

Land uses in the Connecticut River watershed include predominantly forest and recreation in the northern counties; open agricultural land in rolling hills and along alluvial floodplains and terraces; and mixed residential, commercial, and industrial uses in population centers and along transportation corridors. Overall, 80 percent of watershed land is forested, 7 percent is in grassland, pasture, or croplands, 9 percent (9%) is developed; 4 percent (4%) is wetland; 2 percent (2%) is shrub-scrub; and 2 percent (2%) is water (USFWS 2006). Agriculture and forestry are the two main land use industries in the upper portion of the watershed, often characterized by dairy farms along the main stem and a few of the tributaries and expansive pastures for livestock. A majority of the land along the river is zoned for limited residential use, but there are commercial and industrial sites (USFWS 2006).

Property owned by Great River Hydro is roughly 85% forested, 9.3% developed, 4.3% undeveloped, 0.5% agriculture, and 0.8 undetermined (TransCanada 2006). For over 40 years, approximately 8,200 acres of forest land owned by Great River Hydro both inside and outside of the Project boundary in Vermont and New Hampshire adjacent to the Connecticut River has been in professional forest management. The current Land Management Plan emphasizes multiple-use of various forest resources, production of higher quality timber for saw logs and other wood products, passive recreation, and wildlife management.

There are no Shoreline Management Plans or similar protection requirements for the Fifteen Mile Falls Project and no agency recommendations or management plans for shoreline management. In large part this is due to the fact that the vast majority of the shoreline is owned in fee, undeveloped, available for day-use only, has a number of resource specific management plans to address resources far more expansive than a Shoreline Management Plan and lastly the shorelines are also overseen by the perpetual conservation easement holders.

Great River Hydro owns significant portions of the shoreline within its Fifteen Mile Falls project boundary (Table 4). The Settlement Agreement for the Project set out specific requirements for management and permanent conservation of these properties, including establishment of a series of specific riparian protection management buffers. The protections are defined within the following zones:

- 600 ft along both sides of 4th Order and greater rivers,

- 300 ft along both sides of 3rd Order rivers and along shores of ponds and non-forested wetlands greater than 10 acres in size, and
- 100 ft along both sides of 1st and 2nd Order streams and along shores of ponds and non-forested wetlands less than 10 acres in size.

Table 4. Great River Hydro owned shoreline within the Fifteen Mile Falls project boundary.

Pond	Total Shoreline (ft)	GRH Owned/Protected (ft)	Percentage
Moore	197,753	189,175	95.6%
Comerford	100,511	47,465	47.2%
McIndoe	124,356	42,954	38.3%
TOTAL:	422,620	279,594	66.2%

Furthermore, conservation easements were conveyed to New England Forestry Foundation, Inc. in 2008 that mirrored and adopted these buffer requirements. The conservation easements permanently conserve all upland acreage of both project and abutting non-project lands totaling 6,918 acres in New Hampshire and Vermont (Figure 6).

In addition to the conservation of Great River Hydro's property, the Settlement Agreement established the Upper Connecticut River Mitigation and Enhancement Fund (MEF, or fund) funded by the then-project owner. The MEF specifically supports restoration, protection, and enhancement of the river, wetlands, and shore lands within the Connecticut River watershed upstream of the confluence of the White River and the Connecticut River at White River Junction, VT and West Lebanon, NH. Since its inception, the fund has helped to conserve over 14,700 acres of property in the Upper Connecticut River watershed. Since 2017, when Great River Hydro last updated LIHI on the fund, close to 1,600 acres have been conserved representing over 138,000 feet of river and stream frontage (of which, over 38,000 is on the Connecticut River mainstem), 27 barriers to aquatic organism passage have been removed to restore over 288 miles of riparian habitat, and over 156,000 feet of in-stream habitat has been enhanced and/or restored. Table 5 details MEF accomplishments since 2012. The MEF is administered through the New Hampshire Charitable Foundation and is guided by a twelve-person advisory committee made up of representatives of environmental organizations, state and federal agencies, local community groups and Great River Hydro. MEF is expected to provide approximately $22 million for these projects. To date, the fund has awarded more than $17.4 million in grants. Over $1.7 million has been awarded for 12 projects across the upper Connecticut River watershed in 2021 alone. The fund balance, as of September 30, 2021, remains at approximately $4.8 million for future conservation and riparian projects. Table 6 provides a funding status report for the MEF.

Table 5. Resource enhancements from projects funded through the Fifteen Mile Falls Mitigation and Enhancement Fund for the years 2012-2021.

Resource Objective	Unit	Total	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
Land Protection												
Total Acres Protected	***Acres***	***14,740.3***	***790.0***	***513.7***	***248.0***	***39.3***	***1,252.2***	***199.0***	***1,288.3***	***168.7***	***502.7***	***1,589.9***
Upland Forest	Acres	**6,954.8**	50.0	364.0	102.4	3.0	608.0	89.0	462.8	57.2	90.0	363.1
Farmland	Acres	**4,437.9**	451.0	8.7	73.0	29.3	626.0	25.0	80.7	4.2	284.5	628.1
Wetland (1)	Acres	**1,796.1**	197.0	136.3	24.4	0.0	0.0	74.8	30.8	3.0	88.5	426.1
Riparian Buffer	Acres	**744.2**	92.0	4.8	33.3	7.0	18.2	10.2	199.1	104.3	39.7	144.8
River	Acres	**807.3**	0.0	0.0	15.0	0.0	0.0	0.0	514.9	0.0	0.0	27.8
Wetland Protection												
Total Acres Protected	***Acres***	***1,087.9***	***196.0***	***135.0***	***17.0***	***9.5***	***31.5***	***74.8***	***32.5***	***79.3***	***88.5***	***397.3***
Aquatic Bed	Acres	**31.1**	5.0	6.8	0.0	0.0	0.0	0.0	1.5	0.0	1.5	9.0
Emergent	Acres	**109.6**	65.0	9.8	1.0	1.5	0.0	0.0	0.0	0.0	8.0	22.7
Shrub-Scrub	Acres	**344.1**	69.0	28.1	2.0	0.0	15.9	10.3	7.5	3.0	0.0	196.7
Forested	Acres	**574.3**	57.0	90.3	14.0	8.0	14.6	64.5	23.5	76.3	79.0	141.1
River	Acres	**28.8**	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	27.8
Wetland Restoration												
Total Acres Restored	***Acres***	***570.6***	***467.6***	***2.6***	***11.0***	***3.4***	***0.0***	***0.0***	***0.0***	***0.0***	***1.0***	***71.0***
Aquatic Bed	Acres	**179.4**	176.8	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emergent	Acres	**10.0**	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shrub-Scrub	Acres	**63.6**	6.2	0.0	1.0	3.4	0.0	0.0	0.0	0.0	0.0	53.0
Forested	Acres	**317.6**	284.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	18.0
Shoreland Protection												
Total Stream Frontage	***Feet***	***419,988***	***66,622***	***43,449***	***20,497***	***7,901***	***15,202***	***3,900***	***69,689***	***26,748***	***53,836***	***77,119***
Connecticut River	Feet	**145,827**	31,114	4,000	1,900	1,500	0	0	4,610	100	40,365	58,714
Major Tributaries (2)	Feet	**109,533**	14,807	24,500	3,562	4,081	0	0	11,321	26,513	3,500	6,261
Other streams	Feet	**164,628**	20,701	14,949	15,035	2,320	15,202	3,900	53,758	135	9,971	12,144
River/Stream Restoration												
Barriers Removed (3)	#	**65**	4	5	9	9	5	1	4	2	9	2
Upstream River Restored (4)	Miles	**430.8**	62.0	46.0	28.0	152.3	30.0	56.0	14.2	16.4	13.8	4.6
Total River Restored (5)	Miles	**835.8**	120.0	96.0	81.5	245.9	21.0	98.0	48.4	42.3	31.9	19.3
Instream Habitat Restored (6)	Feet	**320,241**	0	16,240	102,730	37,920	42,627	400	41,729	285	27,440	37,560
Shoreland Restoration (7)	Acres	**48.6**	1.0	2.2	30.3	6.5	0.0	0.4	8.0	0.2	0.0	0.0

NOTES

1 Detailed breakdown for type of wetland in Wetland Protection section

2 Major Tributaries (listed South to North, by state)

VERMONT	NEW HAMPHIRE
White River	Ammonoosuc River
Ompompanoosuc River	Johns River
Waits River	Upper Ammonsoosuc River
Wells River	Mohawk River
Stevens River	Indian Stream
Passumpsic River	
Nulhegan River	

3 Culverts, dams and other obstructions

4 Miles of stream (and tributaries) made accessibe upstream of project site

5 Miles of stream down to next downstream obstruction PLUS miles of Upstream River Restored

6 For actual in-stream restoration projects ONLY

7 For replanting and other active restoration within riparian buffer and other shoreland areas.

Table 6. Funding status of the Fifteen Mile Falls Mitigation and Enhancement Fund as of September 30, 2021.

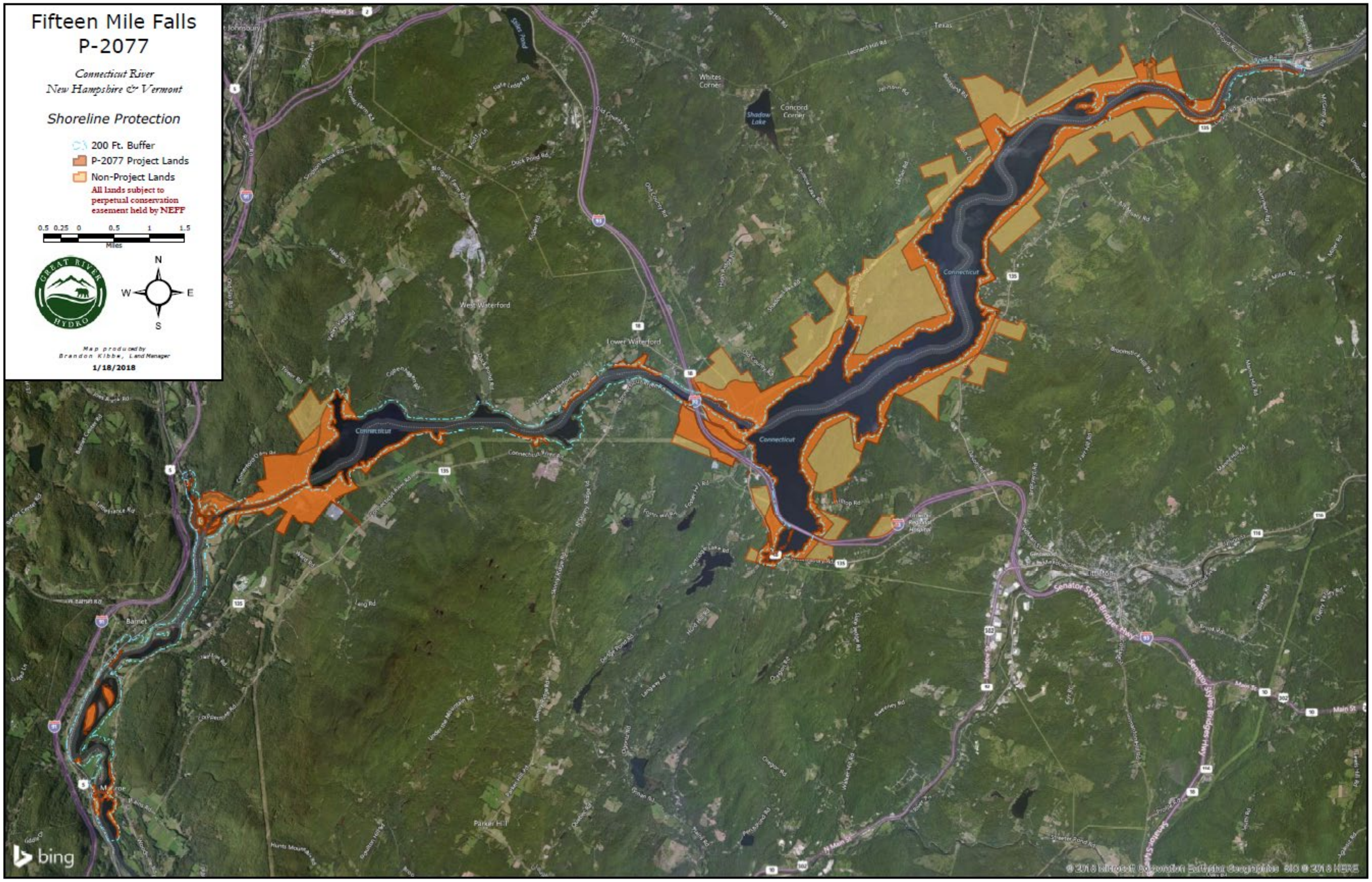
Upper Connecticut River Mitigation and Enhancement Fund
Accumulated Fund Status Report

Year	Beginning of Year Fund Balance	Contributions	Total Return (net of investment fees)	Foundation Fee	Program Expenses	Easement Expenses	Grants	Payments to Towns	End of Year Fund Balance
2002	$ -	$ 3,371,731	$ 13,984	$ (33,737)	$ (9,274)	$ -	$ -	$ -	$ 3,342,704
2003	$ 3,342,704	$ 112,500	$ 27,920	$ (8,125)	$ (10,526)	$ (99,029)	$ (494,215)	$ -	$ 2,871,229
2004	$ 2,871,229	$ 1,566,803	$ 31,680	$ (21,178)	$ (6,416)	$ -	$ (680,918)	$ -	$ 3,761,201
2005	$ 3,761,201	$ 2,212,511	$ 138,115	$ (29,165)	$ (1,346)	$ -	$ (867,257)	$ -	$ 5,214,059
2006	$ 5,214,059	$ 5,540,594	$ 335,092	$ (61,326)	$ (849)	$ -	$ (1,312,285)	$ -	$ 9,715,286
2007	$ 9,715,286	$ 4,306,927	$ 547,336	$ (51,349)	$ (11,023)	$ (122,949)	$ (485,672)	$ (1,742,223)	$ 12,156,333
2008	$ 12,156,333	$ 3,894,284	$ 370,777	$ (46,620)	$ (4,038)	$ (100,752)	$ (817,918)	$ (389,430)	$ 15,062,638
2009	$ 15,062,638	$ -	$ 80,560	$ (10,119)	$ (2,093)	$ (34,583)	$ (735,121)	$ -	$ 14,361,281
2010	$ 14,361,281	$ -	$ 14,217	$ (9,836)	$ (5,059)	$ (22,491)	$ (538,239)	$ -	$ 13,799,872
2011	$ 13,799,872	$ -	$ 18,596	$ (9,162)	$ (1,110)	$ (119,167)	$ (2,004,156)	$ -	$ 11,684,873
2012	$ 11,684,873	$ -	$ 12,847	$ (11,162)	$ (937)	$ -	$ 113,208	$ -	$ 11,798,829
2013	$ 11,798,829	$ -	$ 8,023	$ (9,918)	$ (1,301)	$ -	$ (788,733)	$ -	$ 11,006,901
2014	$ 11,006,902	$ 1,000	$ 6,271	$ (8,360)	$ (992)	$ -	$ (445,600)	$ -	$ 10,559,220
2015	$ 10,559,220	$ -	$ 11,440	$ (8,652)	$ (907)	$ -	$ (1,326,093)	$ -	$ 9,235,008
2016	$ 9,235,008	$ -	$ 41,765	$ (8,726)	$ (1,530)	$ -	$ (628,808)	$ -	$ 8,637,710
2017	$ 8,637,710	$ -	$ 73,651	$ (8,759)	$ (1,492)	$ -	$ (461,089)	$ -	$ 8,240,022
2018	$ 8,240,022	$ -	$ 150,847	$ (7,989)	$ (1,576)	$ -	$ (595,724)	$ -	$ 7,785,580
2019	$ 7,785,580	$ -	$ 219,234	$ (5,897)	$ (188)	$ -	$ (684,996)	$ -	$ 7,313,733
2020	$ 7,313,733	$ -	$ 149,463	$ (6,388)	$ -	$ -	$ (1,039,099)	$ -	$ 6,417,709
2021*	$ 6,417,709	$ -	$ 1,568	$ (3,888)	$ -	$ -	$ (1,553,468)	$ -	$ 4,861,921
Subtotals		**$ 21,006,350**	**$ 2,253,387**	**$ (360,357)**	**$ (60,655)**	**$ (498,971)**	**$ (15,346,182)**	**$ (2,131,653)**	**$ 4,861,920**
	Total assets:	$ 23,259,737		Total expenses:	$ (421,012)		Total grants:	$ (17,477,835)	

Foundation Fee equals 1.0% of the TC contributions plus Charitable Foundation staff costs (starting in 2003; in 2002, staff costs incuded in Program Exp)
Program expenses include phone, legal, meeting expense, web hosting, staff travel, etc.
Easement expenses include all expenses for VT and NH FMF Project Area and CT Lakes easements
2010 grants equals ($755,732) in new grant awards and $107,492.70 in grants returned (VLT, CRJC)
2012 grants total equals ($1,164,961) in new grant awards and $1,278,169.82 in grants returned (VYCC, VLT/Pew-Johnson Farm, SPNHF, CRWC/Johns River)
2013 grants total equals ($813,313) in new grant awards and $30,580 in grants returned (White River Partnership--two grants)
2015 grants total equals ($1,348,064) in new grant awards and $21,971.44 in grants returned (from 2014 grants)
2016 grants total equals ($893,948) in new grant awards and $265,140.49 in returned grants (PVLT, TNC, UVLT, VRC)
2017 grants total equals ($522,598) in new grant awards and $61,508.89 in returned grants (CRC, ACT, VRC)
2018 grants total equals ($596,600) in new grant awards and $876 in returned grants (CRWC)
2019 grants total equals ($689,996) in new grant awards and $5,000 in returned grants (Hanover Cons)
2020 grants total equals ($1,208,662) in new grant awards and $169,563 in returned grants (TNC, VRC, CRC, ACT, AR)
2021 grants total equals ($1,771,227) in new grant awards and $217,759 in returned grants (AR)

*Current as of 9/30/21

Grants to date: $ (17,477,835)



Fifteen Mile Falls
P-2077
Connecticut River
New Hampshire & Vermont
Shoreline Protection
200 Ft. Buffer
P-2077 Project Lands
Non-Project Lands
All lands subject to perpetual conservation easement held by NEFF
0.5 0.25 0 0.5 1 1.5
Miles
N
W
E
S
GREAT RIVER HYDRO
Map produced by
Brandon Kibbe, Land Manager
1/18/2018
Connecticut
Connecticut
Connecticut
West Waterford
Lower Waterford
Barnet
Monroe
Parker Hill
Whites Corner
Concord Corner
Shadow Lake
Texas
Cushman
bing

4.6 Threatened and Endangered Species Protection

All Zones of Effect meet Standard 2 for Criterion F, Threatened and Endangered Species Protection.

Criterion	*Standard*	*Instructions*
F	2	Finding of No Negative Effects: • Identify all federal and state listed species in the facility area based on current data from the appropriate state and federal natural resource management agencies. • Provide documentation that there is no demonstrable negative effect of the facility on any listed species in the area from an appropriate natural resource management agency or provide documentation that habitat for the species does not exist within the ZoE or is not impacted by facility operations.

Following the Settlement Agreement and FMF License Articles 415 (Wildlife and Forestry Plan), 416 (Management Plan for Threatened and Endangered Species), and 417 (Rare and Unusual Plant/Plant Community Management Plan), the company filed a Land Management Plan on December 26, 2006 covering the required aspects of each Article. The Land Management Plan primarily represents technical guidance for the professional foresters and ecologists managing the lands associated with the Fifteen Mile Falls Project. As such, it articulates the company's land management policies and provides management guidelines for all active management practices. However, the document represents only one component of the Land Management Plan, which relies heavily on a specific, comprehensive, and regularly updated Geographic Information System (GIS) that contains maps of natural communities, recreation sites, rare plant locations, important wildlife habitats, forest stands, cultural resource sites, and detailed stand management prescriptions.

Current lists of threatened and endangered species in the Fifteen Mile Falls Project area, provided in Appendix B, were obtained by accessing USFWS's IPaC project review website (Appendix B, 6.7 - confidential), NH Division of Forests and Lands' DataCheck Tool (Appendix B, 6.8 – confidential), and an email request to VT's Natural Heritage Bureau (Appendix B, 6.9 – confidential). Provided below is a summary of the threatened and endangered species identified by the agencies and general discussion relative to Project affects.

Mammals
Two federally threatened mammals were identified: Canada lynx (*Lynx canadensis*) and Northern long-eared bat (*Myotis septentrionalis*).

The Canada lynx is a medium-sized cat with adult males averaging 22 pounds and females 19 pounds. The lynx's long legs and large feet make it highly adapted for hunting in deep snow. The distribution of lynx in North America is closely associated with the distribution of North

American boreal forest where lynx are most likely to persist in areas that receive deep snow and have high-density populations of snowshoe hares, the principal prey of lynx (https://ecos.fws.gov/ecp/species/3652). In the contiguous United States, lynx are considered to be part of a larger metapopulation located in the northern boreal forest of central Canada, with populations emanating from this area. At its southern margins in the United States, the boreal forest becomes naturally fragmented into patches of varying size as it transitions into other vegetation types. These southern habitat patches are small relative to the extensive northern boreal forest of Canada and Alaska, which constitutes the majority of the lynx range. Many of these southern boreal forest habitat patches are able to support resident populations of lynx and snowshoe hare. In the Northeast, the amount of lynx habitat is naturally limited and does not contribute substantially to the persistence of the contiguous United States distinct population segment. Only two reports of lynx in New Hampshire exist for the 1990s. Although reports are scarce, lynx are expected to be present in New Hampshire because habitat remains contiguous with Maine where a resident population is believed to exist. Lynx are not thought to occur in Vermont (https://www.govinfo.gov/content/pkg/FR-2000-03-24/pdf/00-7145.pdf#page=3). The status of Canada lynx is not impacted by operation of the Project.

The Northern long-eared bat is a medium-sized bat found across much of the eastern and north central United States and all Canadian provinces from the Atlantic coast west to the southern Northwest Territories and eastern British Columbia. White-nose syndrome, a fatal fungal disease known to affect bats, is currently the predominant threat, especially throughout the Northeast where the species has declined by up to 99 percent from pre-white-nose syndrome levels at many hibernation sites (https://ecos.fws.gov/ecp/species/9045). Management is focused on studying the population in relation to white-nose syndrome. The status of the species is not impacted by operation of the Project.

Birds

Cliff swallows (*Petrochelidon pyrrhonota*) are threatened in NH. Cliff swallows are aerial insectivores, a group of birds that includes nightjars, swifts, flycatchers, and swallows. All are highly aerial, and feed entirely on insects captured during sustained flight – often quite high in the air column. Recently listed, the cliff swallow was rare in the Northeast prior to European settlement but increased during the early 19th century due to the construction of bridges and buildings that provided nesting substrate similar to the rocky cliffs and outcrops in the mountains and foothills of western North America from where they expanded. In the northeastern U.S., including NH, all colonies are located on man-made structures, and generally near open habitats (often fields) for foraging. Over the last 20 years, the number and size of colonies in NH has declined considerably and the species is now found primarily in Coos County and the Lakes Region, with scattered colonies near the Seacoast (NHFW 2015). Threats identified for the group of aerial insectivores as a whole include changes in food supply, effects of insecticides on adults or young, loss of nesting locations, and climate change (NHFW 2015). Project operation does not impact the status of the species.

The bald eagle (Haliaeetus leucocephalus) is endangered in Vermont but has been recommended for delisting. It was proposed for delisting from the federal Endangered Species

Act on July 6, 1999, and officially removed on July 9, 2007. The bald eagle has returned to many parts of its former range, including Vermont, and has become reestablished as a breeding species in the northeastern United States. Successful restoration of bald eagle populations to North America is due to the ban on dichlorodiphenyltrichloroethane (DDT), extensive reintroduction programs, and the protection of critical breeding and wintering habitat. Presently, the species has continued protection under the Bald and Golden Eagle Protection Act (1940), the Lacey Act (1900), and the Migratory Bird Treaty Act (1918). Bald eagle nests occur in the Project area and eagle sightings are common. Project operation does not negatively impact the status of the species.

Insects

The monarch butterfly (*Danaus plexippus*) is a federal candidate species and not yet listed or proposed for listing. It is globally distributed throughout 90 countries, islands, and island groups. Census data for the two North American populations (located east and west of the Rocky Mountains) indicate long-term declines in population abundance at the overwintering sites, leading the USFWS to identify it as a candidate species. During the breeding season, monarchs lay their eggs on their obligate milkweed host plant and larvae emerge after two to five days. Larvae develop through five larval instars (intervals between molts) over a period of 9 to 18 days, feeding on milkweed and sequestering toxic chemicals (cardenolides) as a defense against predators. The larva then pupates into a chrysalis before emerging 6 to 14 days later as an adult butterfly. There are multiple generations of monarchs produced during the breeding season, with most adult butterflies living approximately two to five weeks; overwintering adults enter into reproductive diapause (suspended reproduction) and live six to nine months. Individual monarchs in temperate climates, such as eastern North America, undergo long-distance migration, and live for an extended period of time. In the fall monarchs begin migrating to their respective overwintering sites. This migration can take monarchs distances of over 3,000 km and last for over two months. In early spring (February-March), surviving monarchs break diapause and mate at the overwintering sites before dispersing. The same individuals that undertook the initial southward migration begin flying back through the breeding grounds and their offspring start the cycle of generational migration over again. The status of the species is not impacted by operation of the Project.

Invertebrates

The dwarf wedgemussel (*Alasmidonta heterodon*) is a federally and state (NH and VT) listed endangered species. As its name suggests, the dwarf wedgemussel is a tiny mollusk, barely 1.5 inches long, that lives in freshwater streams and rivers along the Atlantic coast drainage. Populations are believed to occur in Connecticut, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Vermont, and Virginia (https://ecos.fws.gov/ecp/species/784#lifeHistory). Dwarf wedgemussels live on sand, firm muddy sand, firm clay, and gravel bottoms in creeks and rivers of varying sizes with a slow to moderate current. When ready to reproduce the female carries eggs in the gills that are fertilized as sperm-laden water passes through the gills. Within the female's gills, the fertilized eggs develop into larvae called glochidia, which the female releases into the water. A larva then attaches to a host fish's gills to continue growth. The glochidium is thought to only uses the fish as a means of dispersal; after some weeks, the larva detaches itself from the unharmed fish and drops to the river bottom, where it may live as an adult for 10 years (https://www.fws.gov/northeast/pdf/dwarfwed.pdf). According to the USFWS IPaC website, no conservation plans are currently available for this species.

Surveys for dwarf wedge mussels were conducted throughout the Fifteen Mile Falls Project area during the summer and fall of 1997 (Woodlot Alternatives 1998). During these surveys, seven live dwarf wedge mussels and two relic shells were found at the upstream end of the Project area. Additional SCUBA surveys were conducted to document the size of the population, available habitat, and approximate mussel density. The presence of rapids downstream of the mussel population suggested that Moore Reservoir may not have a direct influence on the dwarf wedge mussel site. To assess the potential influence of Moore Reservoir on the mussel habitat, a topographic survey was conducted (Alpine Land Surveying Co., Littleton, NH) on March 3, 1998. Bathymetric measurements were taken at the estimated deepest portion of the river channel to just above the head of the rapids, and bank-to-bank cross-section measurements were collected from upstream to downstream of the known mussel population.

The SCUBA and topographic surveys indicated that water levels and flow conditions in the reach occupied by the mussels are controlled primarily by inflow from the upstream dam. In addition, a submerged ledge outcrop downstream of the mussels constricts the channel and creates a backwater that floods the mussel population, apparently even under low-flow conditions. USFWS staff visited the site to evaluate habitat conditions in the vicinity of the mussel and concluded that the mussels were not likely to be influenced by operation of the Fifteen Mile Falls Project (see License Order, page 8). No operational changes have occurred at the Project that would alter this conclusion, and no action has been issued by a regulatory agency regarding the existing population.

Plants
No federally listed plant species were identified in the Project affected area. Some of the plant species identified by New Hampshire and Vermont are likely outside of the Project affected area but are included here for consistency with the state provided lists. New Hampshire state listed plants include 9 endangered and 8 threatened species. For 8 of the listed species the most recent report of an occurrence was made over 20 years ago. NH endangered plant species occurring in the Project affected area include bur-reed sedge (*Carex sparganioides*), crested sedge (*Carex cristatella*), great St. John's-wort (*Hypericumascyron ssp. pyramidatum*), limestone-meadow sedge (*Carex granularis*), marsh horsetail (*Equisetumpalustre*), Sensitive species, shining ladies'-tresses (*Spiranthes lucida*), small dropseed (*Sporobolus neglectus*), and sticky false asphodel (*Trianthaglutinosa*). Only great St. John’s-wart, Sensitive species, and sticky false asphodel occurrences have been documented in the Project area within the past 20 years. NH threatened plant species occurring in the Project affected area include American spurred-gentian (*Halenia deflexa ssp.* deflexa), Bailey's sedge (*Carexbaileyi*), balsam groundsel (*Packera paupercula*), brook lobelia (*Lobelia kalmii*), elk sedge (*Carex garberi*), fen grass-of-Parnassus (*Parnassiaglauca*), golden-fruited sedge (*Carex aurea*), and Loesel's wide-lipped

orchid (*Liparis loeselii*). The last report of an occurrence for two of these species, Bailey's sedge and balsam groundsel, was over 20 years ago.

Vermont state listed plants include 2 endangered species: Greene's rush (*Juncus greenei*) and woodland cudweed (*Omalotheca sylvatica*); and 9 threatened species: Muehlenberg's sedge (*Carex muehlenbergii var. muehlenbergii*), sticky false asphodel (*Triantha glutinosa*), tubercled orchid (*Platanthera flava var. herbiola*), bog wintergreen (*Pyrola asarifolia ssp. asarifolia*), Garber's sedge (*Carex garberi*), lance-leaved violet (*Viola lanceolata ssp. lanceolata*), marsh horsetail (*Equisetum palustre*), slender mountain rice (*Piptatheropsis pungens*) and stiff gentian (*Gentianella quinquefolia*).

Due to the close association of rare plants with rare and unusual plant communities identified in the Project area, threatened and endangered plants are managed as part of the Rare and Unusual Plant/Plant Community Management portion of the Land Management Plan. This approach, i.e., monitoring by community, mirrors that of the State Natural Heritage Programs (NHP). The state NHP datasets of rare, threatened and endangered (RTE) species and communities are now available online. In advance of any activity conducted on Project lands such as timber harvests, construction, and vegetation management, Great River Hydro accesses NH's DataCheck Tool to request a project review for RTE species, or VT's tool at http://anrmaps.vermont.gov/websites/anra5/. We also consult with state wildlife biologists directly on each timber harvest. An example data check for a recent forest management project in NH is included in Appendix B, 6.10 (confidential). This process provides the most current data specific to a location of activity. Identified RTE species and plant and plant community locations are GIS mapped and buffered from forest management, or other activity. Agency staff are consulted prior to any management action and are provided access to Project lands to monitor these RTE species and plant communities and recommend management options.

4.7 Cultural and Historic Resources Protection

All Zones of Effect meet Standard 2 for Criterion G, Cultural and Historic Resources Protection.

Criterion	***Standard***	***Instructions***
G	2	Approved Plan: • Provide documentation of all approved state, federal, and recognized tribal plans for the protection, enhancement, and mitigation of impacts to cultural and historic resources affected by the facility. • Document that the facility is in compliance with all such plans.

The Project operation complies with Article 419 of the License, which provides for cultural resources protection, via implementation of a Programmatic Agreement (PA) executed February 6, 2002 between FERC, the Advisory Council on Historic Preservation, the Vermont State Historic Preservation Officer (VT SHPO) and the New Hampshire State Historic Preservation Officer (NH SHPO). In accordance with the PA, License and Settlement Agreement, a Cultural Resources Management Plan (CRMP) was filed by the company on January 4, 2008 and modified and approved by FERC on January 21, 2009. The modification was a requirement for the company to file a PA stipulated land-use map with FERC, the VT SHPO, and NH SHPO. The map was filed as a component of the Land Management Plan and associated GIS dataset.

The Fifteen Mile Falls hydroelectric facilities are considered eligible for listing in the National Register of Historic Places and one prehistoric site was recommended eligible for listing. An historical summary of the Project prepared for the Company by the Public Archeology Laboratory Inc. is provided in Appendix B, 6.9.

The CRMP includes mitigation measures for the historic properties, including an evaluation of any site that will be impacted by an activity. All of the archeological sites were monitored to establish a baseline. An Historic American Building Survey/Historic American Engineering Record of the historic buildings and structures was also conducted. This baseline information is updated at 10-year intervals, through visual inspections by a qualified professional architectural historian; the last 10-year report was filed with the VT and NH SHPO's on October 1, 2019 (Appendix B, 6.10).

The CRMP also integrates cultural resource management into the Company's master planning process for the Project. Cultural resources are evaluated during planning for any alterations to Project facilities, and consultation with the appropriate SHPO is initiated if activities could impact those resources. Biennial reports summarize these evaluations and document consultation. The last biennial report filed with the VT and NH SHPO's on April 15, 2020 is included in Appendix B, 6.11).

4.8 Recreational Resources

All Zones of Effect meet Standard 2 for Criterion H, Recreational Resources.

Criterion	***Standard***	***Instructions***
H	2	Agency Recommendation: • Document any comprehensive resource agency recommendations and enforceable recreation plan that is in place for recreational access or accommodations. • Document that the facility is in compliance with all such recommendations and plans.

The Project provides recreational access, accommodation and facilities. In accordance with Article 418 and in consultation with resource agencies, upgrades to existing recreational areas for picnicking, boating, and hiking are in place and construction of new primitive camp sites are completed as described in the Fifteen Mile Falls Recreation Management Plan dated July 2007. The plan was approved, with modification, by FERC on November 21, 2008. The modification called for company to file as-built drawings of the recreation facilities and improvements proposed in the plan, except that such drawings were not required for picnic tables and grills, signs, or buoys. Safety devices such as signage, warning lights, sirens, and recorded messages are in place to ensure that recreational users, particularly fishermen, are properly warned of sudden changes in discharge flows. The location of each safety device is specified in the Company's Public Safety Plan filed with FERC and updated when changes are made or at least every 10-years.

In addition, the Company maintains minimum reservoir levels for open water recreation (e.g., boating) at Moore and Comerford reservoirs. These reservoir restrictions have been incorporated into the Project's water management and operations protocols.

FERC conducted an environmental and public use inspection of the Fifteen Mile Falls Project on August 8, 2018, and identified eight items for follow up in their August 30, 2018, letter, including repairs to 3 boat ramps, replacement and corrections to part 8 signs, recovering a picnic table from the lake, and filing revised exhibits reflecting switchyard upgrades. On September 28, 2018 Great River Hydro provided a plan and schedule to address each item and filed follow up letters annually until all items were completed (July 3, 2019 and June 9, 2020).

4.9 Literature Cited

Acres International Corporation (Acres). 1998. FMF Project, Smallmouth Bass Spawning Report. Amherst, New York. December 1998.

Environmental Protection Service (EPA). Website: How's My Waterway https://mywaterway.epa.gov/state/NH/water-quality-overview accessed October 12, 2021.

Gomez and Sullivan Engineers. 1997a. Draft riverine habitat mapping report. Fifteen Mile Falls Hydroelectric Project FERC No. 2077. Prepared for the New England Power Company. January 1997.

Gomez and Sullivan Engineers. 1997b. Demonstration flow study for the Nine Islands reach of the Connecticut River. Fifteen Mile Falls Hydroelectric Project FERC No. 2077. Prepared for New England Power Company. June 1997.

Gomez and Sullivan Engineers. 1998. Flow effects on riverine habitat in the main stem of the Connecticut River. Fifteen Mile Falls Hydroelectric Project FERC No. 2077. Prepared for U.S. Generating Company, New England, Inc. December 1998.

Louis Berger & Associates, Inc. 2000. 1999 Program addressing dissolved oxygen issues at the Fifteen Mile Falls Hydroelectric Project No. 2077. Needham, Massachusetts.

New Hampshire Department of Environmental Services (NHDES). January 3, 2020. 2018 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM). State of New Hampshire Department of Environmental Services, Concord, NH.

New Hampshire Fish and Wildlife Department. 2015. New Hampshire Wildlife Action Plan 2015 Revised Edition. New Hampshire Fish and Game Department. Concord, NH. (https://wildlife.state.nh.us/wildlife/wap.html)

Normandeau Associates, Inc. 1999. FMF Project, 1997 and 1998 Water Quality Monitoring. Bedford, New Hampshire.

Normandeau Associates, Inc. 1997. FMF Project, 1997 Water Quality Monitoring. Bedford, New Hampshire.

PG&E US Generating Company. 1999. Fifteen Mile Falls Project (FERC No. 2077) Preliminary Draft Applicant Prepared Environmental Assessment. Lebanon, New Hampshire.

TransCanada Hydro Northeast Inc. 2006. Fifteen Mile Falls Land Management Plan, Final. Concord, NH.

US Generating Company, New England, Inc. 1999. Final riverine habitat report. Fifteen Mile Falls Hydroelectric Project FERC No. 2077. Lebanon, New Hampshire.

United States Fish and Wildlife Service (USFWS). December 2006. Silvio O. Conte National Fish and Wildlife Refuge Final Comprehensive Conservation Plan and Environmental Impact Statement. U.S. Fish and Wildlife Service, Sunderland, MA.

Woodlot Alternatives. 1998. Dwarf Wedge Mussel Survey Results, Fifteen Mile Falls Project, FERC No. 2077. Report prepared for New England Power Company.

5.0 APPENDIX A – CONTACTS

5.1 Facility Contacts

Project Owner:	
Name and Title	Scott Hall
Company	Great River Hydro, LLC
Phone	603-268-2802
Email Address	shall@greatriverhydro.com
Mailing Address	112 Turnpike Road, Suite 202, Westborough, MA 01581
Project Operator (if different from Owner):	
Name and Title	
Company	
Phone	
Email Address	
Mailing Address	
Consulting Firm / Agent for LIHI Program (if different from above):	
Name and Title	
Company	
Phone	
Email Address	
Mailing Address	
Compliance Contact (responsible for LIHI Program requirements):	
Name and Title	John Ragonese, FERC License Manager
Company	Great River Hydro, LLC
Phone	603-498-2851
Email Address	jragonese@greatriverhydro.com
Mailing Address	40 Pleasant St. Suite 202, Portsmouth, NH 03801
Party responsible for accounts payable:	
Name and Title	Marie LeBlanc
Company	Great River Hydro, LLC
Phone	413-773-6700
Email Address	mleblanc@greatriverhydro.com
Mailing Address	112 Turnpike Road, Suite 202, Westborough, MA 01581

5.2 Agency Contacts

Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources X, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	Vermont Fish and Wildlife Department
Name and Title	Peter Emerson, Fisheries Biologist
Phone	802-751-0485
Email address	peter.emerson@vernont.gov
Mailing Address	100 Mineral Street, Suite 302, Springfield, VT 05156-3168

Agency Contact (Check area of responsibility: Flows_X_, Water Quality _X_, Fish/Wildlife Resources __, Watersheds _X_, T/E Spp. _X_, Cultural/Historic Resources __, Recreation _X_):	
Agency Name	Vermont Department of Environmental Conservation
Name and Title	Jeff Crocker, Supervising River Ecologist
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Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources _X_, Recreation __):	
Agency Name	Vermont Division for Historic Preservation
Name and Title	Elizabeth Peebles, Historic Resources Specialist
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Email address	Elizabeth.peebles@vermont.gov
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Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds ___, T/E Spp. X__, Cultural/Historic Resources ___, Recreation __):	
Agency Name	Vermont Department of Fish and Wildlife
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Email address	Bob.popp@vermont.gov
Mailing Address	5 Perry St. Suite 40, Barr, VT 05641

Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __):	
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Mailing Address	103 East Plumtree Road, Sunderland, MA 01375

Agency Contact (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	New Hampshire Fish and Game Department

Name and Title	Andrew Schafermeyer, Fisheries Biologist
Phone	603-788-3164
Email address	Andrew.schafermeyer@wildlife.nh.gov
Mailing Address	629B Main Street, Lancaster, NH 03584

Agency Contact (Check area of responsibility: Flows _X_, Water Quality _X_, Fish/Wildlife Resources __, Watersheds _X_, T/E Spp. __, Cultural/Historic Resources __, Recreation X__):	
Agency Name	New Hampshire Department of Environmental Services
Name and Title	Gregg Comstock, Watershed Management Bureau, Water Division
Phone	603-271-2983
Email address	Gregg.comstock@des.nh.gov
Mailing Address	29 Hazen Drive, PO Box 95, Concord, NH 03302

Agency Contact (Check area of responsibility: Flows __, Water Quality __, Fish/Wildlife Resources ___, Watersheds ___, T/E Spp. __, Cultural/Historic Resources _X_, Recreation __):	
Agency Name	New Hampshire Division of Historical Resources
Name and Title	Elizabeth Muzzey, SHPO and Director
Phone	603-271-3483
Email address	preservation@dncr.nh.gov
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Agency Contact (Check area of responsibility: Flows ___, Water Quality ___, Fish/Wildlife Resources ___, Watersheds ___, T/E Spp. X_, Cultural/Historic Resources __, Recreation __):	
Agency Name	New Hampshire Division of Forests and Lands
Name and Title	Jessica Bouchard, Natural Heritage Bureau, Environmental Reviewer
Phone	603-271-2834
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Agency Contact (Check area of responsibility: Flows ___, Water Quality ___, Fish/Wildlife Resources _X, Watersheds ___, T/E Spp. __, Cultural/Historic Resources __, Recreation __):	
Agency Name	New Hampshire Fish and Game Department
Name and Title	Jake DeBow, Regional Wildlife Biologist, NHFGD
Phone	603-788-3164
Email address	Jacob.debow@wildlife.nh.gov
Mailing Address	629B Main Street, Lancaster, NH 03584

5.3 Non-governmental Stakeholders

Non-Governmental Stakeholder	
Organization	New England Forestry Foundation
Name and Title	Andrew Bentley, Conservation Easement Manager
Phone	(978) 952-6856 x120
Email address	abentley@newenglandforestry.org
Mailing Address	32 Foster Street, P.O. Box 1346, Littleton, MA 01460

Non-Governmental Stakeholder	
Organization	Connecticut River Conservancy
Name and Title	Ron Rhodes, Director of Restoration Programs
Phone	413-772-2020 ext. 214 or 413-768-4994
Email address	rrhodes@ctriver.org
Mailing Address	15 Bank Row, Greenfield, MA 01301

Non-Governmental Stakeholder	
Organization	Vermont River Conservancy; Connecticut River Paddlers Trail
Name and Title	Noah Pollock, Stewardship Coordinator
Phone	802-540-0319, 802-540-0319
Email address	Noah.pollock@gmail.com
Mailing Address	29 Main St., Montpelier, VT 05602

6.0 APPENDIX B – SUPPORTING DOCUMENTATION

6.1 Great River Hydro letter to LIHI dated January 28, 2016

US Northeast Hydro Region
One Harbour Place; Suite 330
Portsmouth, NH 03801
tel 603.559-5513
web www.transcanada.com

January 28, 2016

VIA ELECTRONIC MAILING
Ms. Dana Hall, Deputy Director
Low Impact Hydropower Institute
PO BOX 194
Harrington Park, NJ 07640

**Re: TransCanada Hydro Northeast Inc.;
Project P-2077 Fifteen Mile Falls**

Dear Ms. Hall:

TransCanada Hydro Northeast Inc. ("TransCanada"), licensee for the Fifteen Mile Falls Project respectfully provides the Low Impact Hydropower Institute (LIHI) notification that TransCanada has filed a request with the Federal Energy Regulatory Commission (FERC) to suspend the requirement to operate and maintain downstream passage facilities at Moore Dam. Downstream passage for Atlantic Salmon smolts is currently a requirement of Article 410 of our FERC License. Our request to FERC was filed with our annual report of 2015 monitoring, and trap and truck operation, for downstream passage of salmon smolts. That filing is attached to this letter.

Article 410 of the Fifteen Mile Falls licenses states, "Within 180 days of being notified by the New Hampshire Fish and Game Department (NHFGD), the Vermont Department of Fish and Wildlife (VTDFW), and the U.S. Fish and Wildlife Service (FWS) that an Atlantic salmon stocking program has been initiated upstream from the Moore reservoir and that such passage facilities are needed at the developments, the licensee shall file, for Commission approval, a plan for the construction, operation, and maintenance of permanent downstream fish passage facilities at the Moore and Comerford developments." By letter dated November 4, 2002, the Connecticut Department of Environmental Protection, representing the Connecticut River Atlantic Salmon Restoration Commission (CRASC) and its partners the FWS, NHFGD and VTDFW requested the Licensee provide downstream passage for salmon smolts. The letter states, "*Inclusion of upper basin habitat is necessary to meet restoration program targets for fry stocking and smolt production and* ***we now consider these stocking efforts as permanent components of the restoration program*** *(emphasis added). Therefore, in order to assure protection of outmigrating* *salmon smolts, downstream passage measures will be needed at your Moore and Comerford developments*."

In July 2012, the USFWS announced it would no longer support the restoration program of Atlantic Salmon in the Connecticut River basin. As a result, salmon stocking above Moore Dam ended after 2013. With the suspension of salmon stocking above the Moore Dam, the key rationale for requiring passage at the Moore and Comerford Dams has been nullified.

The attached report describes the results of operating a fish trap at Moore Dam during the 12th year of downstream passage migration, in which TransCanada trapped emigrating salmon smolts and trucked them to a release point below the Fifteen Mile Falls Project. In our November 11, 2015 correspondence with USFWS, NHFGD and VDFW transmitting the 2015 report for review and comment, TransCanada requested concurrence to discontinue operation of the Moore fish trap. In their responses, NHFGD and VDFW offered no objection to this request. Agency responses to the draft report are included in the attached filing.

If there are further questions regarding this matter, please contact me at 603-445-6806 or John Ragonese at 603-498-2851 to discuss things further. Thank you for your consideration.

Sincerely,

Jennifer Griffin
Project Scientist
FERC Licensing and Compliance

CC: Michael J. Sale – Executive Director LIHI
John Ragonese - TransCanada
Shawn Keniston - TransCanada

US Northeast Hydro Region
Concord Hydro Office
4 Park Street, Suite 402
Concord NH 03301-6373

tel 603.225.5528
fax 603.225.3260
web www.transcanada.com

December 31, 2015

VIA ELECTRONIC FILING
Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Re: TransCanada Hydro Northeast Inc.; Project P-2077; Report on Downstream Passage 2015 Monitoring and Plans for 2016

Dear Secretary Bose:

TransCanada Hydro Northeast Inc. ("TransCanada"), licensee for the Fifteen Mile Falls Project (P-2077) respectfully submits final report entitled, "*Report on Atlantic Salmon Smolt Sampling Efforts at Moore Dam (FERC Project No. 2077), Spring 2015*". Additionally, TransCanada is requesting the Commission suspend the requirement to operate and maintain downstream passage facilities at Moore Dam. Downstream passage for Atlantic Salmon smolts is currently a requirement under Article 410.

By letter dated November 4, 2002, the Connecticut Department of Environmental Protection, representing the Connecticut River Atlantic Salmon Restoration Commission (CRASC) and its partners the US Fish and Wildlife Service (USFWS), New Hampshire Fish and Game Department (NHFGD) and Vermont Department of Fish and Wildlife (VDFW) requested the Licensee provide downstream passage for salmon smolts. The letter states, "*Inclusion of upper basin habitat is necessary to meet restoration program targets for fry stocking and smolt production and* ***we now consider these stocking efforts as permanent components of the restoration program*** *(emphasis added). Therefore, in order to assure protection of outmigrating salmon smolts, downstream passage measures will be needed at your Moore and Comerford developments*."

The 2015 annual report on Atlantic Salmon smolt sampling efforts describes the results of operating the Moore sampler (a.k.a. fish trap) during the 12th year of downstream passage migration, in which TransCanada trapped and trucked the smolts to a release point below the

Fifteen Mile Falls Project. This work is in response to the request by CRASC and its partners USFWS, NHFGD and VDFW, to provide salmon smolts downstream passage around Moore and Comerford Dams, as required under Article 410 of the License.

A draft of the 2015 report was provided to the USFWS), NHFGD and VDFW on November 17, 2015. NHFGD provided comments on December 11, 2015, VDFW provided comments on December 21, 2015, and no comments were received from USFWS. Agency comments are addressed in Appendix B of the report, and email correspondence from VDFW and NHFGD is provided with this submittal.

In consultation with the agencies, the monitoring plan for 2015 continued the plan implemented since 2012, which itself was modified from previous years. The 2012 modifications were made in light of the USFWS decision to discontinue Atlantic Salmon restoration efforts and redirect restoration funding to other diadromous species in the Connecticut River basin. Based upon this decision and the agencies' willingness to consider the expense and operation of the current inducer/surface directional flow system installed for the 2010 and 2011 migration seasons, and to improve overall outmigrating smolt numbers TransCanada was allowed to transport collected smolts to below Vernon Dam (P-1904) in lieu of the current inducer system. The Vernon Dam release site is about 126 river miles farther downstream of previous years release site, and bypasses four additional dams, thus providing safe and expeditious passage past seven dams. The improved passage transportation modification offsets the improved collection at the trap due to current inducer operation experienced in 2011.

In 2015, a total of 202 smolts were collected in the fish trap. Of those, 191 were released below the Project, and 11 (5.5%) smolts died. The number of smolts collected during this year's migration was the lowest on record, down from some years of over 3,000. Salmon stocking was limited after 2011 with the USFWS' decision to discontinue Atlantic Salmon restoration efforts, and stocking ended after 2013. The 2015 smolts collected appear to represent in large part, the age-class associated with the last stocking of fry in the basin above Moore Dam. The annual smolt migration at Moore has been dominated by the age-2 year class and 2015 was the last of this cohort to migrate. TransCanada believes that operating the sampler to collect and transport the few fish that might migrate next year will add little value to a program that has otherwise been abandoned by regulating agencies.

In our November 11, 2015 correspondence with USFWS, NHFGD and VDFW transmitting the 2015 report for review and comment, TransCanada requested concurrence to discontinue operation of the Moore sampler. In their responses, NHFGD and VDFW offered no objection to this request.

In light of the discontinuation of salmon stocking in the Connecticut River basin upstream of Moore Dam, the key rationale for requiring passage at the Moore and Comerford Dams, continued operation of the sampler should also be discontinued. Since initial operation of the sampler, at the request of all agencies, all other fish (other than salmom smolts) collected in the trap have been returned back to the Moore Reservoir. Use of the sampler to trap and truck resident species below Moore Dam, offers very little value as there is no unique and critical additional habitat in Comerford Reservoir (extends to base of Moore Dam), no downstream passage at Comerford Dam, and no upstream passage at either. The purpose of the Moore fish trap was to support the salmon restoration program. The program has been discontinued and TransCanada's requirement to operate the trap should likewise be discontinued. For the above stated reasons, we respectfully request the FERC suspend the requirement or permanently amend the License to eliminate the requirement under Article 410 to provide downstream passage at Moore Dam.

If there are further questions regarding this matter, please contact me at 603-498-2851 to discuss things further. Thank you for your consideration.

Sincerely,

John L. Ragonese
FERC License Manager

CC: John Warner, USFWS
Ken Sprankle, USFWS
Len Gerardi, VDFW
Matthew Carpenter, NHFGD

Enclosures:

(1) Report on Atlantic Salmon Smolt Sampling Efforts at Moore Dam (FERC Project No, 2077), Spring, 2015
(2) Email comments received from Len Gerardi (VDFW)
(3) Email comments received from Andrew Schafermeyer (NHFGD)
(4) Email received from Matthew Carpenter (NHFGD)

Report on Atlantic Salmon Smolt Sampling Efforts at Moore Dam (FERC Project No. 2077), SPRING, 2015

Prepared For:
TransCanada Hydro Northeast, Inc.
4 Park Street
Suite 402
Concord, NH 03301

Submitted On:
November 16, 2015

Prepared By:
Normandeau Associates, Inc.
917 Route 12
Westmoreland, NH 03467

www.normandeau.com

(Project No. 23003.005)

Executive Summary

The Fifteen Mile Falls Project is a three development hydroelectric project on the upper Connecticut River owned by TransCanada Hydro Northeast Inc. (TransCanada) and licensed by the Federal Energy Regulatory Commission (FERC, Project No. 2077). The three developments comprising the Project are Moore, Comerford, and McIndoes. The Moore Development is the uppermost of the three located at river mile 283.5 near the town of Littleton in Grafton County, NH on the east side of the river and Waterbury, VT in Caledonia County, on the west side. Having received notification in 2002 from the Connecticut River Atlantic Salmon Commission (CRASC) of Atlantic Salmon (*Salmo salar*) stocking above the Moore Reservoir, TransCanada was required by license to install permanent downstream fish passage for out-migrating smolts at the Moore and Comerford Developments. TransCanada requested and received FERC approval to evaluate the timing and season of stream-reared smolt passage prior to submitting a permanent passage plan for downstream passage. TransCanada constructed an inclined-plane fish sampler and collection tank (collectively referred to as the fish sampler) in the skimmer gate of the Moore Dam. In 2004 this mechanism became operational and has since served as the primary downstream passage facility through the entire project for all out-migrating Atlantic Salmon smolts originating above Moore Dam.

Since installation, the fish sampler has been monitored annually for seasonal timing and duration of the stream-reared Atlantic Salmon smolt migration. In addition, and with FERC and resource agency approval, the effectiveness of the sampler as the collection point for a trap and transport operation has been studied and a series of modifications made to improve its effectiveness.

In July 2012, the USFWS announced it would no longer support the restoration program of Atlantic Salmon in the Connecticut River basin. However, since many thousands of salmon fry were stocked in tributaries upstream of Moore Dam from 2011 through 2013, TransCanada and regulators agreed that operation of the fish sampler would continue at least through the 2015 emigration season.

This report presents the results from spring 2015, the 12th year of operation of the fish sampler and transport program. The fish sampler was operated from 5 May through 26 June. Collected salmon were enumerated and the majority of live smolts were transported to, and released below, the Vernon Dam at Connecticut River Mile 142. A summary of the 2015 results follows.

- A total of 202 emigrating Atlantic Salmon smolts were collected during the typical time period for a full-season passage run. This was the lowest number of smolts collected in any sampling season during the twelve-year fish sampler program. The greatest number of smolts collected in one day (N=21) occurred on 18 May. Over 80% of the catch was collected between 5 May and 14 June, and 95% was collected by 22 June.
- Passage peaks were related to increased discharge resulting from rain events.

- In general, the fish sampler was checked and fish removed from the collection tank three times per day: in the morning (between 06:30 and 07:00), afternoon (between 11:00 and 13:50) and evening (between 17:18 and 19:45). CPUE for stream-reared salmon smolts was greatest for the Morning collection at 0.32 smolts/h (SD=0.389), and least for the Afternoon collection (0.01 smolts/h, SD=0.039). Overall, CPUE for Atlantic Salmon smolts for the season was 0.13 smolts/h.
- Total mortality in 2015 was 5.4%, up from the value of 4% last year. Much of the mortality in 2015 (45%) was likely due to attempted predation by a coincidently collected Northern Pike.
- Overall, 191 Atlantic Salmon smolts were released below the Fifteen Mile Falls Project, with the majority (188) released below Vernon Dam during the spring of 2015.
- The termination of the Connecticut River Atlantic Salmon Restoration effort, the low numbers of smolts collected in the fish sampler, and the declining smolt production estimates upstream from Moore Dam warrant a thoughtful analysis of future fish sampler operations.

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Abbreviations and Definitions

˚C	Degree Celsius
CFD	Computational flow dynamics
cfs	Cubic foot per second
CPUE	Catch-per-unit-effort
CI	Confidence Interval
CRASC	Connecticut River Atlantic Salmon Commission
FERC	Federal Energy Regulatory Commission
FMF	Fifteen Mile Falls
ft	Foot
gal	Gallon
h	Hour
HP	Horsepower
mm	Millimeter
Msl	Mean sea level
N	Number
NH	New Hampshire
NHDES	New Hampshire Department of Environmental Services
NHFG	New Hampshire Fish and Game Department
Smolts/h	Smolts per hour
TL	Total length
TransCanada	TransCanada Hydro Northeast
USGS	Unites States Geological Survey
USFWS	United States Fish and Wildlife Service
VT	Vermont
VTFWD	Vermont Fish and Wildlife Department
W	Watt

1.0 Introduction

The Fifteen Mile Falls Project (FMF) (FERC Project No. 2077) is a three development hydroelectric project on the upper Connecticut River (Figure 1-1) owned by TransCanada Hydro Northeast Inc. (TransCanada). The three developments comprising the project are Moore, Comerford, and McIndoes. Moore Dam, the upper most development, is located near the town of Littleton in Grafton County, NH and Caledonia County, VT (Figure 1-2).

The FERC issued a license renewal for continued operation of the FMF Project on 8 April 2002. Article 410 of the license required that within 180 days of being notified by the NH Fish and Game Department (NHFG), the Vermont Fish and Wildlife Department (VTFWD), and the U.S. Fish and Wildlife Service (USFWS) that an Atlantic Salmon (*Salmo salar*) stocking program had been initiated upstream from the Moore Reservoir and that such passage facilities are needed at the developments, the licensee must file, for FERC approval, a plan for the construction, operation, and maintenance of permanent downstream fish passage facilities at the Moore and Comerford Developments. TransCanada received a request from the Connecticut River Atlantic Salmon Commission (CRASC) on 4 November 2002, to install downstream passage facilities at the two developments. In a letter to FERC dated 18 September 2003, TransCanada indicated there was a lack of sufficient information to adequately provide and construct such facilities and therefore requested a deadline extension for filing a plan in response to the CRASC letter. TransCanada filed a plan on 15 December 2003 which was approved by FERC through the Commission Order issued 18 March 2004. In the Order, FERC approved a two-year study plan to evaluate the timing and season of smolt passage before filing a fish passage plan. TransCanada proposed to evaluate and characterize smolt downstream passage by constructing an inclined-plane sampler and collection tank (referred to collectively as a fish sampler) in the skimmer gate of the Moore Dam.

Consultation with agencies resulted in a plan of study for a minimum two-year evaluation, with the second year contingent upon approval from the agencies. The first year of study was conducted in 2004. With agency approval the operation of the fish sampler, and the monitoring and collection study, continued beyond two years. In the ensuing years, USFWS and State fishery agencies in both NH and VT approved permanent and temporary modifications (described in previous reports and outlined below) geared towards improving effectiveness that continued through 2011. Based on those efforts to maximize effectiveness, TransCanada proposed and agencies approved to discontinue further improvements in exchange for returning fish trapped at the Moore Dam to the Connecticut River below Vernon Dam (as a means of improving total numbers of smolts below Vernon). Operating, monitoring, and reporting results of the de-facto salmon smolt downstream passage trap and truck system has continued through 2015 with agency approval. The primary goals each year have been to move salmon smolts through the project, qualify the seasonal timing of the downstream migration of stream-reared Atlantic Salmon smolts, and to quantify the number passing the development.

To assess the effectiveness of the fish sampler as a downstream passage route for Atlantic Salmon smolts, including assessing smolt behavior in the vicinity of the skimmer gate entrance, the following efforts were undertaken:

- Mark-recapture techniques were used in 2004, 2005, 2006, 2010, and 2011,
- Radio telemetry tracking was also conducted in 2005, and
- Acoustic telemetry was used in 2007 to assess behavior near the skimmer gate.

Hatchery-reared Atlantic Salmon smolts were used as proxy to stream-reared fish in each year except 2007. In 2007, a sub-set of stream-reared smolts removed from the fish sampler were used in lieu of hatchery fish because the hatchery fish were suspected of having reverted to parr.

Telemetry studies showed that while a majority of tagged smolts approached the Moore Dam and skimmer gate, many wandered near the dam but never entered the fish sampler (Normandeau 2001, 2006 and 2008). To increase effectiveness:

- A guide net was installed in 2009 and 2010 in an attempt to intercept and guide emigrating smolts to the skimmer gate entrance and into the sampler (Figure 1-3; see Normandeau 2009 and 2010 for details on the description, installation and testing of the guide net).
- In 2010 the guide net was installed with current inducers aimed directionally with the guide net towards the entrance to the sampler. No significant improvements were observed with the addition of flow inducers. Due to the challenges associated with flow inducers, including stability of the debris and guidance nets, it was recommended by the agencies that flow inducers be operated absent the guidance net in future trials and operation.
- At the start of the 2011 season, a more robust system of flow inducers were placed along the dam and out into the reservoir in an attempt to create flow patterns and current barriers intended to direct smolts to the skimmer gate entrance (Figure 1-4; see Normandeau 2011 for details on the description, installation and testing of the current inducers).

From 2004 through 2011, collected smolts were transported and released downstream of the McIndoes Development. Beginning in 2012, and with agency agreement, all viable Atlantic Salmon smolts collected in the sampler were transported to and released below Vernon Dam in lieu of operating the current inducers. The Vernon Dam release location is about 126 river miles downstream of the McIndoes Dam release location used in previous years.

2.0 Project Description

2.1 Moore Development

The Moore Development is located at river-mile 283.5 on the Connecticut River and includes an 11-mi-long reservoir with a surface area of 3,490 acres and 223,722-acre-ft of gross storage at a normal maximum operating level of 809 ft msl. The earthen and concrete gravity dam is 2,920 ft long, 178 ft high, and consists of a 373-ft-long concrete spillway with a 15-ft-wide by 20-ft-high skimmer gate, four stanchion bays, three Tainter gate bays and a powerhouse with four Francis type turbine-generator units. The turbines have a combined power rating of 225,600 hp under a design head of 150 ft and a combined rated discharge of 13,300 cfs (FERC 2002). Maximum head and turbine discharge are 158 ft and 18,300 cfs, respectively and runner speed of the turbines is 128 revolutions per minute (NEP 1996).

The Moore Development operates as a daily peaking station and passes discharge directly into the Comerford Development reservoir. Elevation changes in Moore Reservoir average approximately 1 ft per day and generally have approached the normal operating level (~el. 804 – 806 ft msl) by mid-May (NEP 1996). The license provides for 320-cfs-year-round minimum flows (NEP 1997).

2.2 Moore Dam Skimmer Gate and Fish Sampler

An inclined-plane dewatering screen discharging to a collection tank (the fish sampler), was installed at the skimmer gate during early 2004 and has since been monitored for Atlantic Salmon smolt passage (see annual reports by Normandeau Associates for each year). The inclined-plane portion of the fish sampler is 14.5 ft wide and consists of two screened sections connected on a pivot (Figure 2-1). The upstream section is approximately 9 ft long by 14.5 ft wide; the elevation of this section is adjustable. The downstream section is approximately 21 ft long by 14.5 ft wide and pivots at its junction with the upstream section. The angle of the downstream section to the upstream section is adjusted to optimize the amount of water passing over the screens. The screen sections are made of 1.25-in by 0.375-in aluminum bars placed parallel to one another, creating gaps that dewater the discharge passing through the skimmer gate (Figure 2-2). The gap width between the bars is 3/16 inch. A flow guidance structure was built on top of the upstream screen to facilitate even water flow and proper velocity across the downstream end of the screen (Figure 2-2).

At the end of the downstream screen is an angled, fabricated metal trough with solid sides that connects to a 12-inch-diameter discharge pipe (Figure 2-2). The discharge pipe conveys water from the trough to the collection tank. The collection tank is a 4-ft deep, 8-ft by 4-ft-rectangular open-topped metal box. Perforations around top sections of the tank and an adjustable drainage valve at the bottom facilitate circulating water through the tank. A 55-gal drum affixed to a monorail system is used to transport fish from the collection tank to a processing area on the headworks of the dam (Figure 2-2).

Modifications were made to the fish sampler prior to the 2005, 2006 and 2010 passage seasons to improve the effectiveness and efficiency of the trap to attract salmon smolts. Modifications made prior to the 2005 monitoring season included:

- The discharge pipe was moved from the wall to the floor of the trough, reducing the amount of time fish spent in the trough; and,
- A fixed netting structure was added to two sides of the collection tank; additional netting was added mid-season to keep fish from jumping out of the collection tank or splashing out when conveyed through the pipe.

Changes made prior to the 2006 monitoring season included:

- A 14.5-ft by 25-ft wooden attraction flow shelf was submerged approximately five feet below the water surface at the entrance of the skimmer gate to extend the flow-net range into the forebay (Figure 2-3); and,
- A specially designed debris boom was anchored around the skimmer gate entrance to deflect large debris from entering the fish sampler (Figure 2-3).

In 2010, two overhead lights were installed near the skimmer gate. One, a 400W high pressure sodium light, was positioned on the face of the dam to project light into the forebay at the entrance to the skimmer gate, the other, a 400W metal halide flood light was located on the ceiling of the skimmer gate entry way to illuminate the tunnel-like passage area. The lights were set on timers to operate between twilight and dawn (Figure 2-4).

In 2009 and 2010 a guide net was installed in the forebay in an effort to improve guidance of Atlantic Salmon smolts into the skimmer gate entrance (see Figure 3-3 in Normandeau Associates, Inc. 2009). The net was not deployed in 2011, in favor of assessing the individual effect of the current inducer guidance system. It has not been used in recent years (2012-2015) because it did not substantially increase the numbers of smolts collected and had the potential to clog with debris and limit sampling time due to maintenance. In order to clear the net of debris, the sampler must be shut down and the skimmer gate closed. The operation can take up to eight hours before the sampler is returned to service.

A targeted discharge not-to-exceed 500 cfs for downstream passage through the fish sampler has been in place since 2004 and continued through 2015. Discharge rate was maintained by manually adjusting the skimmer gate to within approximately one-foot of pond elevation changes.

3.0 Materials and Methods

3.1 Moore Dam Fish Sampler

The sampler was monitored during each day of operation. A sampling event entailed raising the downstream screen section, allowing the collection tank to drain, and dip-netting all fish out of the collection tank. After all fish were removed, the downstream screen section was lowered to resume water flow over the screen and fish passage to the collection tank. Fish were put in 5-gal buckets half filled with water and carried to the processing area located on the headworks of the dam, or transported to the headworks via the monorail system and a 55-gal drum half filled with water. As in past years, the physical condition of each salmon smolt was noted in accordance with a coding system developed for the evaluation (Table 3-1). Smolts were handled as little as possible. Because fish were not individually handled and visually inspected, only gross observations of physical condition were noted. With the exception of a few fish, all live salmon were transported below all of TransCanada's Projects on the Connecticut River and released in the tailwater of the Vernon Development. Water quality checks of the transport tank near the McIndoes Dam occasionally identified a few smolts in distress and these were released at McIndoes rather than being subjected to the entire journey. Scale samples for aging were taken from the majority of the salmon smolts that died during collection or transport (N = 10). Resident fish removed from the collection tank were identified to species, enumerated, surveyed for gross injuries, and returned to Moore Reservoir.

During each sampling event, operating conditions such as pond elevation, skimmer gate position, position of the upstream screen section, and the Station operator's expectation of pond fluctuation before the next collection, were recorded. Sampling period (period of time the fish sampler was operating between collection events) was also recorded. Adjustments to the downstream screen section were made by Normandeau personnel when necessary. Adjustments to the skimmer gate, upstream screen section, and collection tank platform, were made by TransCanada personnel. Fluctuation in the reservoir elevation of approximately 1 ft necessitated a gate adjustment, after which, the upstream screen, downstream screen, and collection tank platform were adjusted accordingly.

3.2 Environmental Conditions and Station Operation

Water temperature was monitored at three locations for the study duration: Moore Reservoir near the entrance to the Moore Dam skimmer gate; in the Connecticut River below the abandoned railroad trestle near South Lunenburg, VT; and in Paul Stream, a tributary to the Connecticut River, near Maidstone, VT (Figure 1-2). Temperature was recorded from 30 April through 30 June, with Onset TidbiT© temperature loggers. Each station had a redundant logger and loggers were placed approximately 10 ft below the water surface in the Moore Reservoir and approximately 1.5 ft below the surface at the South Lunenburg and Paul Stream monitoring stations. Temperature was recorded every 15 minutes for all monitoring stations.

Provisional stream flow data were downloaded from the U.S. Geological Survey (USGS) national water information web site for gage number 01131500, Connecticut River near Dalton, NH. These data were used to describe stream flow into Moore Reservoir during the study period. Operations data, including flow through the skimmer gate, and unit generation and discharge, were provided by TransCanada.

3.3 Data Collection and Analysis

The number of stream-reared Atlantic Salmon smolts removed from the collection tank was tallied for each collection period. Collections were generally made three times a day: Morning, Afternoon and Evening. An occasional exception occurred when environmental conditions (e.g., lightning storms) precluded staff from safely sampling. Additionally, some missed Afternoon samples occurred (due to salmon smolt transport) and were merged with, and labelled as, the subsequent Evening sample. Catch-per-unit-effort (CPUE) was calculated for salmon smolts for each of the three collection categories and for daily collections.

Temperature data were downloaded at the end of the study, compiled for each logger, checked for gross inaccuracies, averaged for mean, maximum and minimum daily temperature, and graphed. Percent of flow to the skimmer gate (and therefore through the fish sampler) relative to total station discharge was calculated.

4.0 Results

4.1 Fish Sampler Operation

TransCanada installed the boater and debris booms after ice-off. The Moore fish sampler began operating at 13:50 on 5 May and was closed at 06:44 on 26 June 2015. Throughout the season the fish sampler was interrupted only when the height of the skimmer gate was adjusted by TransCanada personnel to adjust for reservoir fluctuations. The sampler operated for about 1,227 h.

Sampling periods, defined as the period of time the sampler operated between fish removal from the collection tank, ranged from 4.3 h to 13.2 h, and averaged 8.7 h (Table 4-1). The fish sampler collection tank was checked 141 times and fish collected in the tank were generally processed three times per day (Appendix Table A-1).

Debris load was moderate (the sampler required cleaning but operation was not affected) during the first week of the sampling season and thereafter was characterized as light. Debris load was not as heavy as that observed in previous years and unrelated to any 2015 mortality events.

4.2 Atlantic Salmon Smolt Collections

Atlantic Salmon smolts were collected on 41 (77%) of the 53 days that the fish sampler operated, and in 46 (33%) of the 141 sampling events. The greatest number of smolts taken in one collection event (N = 21) occurred in the morning collection on 18 May. A total of 202 Atlantic Salmon smolts was collected in 2015. Collections in past years ranged from a low of 240 (2004) to 3,214 (2010). The 2015 collection total is the lowest value ever collected during a full migration season at the Moore sampler (Figure 4-2).

For analysis of CPUE, sample periods were divided into three categories relating to time of day collections were made. The three categories were Morning, Afternoon, and Evening (Table 4-1). The set time for a collection was immediately following the previous sample collection. Of the total 1,227.5 h of sampling, 48.7% of time sampled represented the Morning period (from mid- to late-evening through early morning), 33.5% the Evening period (from early afternoon through early evening), and 17.7% the Afternoon period (from early morning through early afternoon). CPUE for stream-reared salmon smolts was highest for the Morning collection at 0.32 smolts/h (SD=0.389), and lowest for the Afternoon collection (0.01 smolts/h, SD=0.039). Overall, CPUE for Atlantic Salmon smolts for the season was 0.13 smolts/h (Table 4-1). Analysis of past reports indicates that this is the lowest overall CPUE since initiation of the fish sampler project.

Smolts were examined for gross injuries as they were netted from the collection tank, and when they were transported from the buckets to the holding tank, the holding tank to the transport tank, and the transport tank to the river. Of the 202 smolts collected, 94.6% (191) had no observable injuries, 2.5% (5) were preyed upon in the collection tank and 3.0% (6) died of unknown causes for an overall mortality of 5.4% (Table 4-2). Of the eleven mortalities, two occurred in the transport tank, three in the holding tanks, and six were found in the collection tank during Morning collections. Overall, 191 salmon smolts were transported downstream and released into the Connecticut River, most (188) being released just below Vernon Dam.

Length and age data have been collected from dead smolts taken from the sampler beginning in 2005 and samples have generally been dominated by age-2 fish. Despite the extremely small sample size collected (N = 10), this was again the case in 2015 with 60% of the smolts being age-2 (Table 4-3). Three age-3 and one age-4 fish were also collected. One age-3 fish was collected early in the run (15 May) while the remaining age-3 and one age-4 fish were collected on 30 May or later.

4.3 Water Temperature, River Flow, and Station Discharge

Water temperatures recorded on paired thermistors deployed in the three monitoring stations (Paul Stream, Connecticut River at South Lunenburg, NH, and in the Moore Dam forebay) were virtually identical by site and therefore were averaged for reporting purposes. Mean daily water temperature trends for the three monitoring stations were similar, however the stream and riverine temperatures fluctuated episodically with climatological events while the larger water mass of Moore Reservoir tended toward consistent seasonal warming. The most pronounced water temperature fluctuations occurred with cold frontal passage related rain events in mid and late May that yielded increased inflow to Moore Reservoir as measured at Dalton (Figure 4-1). Daily average water temperature ranged from 9.7 to 19.4°C at the Paul Stream monitoring station, from 10.8 to 19.9°C at the South Lunenburg station, and 4.2 to 19.9°C at the Moore Dam forebay during the 5 May through 26 June passage period (Figure 4-1). Smolt collection peaks that occurred in May were concurrent with increased discharge and the inversely related decreased water temperatures at the stream and riverine monitoring sites (Figure 4-1).

Total river discharge from Moore Dam during the Atlantic Salmon smolt collection period was moderate, and closely followed inflows as recorded at the Dalton, NH gage, ranging from about 1,900 cfs to 13,800 cfs. Five distinct discharge peaks occurred in mid-May, late-May, and mid-June, spillage at Moore Dam was rare and occurred for a brief 7-h period during one of those spill events on June 10 (09:10 – 16:00). As noted previously, those discharge events were generally associated with smolt collection peaks (Figure 4-1).

Skimmer gate discharge was maintained at approximately 500 cfs. The proportional flow through the skimmer gate to total station discharge varied throughout the sampling season, ranging from 3 to 100% with an overall average of 26% (Appendix Table A-1). High proportional flow through the skimmer gate occurred when there was little or no turbine discharge and low proportional flow to the skimmer gate occurred when turbine discharge was high. Proportional skimmer gate flow during the survey period was less than 15% of total station discharge 46% of the time (Figure 4-4). Occurrences when proportional skimmer gate flow was 100% of total station discharge (indicating essentially no turbine discharge) were 15% of the time. Generally, the CPUE of Atlantic Salmon smolts was greatest when proportional flow was less than 20%, but this appeared to be a function of the frequency of proportional flow condition occurrence rather than a response to flow proportions (Figures 4-4, 4-5).

4.4 Resident Species

A total of 24,356 resident fish of 19 species was collected in the fish sampler (Table 4-4). The most abundant species collected was Yellow Perch (*Perca flavescens*) representing 56.95% of the resident fish collection. Numbers of that species were typically estimated because they were so dense in the collection tank. To prevent excess mortality, all resident species were quickly released back into the forebay as requested by agencies since the start-up of the fish sampler. Spottail Shiner (*Notropus hudsonius)* 29.14%, Northern Redbelly Dace (*Phoxinus eos)* 7.63%, Golden Shiner (*Notemigonus crysoleucas*) 2.65%, and Common Shiner (*Luxilus cornutus)* 1.24% were the next most common resident species collected. All remaining resident species represented < 1% of the total.

5.0 Discussion

The purposes of this evaluation were to obtain information on the timing and abundance of stream-reared Atlantic Salmon smolt emigration to Moore Dam, and facilitate passage past the dam by collecting and transporting smolts below the Fifteen Mile Falls Project. Those objectives were achieved. Consistent with previous years, in an effort to boost overall outmigration of salmon smolts reared above the Fifteen Mile Falls Project, collected smolts were transported to and released below Vernon Dam, approximately 141 river miles downstream.

TransCanada attempts to open the fish sampler as early as possible in the season to provide passage for smolts that may be emigrating early. In 2015 the fish sampler began operation on the afternoon of 5 May; installation of the boat barrier, debris boom and flow shelf were hampered by ice remaining in the reservoir. Pond elevation was relatively stable (mean elevation = 805 ft MSL) throughout the passage season after the fish sampler was opened (Figure 5-1).

The Atlantic Salmon smolt migration was generally low but steady, accentuated by several peak passage events that occurred during or immediately following periods of elevated river flows. Researchers working on nearby Connecticut River tributaries have similarly shown the combination of decreasing water temperature and peaks in discharge to stimulate migration (Whalen et al. 1999). Migration peaks at the Moore sampler were coincident with water temperature decreases in the riverine and stream monitoring sites, as there was an inverse relationship between rain-induced discharge events and water temperature. Smolt migration eventually ceases each year as warmer temperature thresholds are surpassed and physiological status declines (Whalen et al. 1999).

Most smolts were collected in morning samples, indicating an early- to late-evening, overnight, or early morning downstream migration. Researchers have documented the proclivity of smolts to migrate during dark hours (Thorpe and Morgan 1978, Hvidsten et al. 1995). At the Moore Dam fish sampler, smolt collections from the early- to late-evening and overnight period (morning collections) have been dominant in all years when period comparisons were made (2006 – 2015) except in 2009 when smolt numbers were greater in evening collections than morning.

Salmon smolt mortalities in 2015 were slightly higher compared to 2014; 5.4% in 2015 vs. 4.0% in 2014 (Table 4-2). Total mortality was highest during 2005 (13%) while the 2015 mortality was comparable to that observed in 2004 (5.0%), 2011 (5.5%), and 2013 (5.4%). In 2005, high debris loading was considered to be the primary cause of mortality and the impetus to install a debris boom the following year. The debris boom subsequently prevented much of the debris from entering over the skimmer gate, but not all. This year, debris loading was light; however, attempted predation of smolts in the collection tank was determined to be the predominant cause of collection tank mortality.

Mortality due to handling was considered to be minimal; as in past years, considerable effort was made to reduce handling of smolts during collection and transport. Since the overall mortality rate (5.4%) was fairly low and there was no discernable predictive pattern in debris loading or mortality rates that suggested specific trigger points (Figure 5-2), increased sampling frequency or earlier morning sampling was not invoked.

Just over 24,000 resident fish were collected from the Moore fish sampler this year. The most abundant fish species collected in 2015 was Yellow Perch, followed in decreasing abundance by four shiner species. While the proportions of individual species have shifted annually, this numerical predominance by non-game resident species has been observed routinely. Although collection tank crowding and debris loading have been previously suggested as inducers of stress, there was no apparent correlation in 2015 between smolt mortality and numbers of resident fish collected or debris loading observed.

The number of Atlantic Salmon smolts collected in the sampler in 2015 was the lowest number ever observed for this project (ranking 12th out of the 12 sampling years). The low numbers collected are considered a direct result of the termination of the Connecticut River Atlantic Salmon Restoration effort. Other than the declining trend in catch, valid comparison of other smolt data (e.g., age distribution of emigrating smolts) with past years is severely complicated by the low sample size.

Smolts entering the Moore Dam fish sampler are the product of salmon fry stocked in tributaries above the Moore Dam by NHFGD and VTDFW. The majority of stocked fry matures to the smolt stage two years after stocking and begins migrating downstream. Index streams above the Moore Dam have been sampled by the NHFGD and VTDFW and data had been used to develop smolt production estimates for the following migration season. Note that with the phasing out of USFWS support of Connecticut River Atlantic Salmon Restoration measures through hatchery culture, only Vermont stocked fry above Moore Dam in 2013 (the last year any Atlantic Salmon fry were stocked). The smolt production estimate for 2015 was derived from the Nulhegan River and Paul Stream and was predicted to be at least 1,898 smolts migrating (Personal communication Len Gerardi, VTDFW - Table 5-2). This was the lowest smolt production estimate since 1999. Nearly 11% of that predicted number was collected at Moore Dam in 2015 and this percentage was lower than any previous calculated value from 2005 to 2014 (17.0 to 64.9%) when valid data were employed (with the exception of the 6.7% value observed in 2013). Again, the low percentages are considered a direct result of the termination of the Connecticut River Atlantic Salmon Restoration effort.

Of the 11 smolt mortalities in 2015, scale sample age analysis was available for ten. Of those, six smolts were age-2, three were age-3, and one was age-4. These scale samples represent the full migration season. Length and age data have been collected from dead smolts taken from the sampler since 2005. Length data from smolts collected between 2005 and 2014 showed two distinct frequency distributions, suggesting two age classes of smolts collected at the sampler (Figure 4-3). Analysis of scale samples collected in those years show a prominent age-2 cohort with a smaller cohort of age-3 smolts; six fish collected in 2005 were age-4 (Normandeau 2011) as was one in 2015. In 2008 the subset of fish aged were dominated by the age-3 cohort (60%), with age-2 cohorts (40%) completing the sample. However, all but one of the age-3 fish were collected the morning after the sampler was opened, biasing the age sample to early migrants that may have been holdovers from the previous year. There was only one large age-3 smolt collected at the beginning of the 2015 season. Most smolts older than age-2 migrated late, on or after 30 May. The overall small numbers of smolts collected in the fish sampler and the even fewer fish that subsequently died for age analysis, made valid age-related comparisons with previous years doubtful. Atlantic Salmon smolt collections have generally been dominated by age-2 fish and, despite the small sample size, this was again the case in 2015 (Table 4-3). Age data for this year generally coincides with data from previous years, except 2008.

Atlantic Salmon management in the Connecticut River basin had been supported by state and federal legislation which created CRASC. Restoration efforts have been conducted following the 1998 Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River (CRASC, 1998). CRASC developed a cooperative effort that included habitat protection, fisheries management, research, regulation, hatchery production and stocking. On 10 July 2012, USFWS announced that it would no longer produce hatchery-reared stock for the effort to restore Atlantic Salmon to the Connecticut River Basin due to the continued costs for low numbers of returns. Fry stocking above Moore Dam was significantly reduced in 2012 and again in 2013 (see Table 5-2). VTDFW, the only agency that stocked salmon fry upstream of Moore Dam in 2013, did not anticipate continuing the program past 2013 (personal communication, Lenny Gerardi), and salmon stocking has subsequently ceased in the Connecticut River basin. Similarly, the 2015 salmon smolt production estimate above the Moore Dam (1,898 fish) was the lowest recorded since 1999 and the early days of the Restoration effort (Table 5-2). As a significant majority of salmon smolts collected in the sampler are age-2, it is likely that all fry stocked in 2012 and a significant majority of fry stocked in 2013 will have passed by the end of the 2015 season. Though some age-3 smolts might emigrate in 2016, the number will be extremely small given that the number of fry stocked in 2013 was the lowest ever introduced above Moore Dam and the low proportion of each cohort that passes at age-3. All lines of evidence indicate that the 2016 passage season will result in the collection of substantially fewer smolts than in 2015, therefore TransCanada will consult with the agencies regarding the need for collection and transport efforts in 2016.

6.0 Conclusions

Based on the results of the last 12 years of study, the following conclusions can be made:

- The inclined plane fish sampler is effective at collecting fish that pass over the skimmer gate, providing a non-turbine emigration route past the station for salmon that are stocked above the Moore Reservoir.
- Survival improved after installation of a debris boom in 2006, and by conducting sampling events three times per day, early morning, afternoon, and evening.

Minimal handling and holding time on site after retrieval from the collection tank are also likely contributors to overall survival.

- Passage peaks were related to increased discharge resulting from rain events.
- The 202 Atlantic Salmon smolts collected in 2015 was the lowest number collected since the inception of this program and a direct result of the program's termination.
- Total mortality in 2015 was low (5.4%) and 5 of those 11 mortalities were due to attempted predation of smolts by a Northern Pike in the collection tank. This mortality event was of a small and isolated nature; therefore, no alterations to the collection schedule were made.
- Based on past observations, low numbers of age-3 juvenile salmon may persist in the reservoir in 2016; however, it is unlikely that operation of the Moore fish sampler in 2016 will be an efficient use of resources.

7.1 Literature Cited

Federal Energy Regulatory Commission (FERC). 2002. Final environmental assessment for hydropower license. Fifteen Mile Falls Hydroelectric Project, FERC Project No. 2077-016, New Hampshire and Vermont.

Hvidsten, N.A., A.J. Jensen, H. Vivaas, O. Bakke, T.G. Heggberget. 1995. Downstream migration of Atlantic salmon smolts in relation to water flow, water temperature, moon phase and social interaction. Nordic journal of freshwater research. 70:38-48.

NEP. 1997. Fifteen Mile Falls (Project L.P. #2077) Settlement Agreement (dated 6 August 1997).

NEP. 1996. Fifteen Mile Falls (Project L.P. #2077) Initial Consultation Document, Vol. 1. Prepared by Louis Berger Associates for New England Power Co.

Normandeau Associates Inc. 2001. Atlantic salmon smolt migration through the Moore and Comerford reservoirs, spring 2000. Report prepared for USGen New England, Inc., Concord, NH.

Normandeau Associates Inc. 2005. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2004. Report prepared for USGen New England, Inc., Concord, NH.

Normandeau Associates Inc. 2006. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2005. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2007. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2006. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2008. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2007. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2008. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2008. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2009. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2009. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2010. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2010. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2011. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2011. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2012. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2012. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2013. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2013. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Normandeau Associates Inc. 2014. Atlantic salmon smolt report on fish sampling effort at Moore Dam, spring 2014. Report prepared for TransCanada Hydro Northeast, Inc., Concord, NH.

Thorpe J.E., R.I.G. Morgan. 1978. Periodicity in Atlantic salmon Salmo salar L. smolt migration. Journal of Fish Biology 12 (6), 541–548.

Whalen K.G., D.L. Parrish, S.D. McCormick. 1999. Migration timing of Atlantic salmon smolts relative to environmental and physiological factors. Transactions of the American Fisheries Society 12 (6), 541–548.

Tables

Table 3-1. Codes used to document condition of Atlantic Salmon smolts collected in the Moore fish sampler, spring 2015.

Code	Condition
1	No observed injuries or descaling
2	Minor descaling (<10%)
3	Moderate descaling (10-25%)
4	Major descaling (>25%)
5	Eye injury
6	Contusion on body
7	Lacerations or other open wounds likely caused by sampler
8	Moribund
9	Dead

Table 4-1. Number of collections made at the Moore fish sampler, spring 2015, by collection period with effort, number of Atlantic Salmon smolts collected, and catch-per-unit-effort (CPUE, smolts / h).

		Effort				Smolts		CPUE (smolts/hr)	
Period	No. of Collections	Time of Collections	Hours (sum)	Range (h)	Mean (SD)	N	Mean (SD)	Mean	SD
Morning	52	6:30 - 7:00	598.3	11.0 - 13.2	11.5 (0.32)	193	3.7 (4.49)	0.32	0.389
Afternoon	37	11:00 - 13:50	217.7	4.3 - 7.1	5.9 (0.43)	2	0.1 (0.23)	0.01	0.039
Evening	52	17:18 - 19:45	411.5	5.3 - 12.6	7.9 (2.68)	7	0.1 (0.63)	0.02	0.065
Total	141		1227.5	4.3 - 13.2	8.7 (2.82)	202	1.4 (3.25)	0.13	0.282

Table 4-2. Annual number and proportion of annual total (%) stream-reared Atlantic Salmon smolts collected in the Moore fish sampler, spring 2004-2015 by physical condition category.

	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
Condition	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
No injuries	182	76.0	1,178	83.9	2,360	95.4	886	85.0	665	96.2	3,120	98.0	3,079	95.8	1,380	93.8	1,304	95.4	434	93.7	1,156	94.8	191	94.6
Descaling	22	9.0	11	0.8	1	0.0	109	10.4	0	0.0	1	0.0	94	2.9	3	0.2	0	0.0	0	0.0	19	1.6	0	0.0
Eye injury	0	0.0	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Contusions	5	2.0	6	0.4	16	0.7	1	0.1	0	0.0	0	0.0	4	0.1	1	0.1	0	0.0	2	0.4	0	0.0	0	0.0
Lacerations	8	3.0	8	0.6	2	0.1	2	0.2	0	0.0	4	0.1	1	0.0	2	0.1	1	0.1	2	0.4	0	0.0	0	0.0
Moribund	11	5.0	19	1.3	2	0.1	8	0.8	1	0.1	14	0.4	9	0.3	4	0.3	3	0.2	0	0.0			5	2.5
Dead	12	5.0	182	13.0	92	3.7	26	3.5	25	3.6	44	1.4	27	0.8	81	5.5	59	4.3	25	5.4	49	4.0	6	3.0

Table 4-3. Number (N) of stream-reared Atlantic Salmon smolts collected from the Moore fish sampler with N aged, percent of total that were aged, and range and mean lengths (mm) by age for a sub-set of Atlantic Salmon smolts collected from 2005 - 2015.

				Age-2				Age-3				Age-4			
Year	N Smolts Collected	N Aged	% of Collected	N	% of Aged	Length Range	Mean Length	N	% of Aged	Length Range	Mean Length	N	% of Aged	Length Range	Mean Length
2005	1,404	82	5.84	63	76.8	152-248	199.6	13	15.9	284-340	315.8	6	7.3	325-395	344.7
2006	2,473	77	3.11	67	87.0	162-257	193.3	10	13.0	201-310	274.7	-	-	-	-
2007	1,033	110	10.65	101	91.8	160-340	228.1	9	8.2	187-332	256.1	-	-	-	-
2008[1]	691	20	2.89	8	40.0	165-261	213.0	12	60.0	265-325	303.3	-	-	-	-
2009	3,183	38	1.19	37	97.4	150-240	202.2	1	2.6	355.6	-	-	-	-	-
2010	3,214	28	0.87	28	100.0	178-340	208.2	-	-	-	-	-	-	-	-
2011	1,471	74	5.03	71	95.9	165-310	200.5	3	4.1	210-330	252.0	-	-	-	-
2012	1,367	59	4.32	59	100.0	160-226	195.7	-	-	-	-	-	-	-	-
2013[2]	463	27	5.83	25	92.6	156-228	193.8	1	3.7	325	325.0	-	-	-	-
2014[3]	1,217	47	3.86	43	91.5	154-209	182.0	4	8.5	218-350	284.5	-	-	-	-
2015	202	10	4.95	6	60.0	165-198	183.5	3	30.0	219-270	243	1	10.0		219

[1] Results are not representative, 55% of the aged fish were collected on the first day of operation, all were Age-3 and likely holdovers from previous year.
[2] One smolt (172 mm total length) was age-1.
[3] Scale ageing not available for 2 additional mortalities.

Table 4-4. Resident fish species and estimated number collected in the Moore fish sampler between 5 May and 26 June 2015.

Common Name	Scientific Name	Number Collected	Percent of Total
Yellow Perch	*Perca flavescens*	13,871	56.95
Spottail Shiner	*Notropis hudsonius*	7,098	29.14
Northern Redbelly Dace	*Phoxinus eos*	1,859	7.63
Golden Shiner	*Notemigonus crysoleucas*	645	2.65
Common Shiner	*Luxilus cornutus*	303	1.24
Rock Bass	*Ambloplites rupestris*	205	0.84
Smallmouth Bass	*Micropterus dolomieui*	103	0.42
Brown Trout	*Salmo trutta*	77	0.32
Black Crappie	*Pomoxis nigromaculatus*	51	0.21
Rainbow Smelt	*Osmerus mordax*	39	0.16
Northern Pike	*Esox lucius*	31	0.13
Brook Trout	*Salvelinus fontinalis*	29	0.12
Pumpkinseed	*Lepomis gibbosus*	14	0.06
Rainbow Trout	*Oncorhynchus mykiss*	13	0.05
Largemouth Bass	*Micropterus salmoides*	12	0.05
Blacknose Dace	*Rhinichthys atratulus*	2	0.01
Brown Bullhead	*Ameiurus nebulosus*	2	0.01
White Sucker	*Catostomus commersoni*	1	0.00
Eastern Silvery Minnow	*Hybognathus regius*	1	0.00
Total non-salmon		24,356	

Table 5-1. Annual start date, end date, and number of Atlantic Salmon smolts collected from the Moore fish sampler, 2004 - 2015.

Year	Start Date	End Date	# samples	effort (Hr)	Salmon Smolts Collected
2004[4]	5/19	6/25	76	854.6	240
2005	4/25	6/23	212	1,197.3	1,404
2006	5/1	6/27	136	1,325.9	2,473
2007	5/1	6/22	109	1,129.7	1,029
2008	4/25	6/27	128	932.2	691
2009	4/22	6/23	171	1,458.1	3,183
2010	4/14	6/19	175	1,581.0	3,214
2011	5/9	6/20	122	962.6	1,471
2012	4/17	6/18	184	1,457.7	1,367
2013	5/2	6/25	161	1,232.2	463
2014	4/30	6/23	162	1,252.2	1,220
2015	5/5	6/26	141	1,227.5	202

[4] Installation of the sampler was completed in 2004, shortly after the smolt migration had begun.

Table 5-2. Annual number of Atlantic Salmon fry stocked above the Moore Dam, estimate of smolt production numbers from index sites above the Moore Dam, and number of smolts collected in the Moore fish sampler.

Year	Number of Salmon Fry Stocked Above Moore Dam[5]	Salmon Smolt Production Estimate (Number) Above Moore Dam[6]	Reared Salmon Smolts Collected in the Moore Sampler
1997	81,152	N/A	
1998	232,976	N/A	
1999	60,577	523	
2000	471,428	4,458	
2001	476,028	2,416	
2002	229,279	4,629	
2003	252,840	5,197	
2004[7]	267,638	1,934	240
2005	215,022	3,758	1,404
2006	134,069	4,511	2,473
2007	155,975	5,679	1,029
2008	185,336	4,060	691
2009	189,166	10,608	3,183
2010	208,695	6,119	3,214
2011	224,591	2,266	1,471
2012	71,892	N/A	1,367
2013	24,920	6,860	463
2014	0	5,204	1,220
2015	0	1,898	202

[5] Fry stocking numbers provided by NHFG, VTDFW, and USFWS.

[6] Salmon smolt production numbers for VT and NH provided by VTDFW.

[7] Installation of the sampler was completed in 2004, shortly after the smolt migration had begun.

Figures

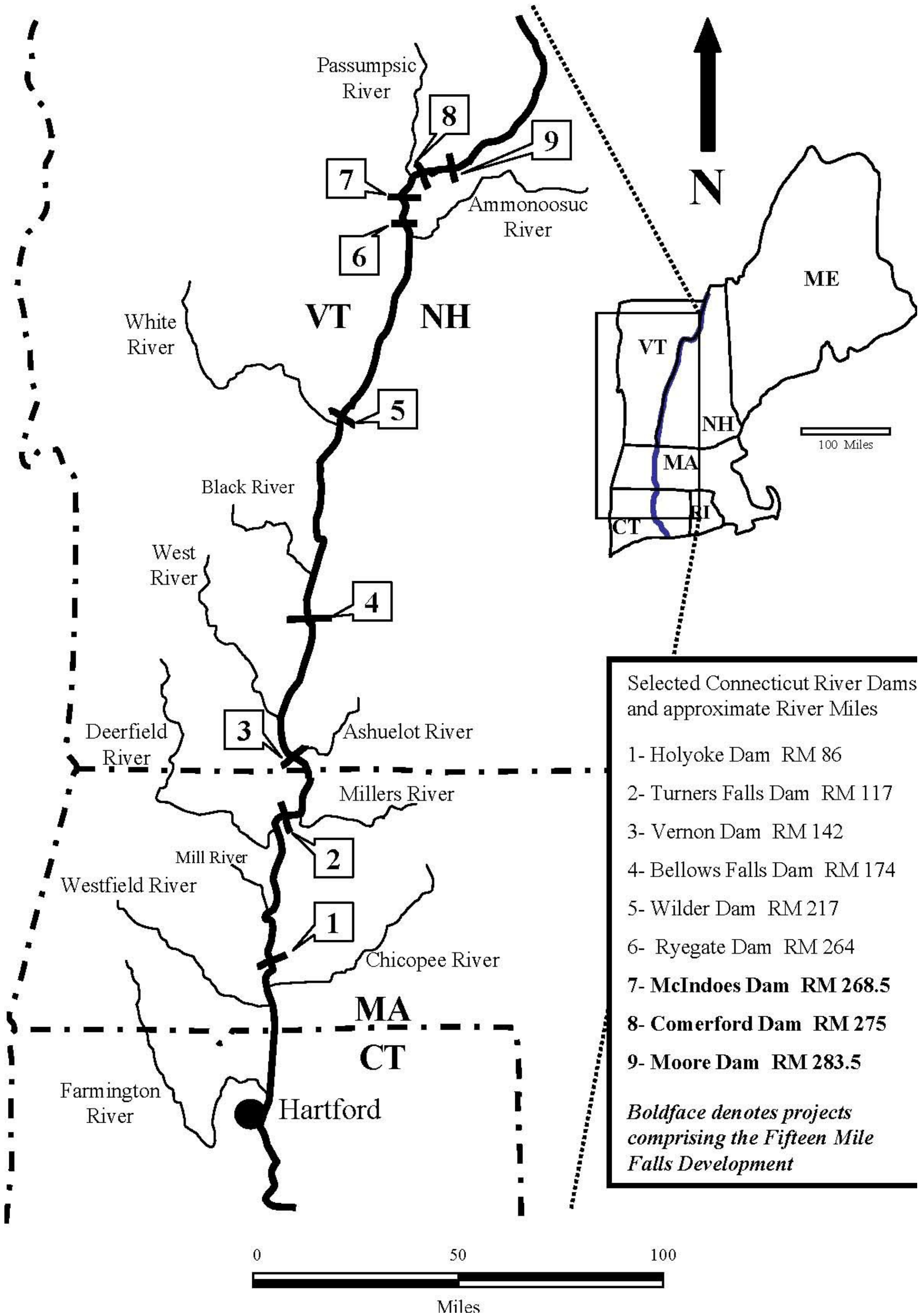

Figure 1-1. Location of the Fifteen Mile Falls Project on the Connecticut River.

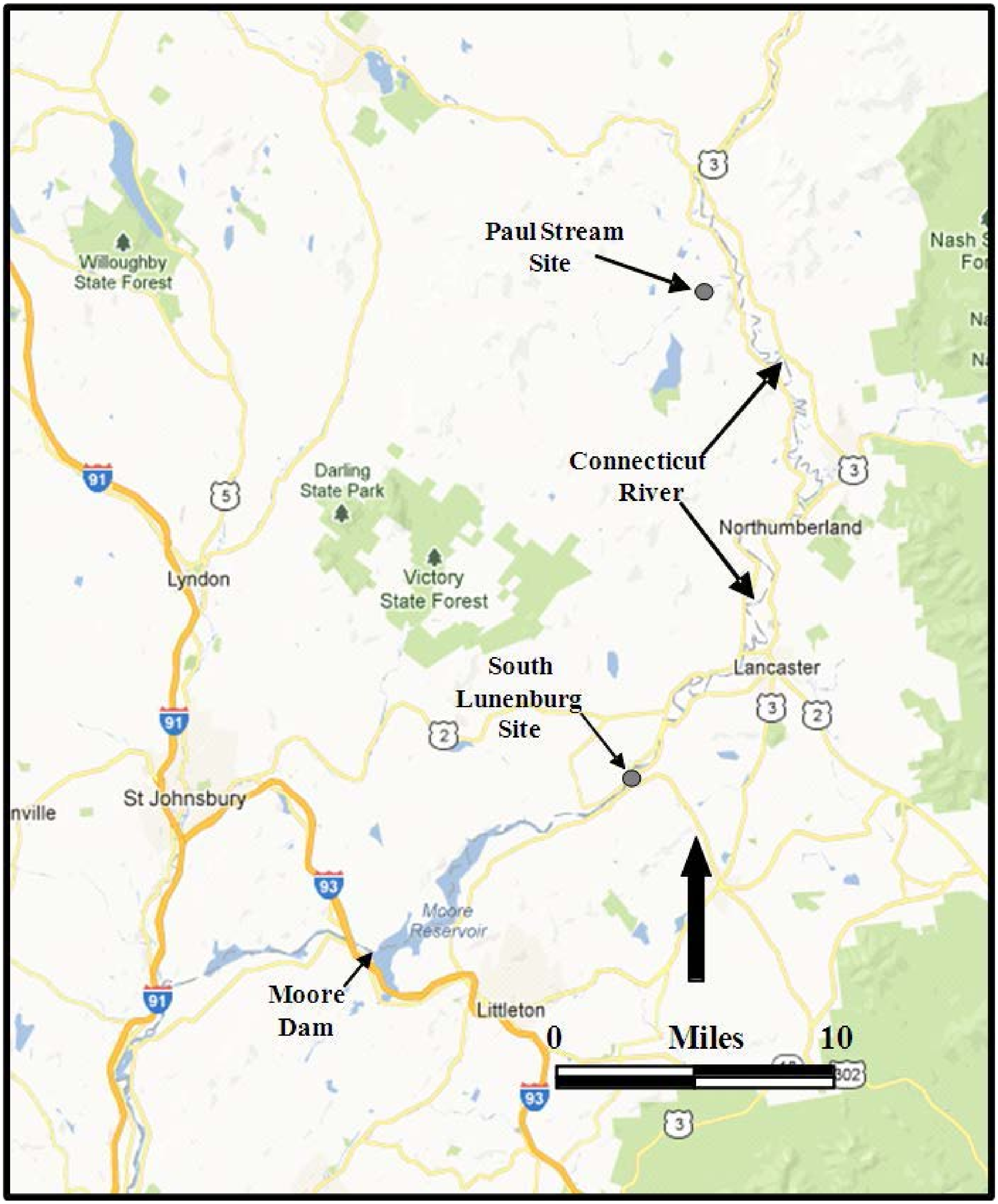

Figure 1-2. Location map showing the Moore Dam and three water temperature monitoring stations: Moore Dam, Connecticut River near South Lunenburg, VT and Paul Stream.

Figure 1-3. Schematic of the Moore Dam Development showing the guide net used during 2009 and 2010 studies and its relation to the fish sampler, hydroelectric turbine intakes and tailrace.

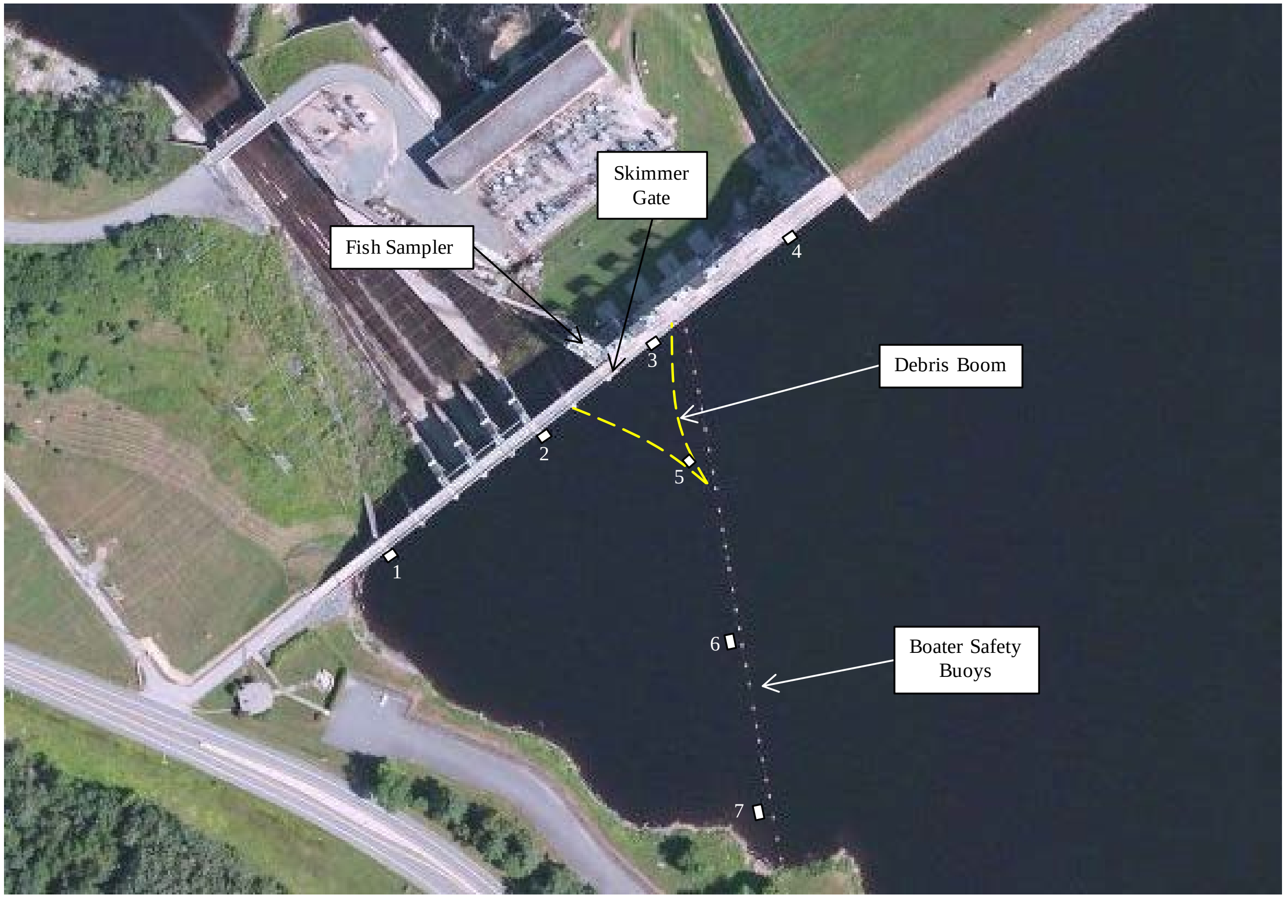

Figure 1-4. Schematic of the Moore Development showing the location of current inducers (7) used during the 2011 study.

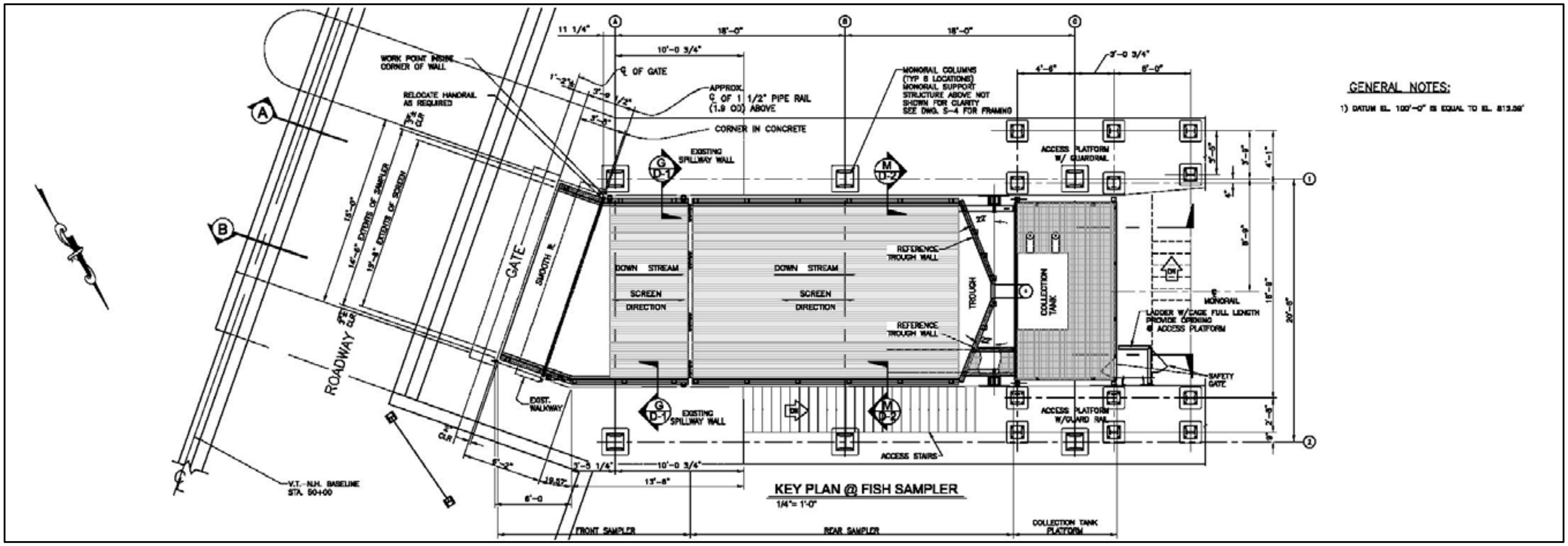

Figure 2-1. Key plan of TransCanada's Moore Development inclined plane sampler. The plan does not show flow reflectors installed after the fish sampler was erected. Plan drawing prepared by Kleinschmidt.

Figure 2-2. Moore fish sampler showing plywood flow adjusters (top), dewatering surface (middle left), discharge pipe and collection tank (middle right), and monorail system used to transport fish from the collection tank to the transport tank (bottom).

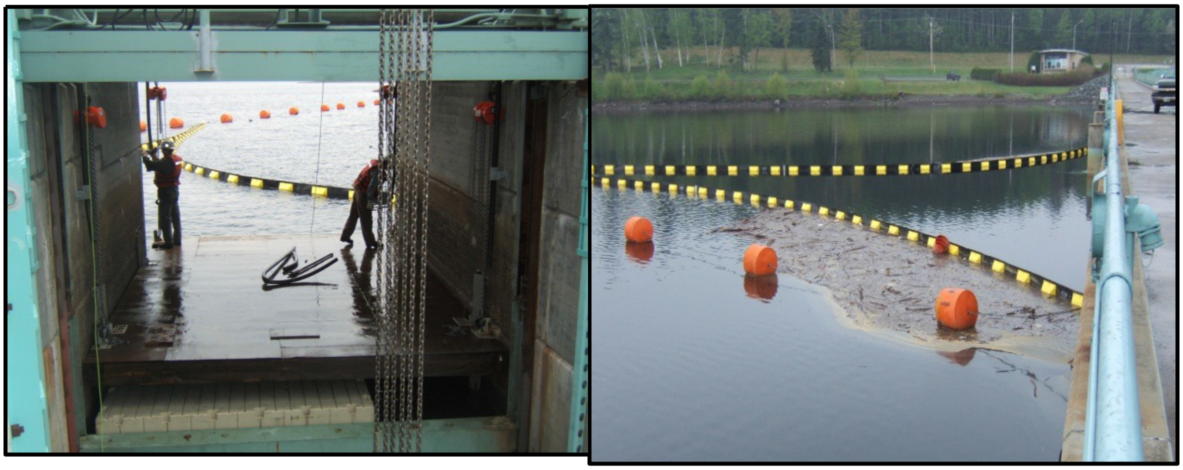

Figure 2-3. Moore fish sampler attraction flow shelf raised for repairs (left), view is looking upstream through the skimmer gate entrance to Moore Reservoir; and the debris boom (right).

Figure 2-4. Moore fish sampler forebay attraction light. The skimmer gate attraction light is not visible from this angle.

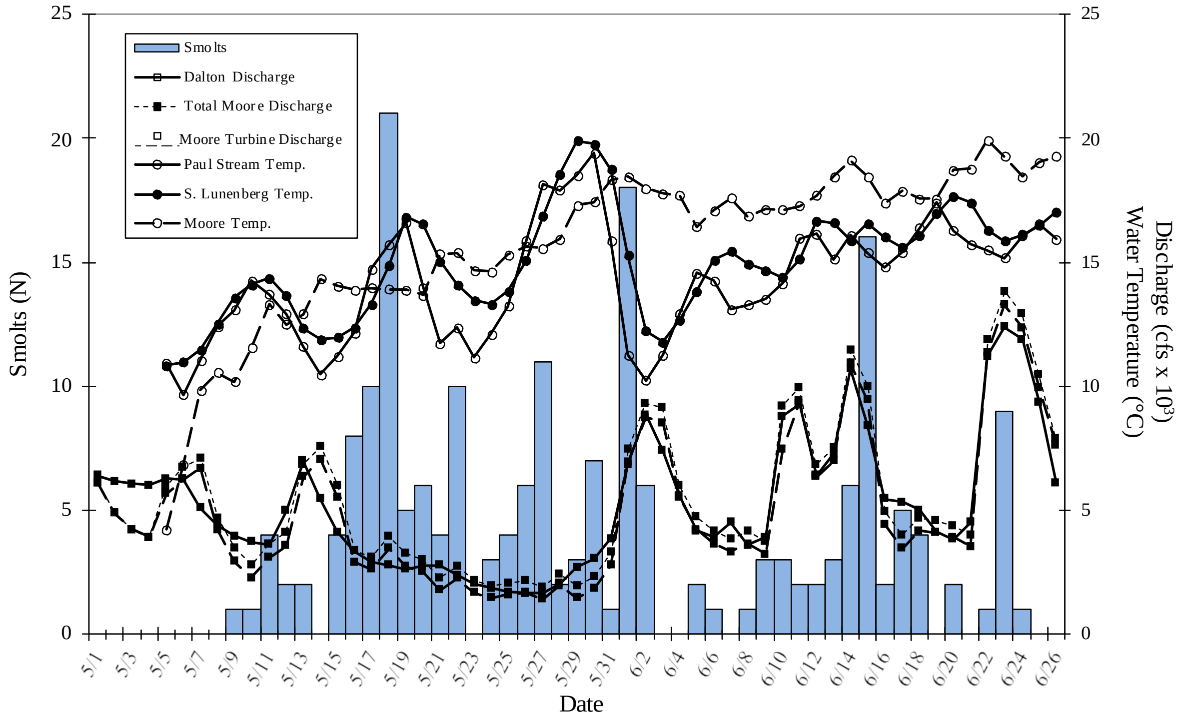

Figure 4-1. Daily Atlantic Salmon smolt collections (N) with mean Connecticut River discharge at Dalton, NH, Moore Development hydroelectric turbine discharge and total discharge, and mean water temperatures in Paul Stream, Connecticut River at South Lunenburg, VT, and in the Moore Dam forebay, spring 2015.

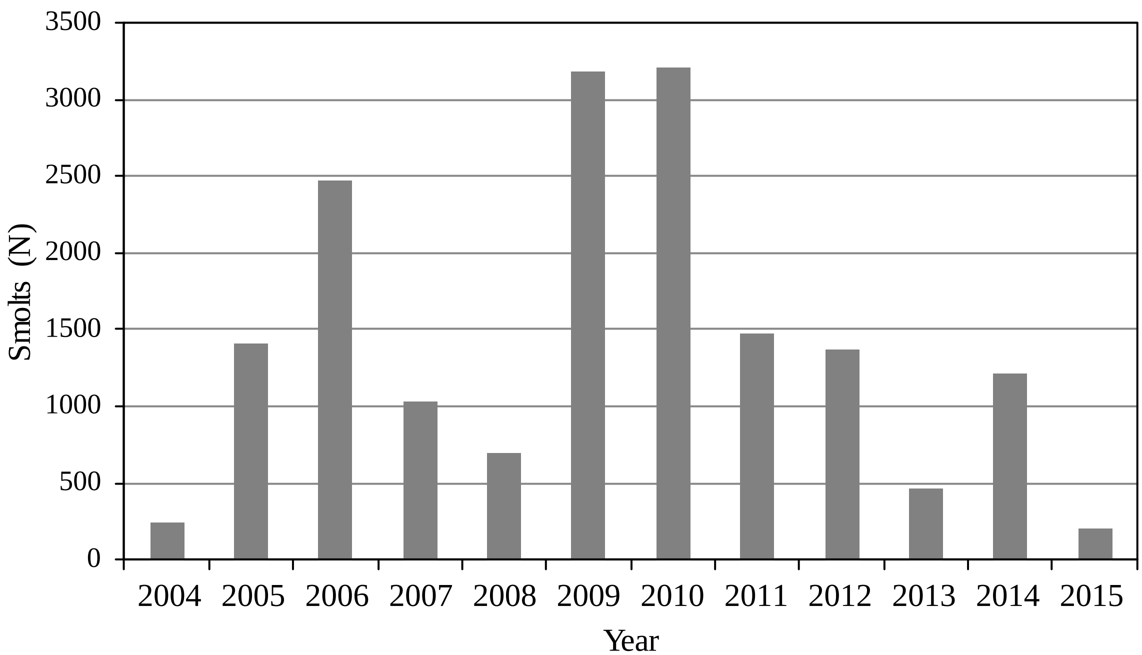

Figure 4-2. Annual Atlantic Salmon smolt collections from the Moore fish sampler, 2004 - 2015.

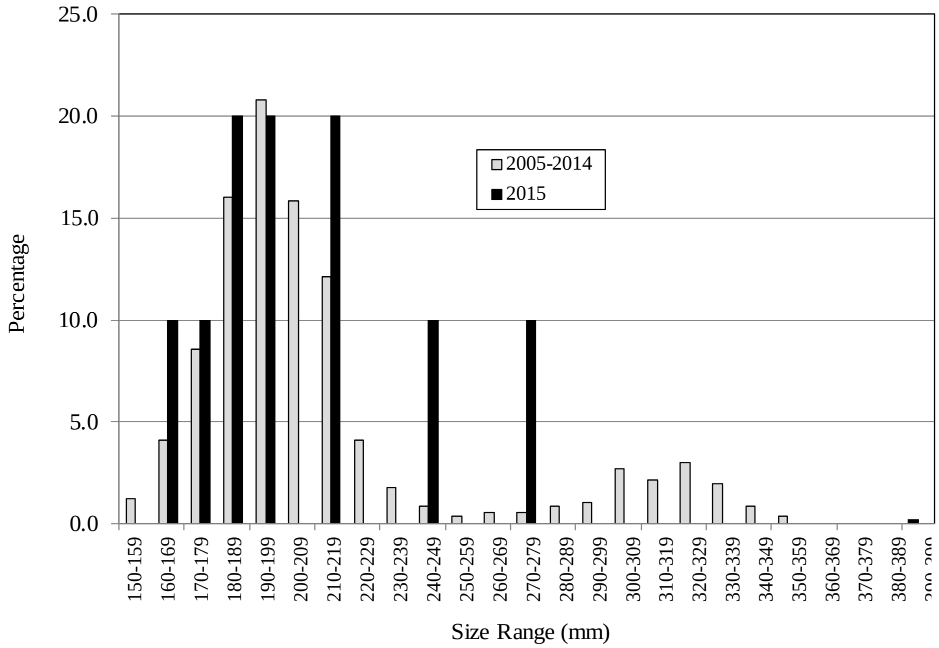

Figure 4-3. Length frequency distribution of a sub-set of stream-reared Atlantic Salmon smolts collected in the Moore fish sampler in 2015 compared with collections made in 2005 through 2014.

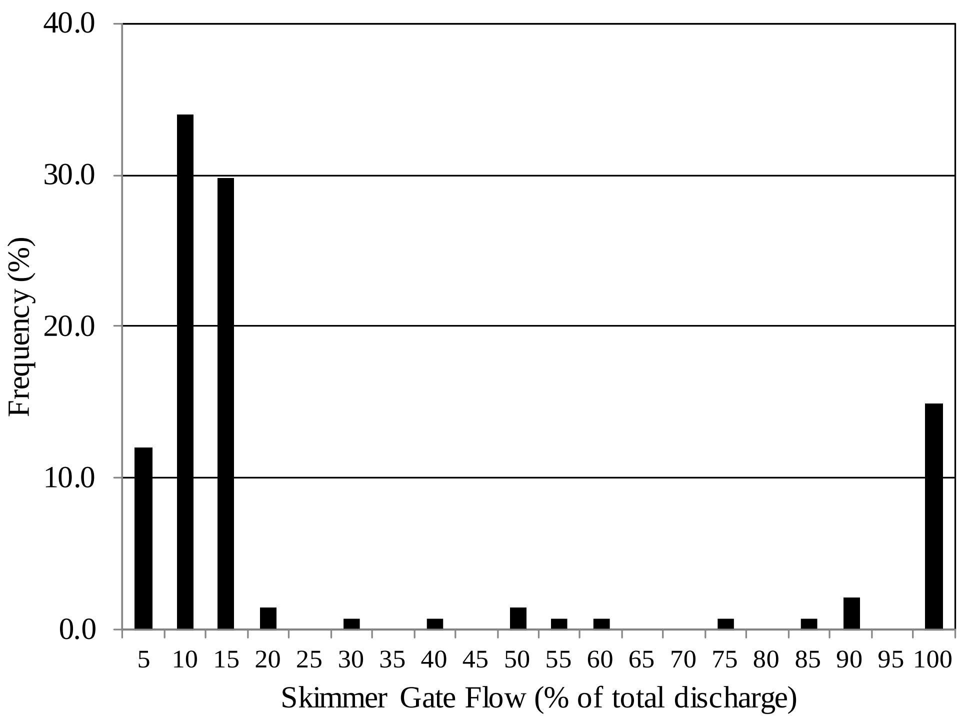

Figure 4-4. Time frequency (% of time during collection period) of proportional (to total project discharge) flow through the skimmer gate during 2015.

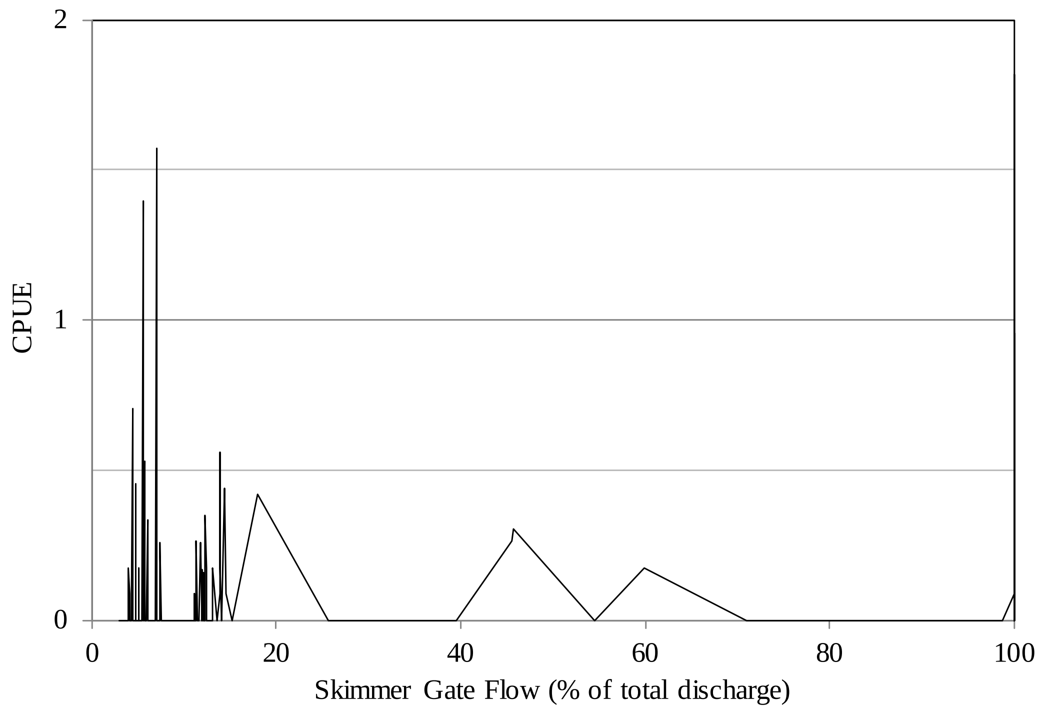

Figure 4-5. Catch-per-Unit-Effort (CPUE, smolts/h) by proportional flow through the skimmer gate (to total project discharge) during the 2015 collection period.

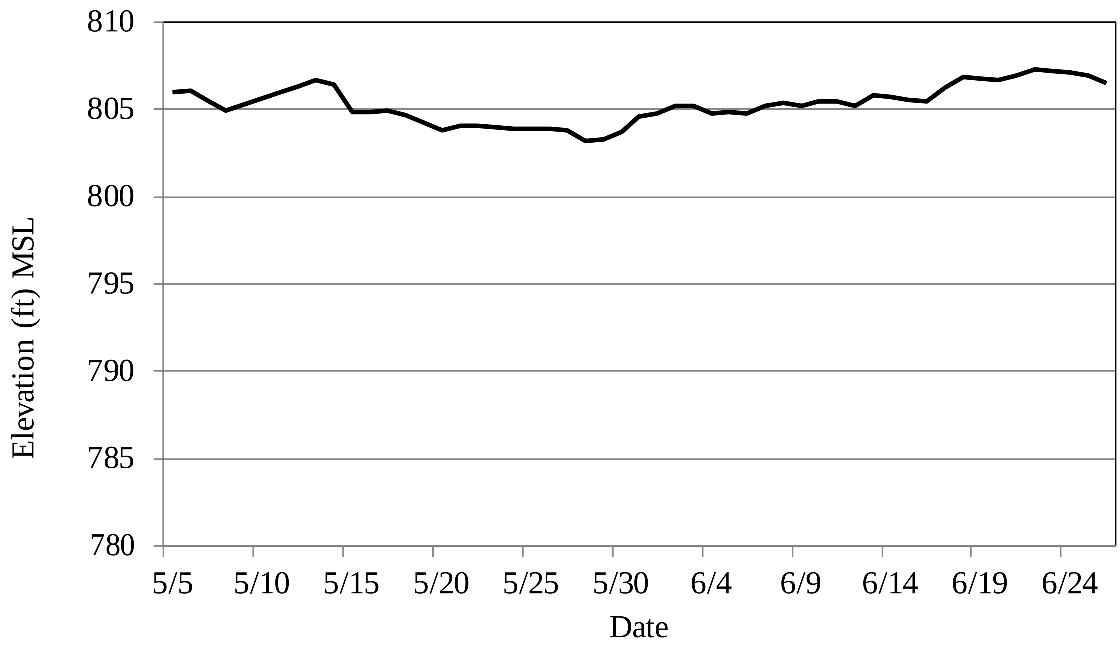

Figure 5-1. Moore Reservoir daily average elevation (ft MSL), spring 2015.

Appendix A: Supplementary Tables

Appendix Table A-1. **Number of Atlantic Salmon smolts (stream-reared) collected, effort (hours from previous end time), and catch-per-unit-effort (CPUE, N / h) for the Moore Dam fish sampler with corresponding total Moore Dam discharge and proportional flow through the skimmer gate (to total project discharge), and mean water temperature during each of 141 sampling periods, spring 2015.**

Period	Set Date	Set Time	End Date	End Time	Effort (h)	Smolts (N)	CPUE	Total Discharge	Percent of Discharge	Water Temp (°C)
Evening	05/05/15	13:50	05/05/15	19:45	5.92	0	0.00	11,021	4.2	
Morning	05/05/15	19:50	05/06/15	06:55	11.07	0	0.00	4,082	12.5	
Afternoon	05/06/15	07:00	05/06/15	12:45	5.74	0	0.00	7,534	7.4	
Evening	05/06/15	12:50	05/06/15	19:11	6.34	0	0.00	10,985	4.2	
Morning	05/06/15	19:16	05/07/15	06:43	11.44	0	0.00	4,431	10.7	
Afternoon	05/07/15	06:48	05/07/15	12:30	5.69	0	0.00	7,480	5.9	11.0
Evening	05/07/15	12:35	05/07/15	19:05	6.49	0	0.00	11,032	2.9	11.0
Morning	05/07/15	19:10	05/08/15	06:35	11.40	0	0.00	915	39.5	11.0
Afternoon	05/08/15	06:40	05/08/15	12:40	5.99	0	0.00	10,679	5.2	10.0
Evening	05/08/15	12:45	05/08/15	19:10	6.40	0	0.00	7,669	6.0	14.0
Morning	05/08/15	19:15	05/09/15	06:40	11.40	1	0.09	546	100.0	12.0
Afternoon	05/09/15	06:45	05/09/15	12:30	5.74	0	0.00	3,977	14.1	10.0
Evening	05/09/15	12:35	05/09/15	19:00	6.40	0	0.00	7,689	6.4	11.0
Morning	05/09/15	19:05	05/10/15	06:35	11.49	1	0.09	532	100.0	10.0
Afternoon	05/10/15	06:40	05/10/15	12:35	5.90	0	0.00	768	71.0	13.0
Evening	05/10/15	12:40	05/10/15	19:10	6.49	0	0.00	7,499	6.9	13.0
Morning	05/10/15	19:15	05/11/15	06:35	11.32	4	0.35	550	100.0	13.0
Afternoon	05/11/15	06:40	05/11/15	11:00	4.32	0	0.00	986	54.6	14.0
Evening	05/11/15	11:05	05/11/15	19:00	7.90	0	0.00	7,381	6.5	14.0
Morning	05/11/15	19:05	05/12/15	07:00	11.90	2	0.17	552	100.0	14.0
Afternoon	05/12/15	07:05	05/12/15	12:33	5.45	0	0.00	3,887	13.5	13.0
Evening	05/12/15	12:38	05/12/15	19:03	6.40	0	0.00	7,729	6.6	13.0
Morning	05/12/15	19:08	05/13/15	06:40	11.52	2	0.17	4,381	13.0	13.0
Afternoon	05/13/15	06:45	05/13/15	12:30	5.74	0	0.00	7,519	6.7	13.0
Evening	05/13/15	12:35	05/13/15	19:10	6.57	0	0.00	11,068	4.4	14.0
Morning	05/13/15	19:15	05/14/15	06:35	11.32	3	0.27	4,533	11.3	15.0
Evening	05/14/15	06:40	05/14/15	19:05	12.40	0	0.00	7,557	6.5	14.0
Morning	05/14/15	19:10	05/15/15	06:35	11.40	1	0.09	3,997	11.1	15.0
Afternoon	05/15/15	06:40	05/15/15	11:35	4.90	0	0.00	7,637	7.6	12.0
Evening	05/15/15	11:40	05/15/15	18:45	7.07	0	0.00	4,034	10.8	15.0
Morning	05/15/15	18:50	05/16/15	06:40	11.82	8	0.68	494	100.0	14.0
Afternoon	05/16/15	06:45	05/16/15	12:30	5.74	0	0.00	7,559	6.6	14.0
Evening	05/16/15	12:35	05/16/15	19:00	6.40	0	0.00	3,968	11.1	15.0
Morning	05/16/15	19:05	05/17/15	06:51	11.75	6	0.51	502	100.0	14.0
Evening	05/17/15	06:56	05/17/15	19:00	12.05	4	0.33	7,553	6.0	14.0

Period	Set Date	Set Time	End Date	End Time	Effort (h)	Smolts (N)	CPUE	Total Discharge	Percent of Discharge	Water Temp (°C)
Morning	05/17/15	19:05	05/18/15	06:40	11.57	21	1.81	490	100.0	15.0
Afternoon	05/18/15	06:45	05/18/15	12:50	6.07	0	0.00	7,569	6.6	15.0
Evening	05/18/15	12:55	05/18/15	19:05	6.15	0	0.00	7,686	7.1	16.0
Morning	05/18/15	19:10	05/19/15	06:35	11.40	5	0.44	563	100.0	15.0
Afternoon	05/19/15	06:40	05/19/15	12:35	5.90	0	0.00	674	85.0	14.0
Evening	05/19/15	12:40	05/19/15	18:35	5.90	0	0.00	7,561	6.5	15.0
Morning	05/19/15	18:40	05/20/15	06:35	11.90	5	0.42	2,910	17.9	15.0
Evening	05/20/15	06:40	05/20/15	19:10	12.49	0	0.00	3,533	12.4	14.5
Morning	05/20/15	19:15	05/21/15	06:40	11.40	4	0.35	514	100.0	14.0
Afternoon	05/21/15	06:45	05/21/15	12:30	5.74	0	0.00	7,601	6.6	14.0
Evening	05/21/15	12:35	05/21/15	19:22	6.77	0	0.00	487	100.0	15.5
Morning	05/21/15	19:27	05/22/15	06:30	11.04	7	0.63	522	100.0	15.5
Afternoon	05/22/15	06:35	05/22/15	12:30	5.90	1	0.17	4,302	11.9	15.0
Evening	05/22/15	12:35	05/22/15	19:08	6.54	2	0.31	1,069	45.8	15.0
Morning	05/22/15	19:13	05/23/15	06:40	11.44	0	0.00	511	100.0	15.0
Evening	05/23/15	06:45	05/23/15	19:10	12.40	0	0.00	3,981	12.1	15.0
Morning	05/23/15	19:15	05/24/15	06:42	11.44	3	0.26	497	100.0	15.0
Afternoon	05/24/15	06:47	05/24/15	13:20	6.54	0	0.00	4,041	12.0	15.5
Evening	05/24/15	13:25	05/24/15	19:10	5.74	0	0.00	3,999	11.9	14.5
Morning	05/24/15	19:15	05/25/15	06:40	11.40	4	0.35	486	100.0	15.5
Afternoon	05/25/15	06:45	05/25/15	13:30	6.74	0	0.00	3,670	13.0	15.5
Evening	05/25/15	13:35	05/25/15	19:09	5.55	0	0.00	4,200	11.4	16.0
Morning	05/25/15	19:14	05/26/15	06:42	11.45	6	0.52	456	100.0	16.0
Afternoon	05/26/15	06:47	05/26/15	12:55	6.12	0	0.00	3,992	11.2	16.5
Evening	05/26/15	13:00	05/26/15	19:10	6.15	0	0.00	478	98.8	16.5
Morning	05/26/15	19:15	05/27/15	06:45	11.49	11	0.96	519	100.0	16.1
Evening	05/27/15	06:50	05/27/15	19:20	12.49	0	0.00	458	100.0	16.5
Morning	05/27/15	19:25	05/28/15	06:45	11.32	2	0.18	513	100.0	16.5
Afternoon	05/28/15	06:50	05/28/15	12:40	5.82	0	0.00	4,058	12.0	16.5
Evening	05/28/15	12:45	05/28/15	19:00	6.24	0	0.00	478	88.9	16.5
Morning	05/28/15	19:05	5/29/15	6:40	11.57	3	0.26	491	100.0	17.0
Afternoon	5/29/15	06:45	5/29/15	12:45	5.99	0	0.00	4,198	11.9	17.5
Evening	5/29/15	12:50	5/29/15	18:10	5.32	0	0.00	4,112	11.5	17.5
Morning	5/29/15	18:15	5/30/15	6:45	12.49	7	0.56	4,111	13.9	17.9
Evening	5/30/15	06:50	5/30/15	19:08	12.29	0	0.00	496	88.6	18.0

Period	Set Date	Set Time	End Date	End Time	Effort (h)	Smolts (N)	CPUE	Total Discharge	Percent of Discharge	Water Temp (°C)
Morning	5/30/15	19:13	5/31/15	6:42	11.47	1	0.09	4,120	13.9	18.0
Afternoon	5/31/15	06:47	5/31/15	12:41	5.89	0	0.00	4,046	12.0	18.5
Evening	5/31/15	12:46	5/31/15	19:08	6.35	0	0.00	4,063	12.5	19.0
Morning	5/31/15	19:13	6/1/15	6:40	11.44	18	1.57	7,695	7.0	18.5
Afternoon	6/1/15	06:45	6/1/15	13:50	7.07	0	0.00	6,121	9.3	18.5
Evening	6/1/15	13:55	6/1/15	19:20	5.40	0	0.00	10,182	5.8	18.5
Morning	6/1/15	19:25	6/2/15	6:46	11.34	6	0.53	10,140	5.7	17.6
Evening	6/2/15	06:51	6/2/15	19:10	12.30	0	0.00	8,622	7.0	18.5
Morning	6/2/15	19:15	6/3/15	6:40	11.40	0	0.00	8,440	7.6	18.0
Afternoon	6/3/15	06:45	6/3/15	12:40	5.90	0	0.00	10,298	5.9	18.0
Evening	6/3/15	12:45	6/3/15	19:00	6.24	0	0.00	8,918	6.2	18.0
Morning	6/3/15	19:05	6/4/15	6:40	11.57	0	0.00	3,992	12.7	18.5
Afternoon	6/4/15	06:45	6/4/15	12:43	5.95	0	0.00	4,325	12.0	18.5
Evening	6/4/15	12:48	6/4/15	19:08	6.32	0	0.00	7,259	7.3	18.0
Morning	6/4/15	19:13	6/5/15	6:42	11.47	2	0.17	3,931	13.9	17.5
Afternoon	6/5/15	06:47	6/5/15	12:40	5.87	0	0.00	7,319	7.6	17.5
Evening	6/5/15	12:45	6/5/15	19:07	6.35	0	0.00	3,886	12.9	17.0
Morning	6/5/15	19:12	6/6/15	6:38	11.42	1	0.09	3,920	14.6	17.0
Afternoon	6/6/15	06:43	6/6/15	12:41	5.95	0	0.00	7,251	7.1	17.5
Evening	6/6/15	12:46	6/6/15	19:09	6.37	0	0.00	3,882	12.8	18.0
Morning	6/6/15	19:14	6/7/15	6:47	11.54	0	0.00	705	85.2	17.5
Evening	6/7/15	06:52	6/7/15	19:11	12.30	0	0.00	3,839	12.2	17.5
Morning	6/7/15	19:16	6/8/15	6:41	11.40	1	0.09	551	100.0	17
Afternoon	6/8/15	06:46	6/8/15	12:58	6.19	0	0.00	7,373	7.0	18
Evening	6/8/15	13:03	6/8/15	19:10	6.10	0	0.00	7,354	6.5	18.5
Morning	6/8/15	19:15	6/9/15	6:39	11.39	3	0.26	1,105	45.6	18
Afternoon	6/9/15	06:44	6/9/15	12:40	5.92	0	0.00	7,181	6.6	18
Evening	6/9/15	12:45	6/9/15	19:07	6.35	1	0.16	4,019	12.1	19
Morning	6/9/15	19:12	6/10/15	6:44	11.52	3	0.26	6,959	7.4	15.9
Evening	6/10/15	06:49	6/10/15	19:08	12.30	0	0.00	10,736	4.8	18
Morning	6/10/15	19:13	6/11/15	6:37	11.39	2	0.18	10,076	5.1	18
Afternoon	6/11/15	06:42	6/11/15	12:35	5.87	0	0.00	10,336	5.0	18.5
Evening	6/11/15	12:40	6/11/15	19:07	6.44	0	0.00	9,422	5.6	18
Morning	6/11/15	19:12	6/12/15	06:42	11.49	2	0.17	9,511	5.0	18
Afternoon	6/12/15	06:47	6/12/15	12:37	5.82	0	0.00	4,085	11.1	18.5

Period	Set Date	Set Time	End Date	End Time	Effort (h)	Smolts (N)	CPUE	Total Discharge	Percent of Discharge	Water Temp (°C)
Evening	6/12/15	12:42	6/12/15	19:08	6.42	0	0.00	4,711	10.8	18.5
Morning	6/12/15	19:13	6/13/15	06:45	11.52	3	0.26	4,644	11.7	18
Evening	6/13/15	06:50	6/13/15	17:18	10.45	0	0.00	9,460	5.9	18.5
Morning	6/13/15	17:23	6/14/15	06:38	13.24	6	0.45	11,766	4.7	18.5
Afternoon	6/14/15	06:43	6/14/15	12:38	5.90	0	0.00	11,644	4.8	19
Evening	6/14/15	12:43	6/14/15	19:06	6.37	0	0.00	11,644	4.7	18.5
Morning	6/14/15	19:11	6/15/15	06:40	11.47	16	1.39	9,787	5.5	19
Afternoon	6/15/15	06:45	6/15/15	12:36	5.84	0	0.00	9,785	5.5	19
Evening	6/15/15	12:41	6/15/15	19:07	6.42	0	0.00	9,314	5.4	19
Morning	6/15/15	19:12	6/16/15	06:44	11.52	2	0.17	3,955	12.4	16.9
Evening	6/16/15	06:49	6/16/15	19:07	12.29	0	0.00	7,430	7.3	19
Morning	6/16/15	19:12	6/17/15	06:38	11.42	5	0.44	4,101	14.3	19
Afternoon	6/17/15	06:43	6/17/15	12:55	6.19	0	0.00	3,392	15.1	19
Evening	6/17/15	13:00	6/17/15	19:06	6.09	0	0.00	4,670	9.6	19
Morning	6/17/15	19:11	6/18/15	06:37	11.42	4	0.35	4,012	12.3	18.5
Afternoon	6/18/15	06:42	6/18/15	12:36	5.89	0	0.00	5,629	9.0	19
Evening	6/18/15	12:41	6/18/15	19:04	6.37	0	0.00	4,573	11.0	19
Morning	6/18/15	19:09	6/19/15	06:40	11.50	0	0.00	5,003	9.7	16.9
Evening	6/19/15	06:45	6/19/15	19:07	12.35	0	0.00	4,353	10.9	19
Morning	6/19/15	19:12	6/20/15	06:37	11.40	2	0.18	817	59.8	19
Afternoon	6/20/15	06:42	6/20/15	12:37	5.90	0	0.00	3,951	11.6	19.5
Evening	6/20/15	12:42	6/20/15	19:08	6.42	0	0.00	7,327	6.2	19
Morning	6/20/15	19:13	6/21/15	06:39	11.42	0	0.00	1,923	25.6	19
Afternoon	6/21/15	06:44	6/21/15	12:34	5.82	0	0.00	4,006	12.1	19
Evening	6/21/15	12:39	6/21/15	19:04	6.40	0	0.00	6,602	7.9	19
Morning	6/21/15	19:09	6/22/15	06:40	11.50	1	0.09	9,766	5.7	19.7
Evening	6/22/15	06:45	6/22/15	19:19	12.55	0	0.00	14,385	3.8	20.5
Morning	6/22/15	19:24	6/23/15	06:44	11.32	8	0.71	12,637	4.4	20
Afternoon	6/23/15	06:49	6/23/15	12:40	5.84	1	0.17	14,097	3.9	20
Evening	6/23/15	12:45	6/23/15	19:20	6.57	0	0.00	14,100	3.9	20
Morning	6/23/15	19:25	6/24/15	06:44	11.30	1	0.09	12,969	4.2	20
Afternoon	6/24/15	06:49	6/24/15	12:40	5.84	0	0.00	12,937	4.2	20
Evening	6/24/15	12:45	6/24/15	19:20	6.57	0	0.00	12,579	4.2	20
Morning	6/24/15	19:25	6/25/15	06:46	11.34	0	0.00	11,518	4.5	19.1
Evening	6/25/15	06:51	6/25/15	19:22	12.50	0	0.00	9,611	5.3	20
Morning	6/25/15	19:27	6/26/15	06:44	11.27	0	0.00	9,400	4.8	20

Appendix B: Response to Comments

Comments were provided by Andrew Shafermeyer of NHFGD and Leonard Gerardi with the VDFW. Their comments are listed below followed by TransCanada's responses.

NHFGD, email from A. Schafermeyer dated 12/11/15

Comment:

I think a great effort was made to assess fish behavior as they approached the Dam and skimmer gate but more could have been done to improve their urge to enter. Telemetry and other methods showed us that some salmon seemed to wander aimlessly as they approached the skimmer. Flow inducers and guide nets were used with little success. It seems like a major component to the success of the sampler was not effective and I've been trying to think of a solution. In 2011, a new type of flow inducers were used and described as "more robust" than those of the past. Do you have any data that shows the effectiveness of these? I know that they were not used in recent years.

You obviously analyzed the data more closely than I have. Were there any other relationships between reluctance of the fish to enter the skimmer gate and other variables like water levels, light conditions, etc…?

Response:

Thanks for reviewing the report and providing feedback. As you indicate, I think the challenge for smotls is finding the sluice gate attraction flow in the 3,490 acre reservoir; however, we were successful in improving their odds. The table below, modified from Table 4.5 in the 2011 report (attached to email), shows a significant improvement in passage of tagged hatchery smolts to the collection tank after the attraction shelf was installed for the 2006 season. Passage increased from around 9% to between 30 – 46%. The shelf effectively moved the sluice gate attraction flow-field out to the forebay (the gate is located about 25 feet downstream from the face of the dam, see Figure 2-3 of the report). The current inducers provided another 10% or so of improved passage effectiveness. As noted in the attached report, two attraction lights were installed in 2010 based on an agency request and were used each year after. We didn't study the effect of the lights on passage, but it did shown passage improvement at Cabot Station.

Year		Number Released	Number Returned	Percent Return	Release Location, as Distance from Dam	Purpose or Method	Total passage numbers
2004[a]		1386	127	9.16	forebay to 11 mi.		240
2005[b]		896	40	4.46	11 mi.		1,404
2006[b,c,d]		805	377	46.83	11 mi.	attraction shelf installed	2,473
2007[b]		102	29	28.43	forebay to 1 mi.		1,029
2009[e]		889	329	37.01	forebay to 1 mi.	guide net	3,183
2010[b]	(released 5/10)	333	160	48.05	~ 450 ft	guide net and current inducers	3,214
	(released 6/11)[f]	416	66	15.87	~ 450 ft		
2011[bg]		826	486	58.84	~ 300 ft	current inducers	1,471

a - Smolts from White River Hatchery

b - Smolts from Pittsford Hatchery

c - Attraction flow shelf and debris boom installed

d - Spill occurred for ~25 h on 11-12 June

e - Smolts from collection tank

f - Fish trap closed 8 days after smolts released

g - Spill occurred for ~4 h on 28 May

VTDFW, email from L. Gerardi dated 12/21/15

Comment:

5.0 Discussion (Page 8, lead sentence "The purposes of the evaluation..." and following); 6.0 Conclusions: Much of the history of the Sampler is captured briefly in this report's sections 1.0 Introduction and 2.0 Project Description. Nevertheless, it may be valuable to make this report a summary analysis of smolt behavior at Moore and the performance and effectiveness of the Sampler for smolt passage by including a more expansive discussion of what has been observed, learned and concluded over the multi-year period of its development and operation. Although the near-term future for restoration of Atlantic salmon to the upper Connecticut River is clear -- the Program is abandoned -- the long-term future is undetermined. The fact that the most recent iteration of salmon restoration in the Connecticut is not the first, leaves open the prospect that there will be yet another iteration. Work and results related to smolt passage at Moore should be summarized and discussed in a single final document that can be readily found and accessed if ever needed in the future.

Response:

TransCanada's license requirement is to provide and monitor passage annually, followed by a report on those activities. The annual reports provide detailed information on environmental conditions (water temperature, river flow, etc.) and project operation, as well as thorough descriptions of that years particular study purpose, methods and results. The history of this smolt passage effort, if valuable in the future, would be best served by a thorough review of the annual reports. All annual reports can be readily found and accessed through FERC's eLibrary.

Comment:

Page ES-2 first bullet; 4.2 Results, page 6, 2nd paragraph; 5.0 Discussion, page 8 , 4th paragraph: I repeat the comment (also pasted below) I offered in 2014 regarding the Sampler collection intervals and check times. It could be valuable in what may well be the final Sampler report to discuss and acknowledge

that smolt movement quantified by the morning counts may not be occurring overnight and early morning, but in the early to mid-evening hours.

Response:

Changes were made to Section 4.2 and 5.0 to address the comment.

Comment:

5.0 Discussion Page 9, last sentence of second to last paragraph: The "percentage" of the estimated smolt outmigration captured in the Sampler is unrelated to the termination of the Restoration effort (unless I'm missing something). It's the low number of smolts estimated to outmigrate that is related to the end of the Program.

Response:

TC agrees with your comment. The point of the sentence is that the low percentage of smolts entering the sampler relative to estimated production numbers is related to termination of the restoration effort. No change made.

Comment:

4.2 Results, page, last paragraph; 5.0 Discussion, pages, pages 8-9; 6.0 conclusions, page 11, third bullet: Regarding smolt injuries and mortalities related predation, there is no specific treatment of when (i.e., in what sampling intervals) the attempted predation incidents occurred. There should be, in light of the differential catch rates by interval, and the relatively long residence time in the Sampler for the overnight "Morning" interval. Table 4.1 could be enhanced for illustration purposes by including the number of mortalities for each collection periods.

Response:

Section 4.2 was changed to specify when mortalities occurred: Of the eleven mortalities, two occurred in the transport tank, three in the holding tanks, and six were found in the collection tank during Morning collections.

From:	Leonard Gerardi
To:	Jennifer Griffin
Cc:	John Ragonese; cgagne@normandeau.com; dcoughlan@normandeau.com; Will, Lael; Matthew.Carpenter@wildlife.nh.gov; dianne.timmins@wildlife.nh.gov; andrew.schafermeyer@wildlife.nh.gov; gabe.gries@wildlife.nh.gov; John_Warner@fws.gov; Kratzer, Jud; Lenny Gerardi -- work
Subject:	Moore smolt passage reoport 2015 -- Gerardi VTFW review and comment
Date:	Monday, December 21, 2015 9:49:56 AM

Jen,

I have reviewed the 2015 report. Thank you for the opportunity. As I've commented in the past I see these annual reports as an important long-term record, with great potential value for future consultation perhaps in future Atlantic salmon restorations efforts, and in relicensings of the 15-Mile Falls Hydroelectric project.

In my review of the report for the 2014 season, I included an number of suggestions that could enhance the accessibility of information. I note them below, and thank you for addressing them and incorporating the changes in the 2015 season report.

The following are my comments on the 2015 report.

5.0 Discussion (Page 8, lead sentance "The purposes of the evaluation..." and following); 6.0 Conclusions

Much of the history of the Sampler is captured briefly in this report's sections 1.0 Introduction and 2.0 Project Description. Nevertheless, it may be valuable to make this report a summary analysis of smolt behavior at Moore and the performance and effectiveness of the Sampler for smolt passage by including a more expansive discussion of what has been observed, learned and concluded over the multi-year period of its development and operation. Although the near-term future for restoration of Atlantic salmon to the upper Connecticut River is clear -- the Program is abandoned -- the long-term future is undetermined. The fact that the most recent iteration of salmon restoration in the Connecticut is not the first, leaves open the prospect that there will be yet another iteration. Work and results related to smolt passage at Moore should be summarized and discussed in a single final document that can be readily found and accessed if ever needed in the future.

Page ES-2 first bullet; 4.2 Results, page 6, 2nd paragraph; 5.0 Discussion, page 8 , 4th paragraph:

I repeat the comment (also pasted below) I offered in 2014 regarding the Sampler collection intervals and check times. It could be valuable in what may well be the final Sampler report to discuss and acknowledge that smolt movement quantified by the morning counts may not be occuring overnight and early morning, but in the early to mid-evening hours.

5.0 Discussion Page 9, last sentence of second to last paragraph

The "percentage" of the estimated smolt outmigration captured in the Sampler is unrelated to the termination of the Restoration effort (unless I'm missing something). It's the low number of smolts estimated to outmigrate that is related to the end of the Program.

4.2 Results, page, last paragraph; 5.0 Discussion, pages, pages 8-9; 6.0 conclusions, page 11, third bullet;

Regarding smolt injuries and mortalities related predation, there is no specific treatment of when (i.e., in what sampling intervals) the attempted predation incidents occurred . There should be, in light of the diffential catch rates by interval, and the relatively long residence time in the Sampler for the overnight "Morning" interval. Table 4.1 could be enhanced for illustration purposes by including the number of mortalities for each collection periods.

Lenny Gerardi
Fisheries Biologist
Vermont Fish and Wildlife Department
1229 Portland Street, Suite 201
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PLEASE NOTE NEW EMAIL ADDRESS AS OF JULY 27, 2015!
LEN.GERARDI@VERMONT.GOV

Table 4.2, page 16.

It would be helpful to show a mulit-year comparison with the partitioning of mortality locations (factors), so that one doesn't have to go back to mine the information from all of the earlier reports.

It would certainly be useful to look at the contribution to mortality that transport has had in these most recent years, not to mention the debris factor. Done. Thank you.

-

Figure 4-1, page 29.

It would be good to show on the x-axis the final date (6/23 or later) of sampler operation and flow/temperature documentatiion. Done. Thank you.

Table A1, pages 34 - 37

Even though temperature can be found graphically in Figure 4.1 (as can number of smolts and discharge, etc.), it would be a benefit to have a column in this table for the Moore skimmer gate temperature, just like there's a column for discharge. Given that the temperature metric for the reservoir is pretty stable over the 24-hour period (relative to at the two riverene locations), a single daily temperature could suffice. I should have requested this addition years ago. Done. Thank you.

Page 6, paragraph 2 in Section 4.2 and Table page 15.

This is just an observation of a possible oversight that should have been or maybe was discussed (looked at and dismissed) in years past:

The morning sampling interval is much longer than either the afternoon and evening intervals, I assume for reasons of staffing. Most sampler use is attributed to the morning interval, and the

CPUE is by far the highest. The report reads that this is “indicating an overnight or early morning downstream migration”. The evening checks were done in 2014 between 18:46 and 19:36. I’ll assume it was roughly the same in other years. May 1 sunset occurs ~19:00 with twilight later than 19:30; June 1 sunset is ~ 19:30 with twilight later than 20:00. I recall Steve McCormick observing on a couple of instances in his smolt PIT tagging work a pronounced staging of smolts after sunset and in the first hours of darkness in the headrace of the East Barnet hydro station on the Passumpsic River just at the confluence with the Comerford tailrace. It is possible that the Morning sampling interval may have lumped a substantial amount of crepuscular activity into a long overnight period. All these years the significant concentrated movement and high CPUE could have been occuring undocumented from 19:00 -23:00 hrs. If so, it’s a little late in the game to be looking at that now. See comment above

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From: Jennifer Griffin [mailto:jennifer_griffin@transcanada.com]
Sent: Tuesday, November 17, 2015 10:39 AM
To: Will, Lael; Gerardi, Len; Carpenter, Matthew (Matthew.Carpenter@wildlife.nh.gov); dianne.timmins@wildlife.nh.gov; andrew.schafermeyer@wildlife.nh.gov; gabe.gries@wildlife.nh.gov; 'John Warner (John_Warner@fws.gov)'
Cc: John Ragonese; cgagne@normandeau.com; David J. Coughlan (dcoughlan@normandeau.com)
Subject: Moore smolt passage reoport 2015

Good Morning,

Attached for your review is our report on 2015 salmon smolt passage at the Moore Dam, under Article 410 of the Fifteen Mile Falls license. This was the 12th year collecting smolts at the Moore dam and transporting them below the Fifteen Mile Falls Project and the second year since salmon stocking above the Project was terminated. This year only 202 smolts were collected; the sampler was operated between May 5 and June 26. Mortality was 5.4%, principally related to predation or attempted predation in the collection tank. Salmon smolts were removed from the collection tank and transported below the Vernon dam. Resident species were removed from the collection tank and returned to Moore reservoir, as has been the procedure defined by agencies since the first year of study and collection.

The number of smolts collected during this year’s migration was the lowest on record, as was expected. Salmon stocking was limited after 2011 and ended after 2013. Only about 25,000 fry were stocked above the Project in 2013 and 72,000 in 2012, as compared with a range of almost 480,000 to 135,000 since 2000. The annual smolt migration at Moore has been dominated by the age-2 year class, and 2015 was the last of this cohort to migrate. TransCanada believes that operating the sampler to collect and transport the few fish that might migrate next year will add little value to a program that has otherwise been abandoned. We therefore seek your concurrence to discontinue operation of the Moore sampler.

Please provide your comments to me by December 18, 2015, if you’re like to have a call to review the report or our request, please let me know and I’ll set it up.

Thanks,
Jen

~~~~~~~~~~~~~~~~~~~~~

Jennifer Griffin
TransCanada Hydro Northeast
N. Walpole Hydro Office
2 Killeen St., N. Walpole, NH 03609
Office: 603-445-6806
Cell: 603-966-0477
jennifer_griffin@transcanada.com

~~~~~~~~~~~~~~~~~~~~~

From: Schafermeyer, Andrew
To: Jennifer Griffin
Cc: Carpenter, Matthew
Subject: Moore Sampler Report
Date: Friday, December 11, 2015 12:59:55 PM

Jenn,

Thanks for putting together the report covering the 2015 sample season. As always you did a great job. I really only have one topic to discuss and I'm not even sure that there is a solution.

I think a great effort was made to assess fish behavior as they approached the Dam and skimmer gate but more could have been done to improve their urge to enter. Telemetry and other methods showed us that some salmon seemed to wander aimlessly as they approached the skimmer. Flow inducers and guide nets were used with little success. It seems like a major component to the success of the sampler was not effective and I've been trying to think of a solution. In 2011, a new type of flow inducers were used and described as "more robust" than those of the past. Do you have any data that shows the effectiveness of these? I know that they were not used in recent years.

You obviously analyzed the data more closely than I have. Were there any other relationships between reluctance of the fish to enter the skimmer gate and other variables like water levels, light conditions, etc…?

Andrew Schafermeyer
Fisheries Biologist
NH Fish and Game Department
629B Main Street
Lancaster, NH 03584
(603) 788-3164
andrew.schafermeyer@wildlife.nh.gov

From:	Carpenter, Matthew
To:	Jennifer Griffin; "Lael Will (lael.will@state.vt.us)"; Len Gerardi; Timmins, Dianne; Schafermeyer, Andrew; Gries, Gabriel; "John Warner (John_Warner@fws.gov)"
Cc:	John Ragonese; cgagne@normandeau.com; David J. Coughlan (dcoughlan@normandeau.com)
Subject:	RE: Moore smolt passage reoport 2015
Date:	Wednesday, December 09, 2015 8:44:26 AM

Hi Jen,
I have no comments on the report.
Thanks,
Matt

From: Jennifer Griffin [mailto:jennifer_griffin@transcanada.com]
Sent: Tuesday, December 08, 2015 4:07 PM
To: 'Lael Will (lael.will@state.vt.us)'; Len Gerardi; Carpenter, Matthew; Timmins, Dianne; Schafermeyer, Andrew; Gries, Gabriel; 'John Warner (John_Warner@fws.gov)'
Cc: John Ragonese; cgagne@normandeau.com; David J. Coughlan (dcoughlan@normandeau.com)
Subject: RE: Moore smolt passage reoport 2015

Hi Everyone – Just a reminder that we're looking to get comments from you by next week (or sooner) on the Moore smolt passage report. If you know now that you will not be providing comments, please let me know as soon as you can.

Thanks,
Jen

From: Jennifer Griffin
Sent: Tuesday, November 17, 2015 10:39 AM
To: 'Lael Will (lael.will@state.vt.us)'; Len Gerardi; Carpenter, Matthew (Matthew.Carpenter@wildlife.nh.gov); dianne.timmins@wildlife.nh.gov; andrew.schafermeyer@wildlife.nh.gov; gabe.gries@wildlife.nh.gov; 'John Warner (John_Warner@fws.gov)'
Cc: John Ragonese; cgagne@normandeau.com; David J. Coughlan (dcoughlan@normandeau.com)
Subject: Moore smolt passage reoport 2015

Good Morning,

Attached for your review is our report on 2015 salmon smolt passage at the Moore Dam, under Article 410 of the Fifteen Mile Falls license. This was the 12th year collecting smolts at the Moore dam and transporting them below the Fifteen Mile Falls Project and the second year since salmon stocking above the Project was terminated. This year only 202 smolts were collected; the sampler was operated between May 5 and June 26. Mortality was 5.4%, principally related to predation or attempted predation in the collection tank. Salmon smolts were removed from the collection tank and transported below the Vernon dam. Resident species were removed from the collection tank and returned to Moore reservoir, as has been the procedure defined by agencies since the first year of study and collection.

The number of smolts collected during this year's migration was the lowest on record, as was expected. Salmon stocking was limited after 2011 and ended after 2013. Only about 25,000 fry were stocked above the Project in 2013 and 72,000 in 2012, as compared with a range of almost 480,000 to 135,000 since 2000. The annual smolt migration at Moore has been dominated by the age-2 year class, and 2015 was the last of this cohort to migrate. TransCanada believes that operating the sampler to collect and transport the few fish that might migrate next year will add little value to a program that has otherwise been abandoned. We therefore seek your concurrence to discontinue operation of the Moore sampler.

Please provide your comments to me by December 18, 2015, if you're like to have a call to review the report or our request, please let me know and I'll set it up.

Thanks,
Jen

Jennifer Griffin

TransCanada Hydro Northeast
N. Walpole Hydro Office
2 Killeen St., N. Walpole, NH 03609
Office: 603-445-6806
Cell: 603-966-0477
jennifer_griffin@transcanada.com

6.2 LIHI letter to Great River Hydro dated January 23, 2018

January 23, 2018

John L. Ragonese
FERC License Manager
Great River Hydro, LLC
One Harbour Place, Suite 330
Portsmouth, NH 03801
Via email: jragonese@greatriverhydro.com

RE: Request for Additional Three Years of Certification Term in Accordance with Condition 3 of the Fifteen Mile Falls' (LIHI Cert #39) Recertification

Dear Mr. Ragonese,

On December 20, 2017 LIHI received Great River Hydro LLC's 2017 Compliance package for Fifteen Mile Falls ("Project") along with a request for three (3) additional years of Certification as offered in Condition 3 of the recertification that was issued in 2015 (Certification term 2013-2018) if the project met certain provisions.

Condition 3 stated:

The facility owner shall provide LIHI with a description of the current status and use of funds from the Mitigation and Enhancement Fund that was part of the Settlement Agreement for the most recent FERC licensing. In particular, this description shall identify the lands and waters that are benefiting from the funds, the current fund balance, and continuing payment schedule, and be sufficient to determine if these funds are achieving the ecological and recreational equivalent of land protection of the buffer zone referred to in Question D.1. This information will be used by LIHI staff to determine if the Fifteen Mile Falls certification qualifies for three additional years in its term. The facility owner may or may not take advantage of this opportunity to request an extended term of their new certificate; if they do not provide this additional information, it will not affect the new five-year term.

Question D.1 of the April 2014 Handbook, referred to above, is as follows:

Is there a buffer zone dedicated for conservation purposes (to protect fish and wildlife habitat, water quality, aesthetics and/or low-impact recreation) extending 200 feet from the average annual high water line for at least 50% of the shoreline, including all of the undeveloped shoreline? (page 41, LIHI Certification Handbook, April 2014 Edition)

Since the beginning of the Mitigation and Enhancement Fund ("Fund") in 2002, a total of $11,534,404 in grants and $2,131,653 in payments to towns for a total of $13,666,057 has been dispersed by the Fund. The current balance of the Fund is $8,157,121. Over the life of the Fund, Great River has contributed $21,005,350 and interest has provided another $1,708,611 to the asset total.

Approximately 2% of the total assets have been spent on fees, program expenses and easement expenses.

Since 2012 the grants have provided for the protection of 3,122 acres of upland forest, farmland, wetland, riparian buffer, and river lands. The acreage associated with the Project's FERC boundary is approximately 3,400 acres. The Fund protected lands, therefore, represent well over 50% of the project's developed and undeveloped shorelines. These lands protect fish and wildlife habitat and water quality, and are "the ecological and recreational equivalent of land protection of the buffer zone referred to in Question D.1".

Therefore, the Project has satisfied Condition 3 and qualifies for an additional three years of Certification term.

In addition to the lands protected and enhanced through the Fund, the Owner has protected through permanent easements, 6,918 acres. These easements were conveyed to New England Forestry Foundation, Inc. in 2008.

By this letter, I hereby amend the Certification term for the Fifteen Mile Falls project (LIHI Cert #39) to December 15, 2013 expiring December 14, 2021.

Sincerely,

Shannon Ames
Executive Director

Cc: Jennifer Griffin via email jgriffin@greatriverhydro.com

6.3 Fifteen Mile Falls Settlement Agreement

FIFTEEN MILE FALLS PROJECT
L. P. No. 2077

Settlement Agreement

New England Power
A NEES company

Final FMF Settlement Agreement
August 6, 1997

Settlement Agreement

The parties to this Agreement, dated this 14 day of August, 1997, are New England Power Company (New England Power), together with the following (collectively, the "Stakeholders"): The State of New Hampshire, by and through its Governor, its Fish and Game Department ("NHFGD") , and its Department of Environmental Services ("NHDES"); the State of Vermont, by and through its Governor and Agency of Natural Resources ("VANR"); the United States Fish and Wildlife Service ("USFWS"); the United States Environmental Protection Agency ("EPA"); the National Park Service ("NPS"); the Appalachian Mountain Club ("AMC"); the Connecticut River Joint Commissions ("CRJC"); the Connecticut River Watershed Council ("CRWC"); the New Hampshire Rivers Council ("NHRC"); the North Country Council ("NCC"); the Northeastern Vermont Development Association ("NVDA"); and the New Hampshire Council of Trout Unlimited ("TU").

I. Background

A. New England Power is the licensee, owner and operator of the Fifteen Mile Falls Project, L.P. No. 2077 ("FMF" or the "Project" as further defined herein). The Project license expires on July 31, 2001, and New England Power has begun the process of obtaining a new license for FMF.

B. The upper Connecticut River generally, and the Fifteen Mile Falls project area specifically, is a highly significant area from an environmental perspective. The Project and the flows it releases downstream provide important fisheries for both warm and cold water fish, habitat for a number of rare plants, includes an unusual flood plain forest, provides habitat for bald eagles and other wildlife species unusual for the region, includes one of the only large lakes with undeveloped shoreline in the region, contains sites once used by Native Americans and provides a variety of recreation opportunities significant to both the quality of life and economy in the area. Water quality improvements achieved over the last two decades have greatly enhanced the area's environmental value and this trend is expected to continue as water quality improves even further.

The Project is important to the region's economy not only because of the amenities it provides but also because of its value to New England's electrical system. It provides not only energy to the system but also contributes to its stability. As a result of its values in this regard, it is a major contributor to the economies in the towns where it is located.

These benefits (both environmental and economic) have an environmental cost. The Connecticut River has been impounded in the Project Area. This has fundamentally changed the nature of this reach of the river. This Agreement serves to strike a carefully considered balance between maintaining the energy values of the Project largely undiminished and mitigating the Project's impacts.

C. The Stakeholders have expressed strong interests in the relicensing of FMF. The undersigned parties represent a broad range of interests potentially affected by the terms and conditions of a new license. The interests and goals represented by the Stakeholders include, but are not limited to, improving water quality, enhancing habitat for fish and other aquatic biota; improving wildlife habitat; protecting threatened and endangered plant and animal species; protecting wetlands; protecting cultural resources; preserving undeveloped lands; enhancing public recreation; protecting aesthetic values; fostering economic development and preserving the local tax base; and maintaining the energy and system reliability benefits of New England's largest hydropower project.

D. In reaching this Agreement, the parties recognize that the Project must meet the requirements of applicable State and Federal law, and agree upon the following inter-dependent principles (the "Principles"). The parties agree that no one of these Principles may be read in isolation from the others and that no one value may be maximized.

i. Aquatic-habitat resources affected by Project operations should be protected, restored and enhanced.

ii. The Project's existing contribution to flood-control, flow-maintenance, and recreation is important and needs to be preserved and in certain instances enhanced.

iii. The Project is an important hydropower resource.

iv. There is broad recognition of the continuing benefits to the river that would be realized if the Project lands and certain other lands are permanently protected through conservation easements. The goal of these easements will be to preserve them in their undeveloped state (subject to power generation and transmission-related uses), prevent their fragmentation and to provide for appropriate forest management. Management plans need to be provided for particular resources.

v. Consistent with the objective of maintaining the existing largely undeveloped character of the Project's shorelands, existing recreational opportunities need to be preserved and new low impact opportunities should be evaluated.

E. As part of the move toward a more competitive structure for the electric utility industry, New England Power agreed in a settlement with the Massachusetts Attorney General to sell its generation business and associated land. New England Power and the FMF Stakeholders agree that it is in the best interest of the parties and of the public to reach a binding agreement, before completion of New England Power's pending sale of the Project, on the appropriate terms and conditions to be incorporated in a new Project license. By entering into an Agreement before completion of the pending sale, the Parties have the opportunity to preserve the Project lands as well as other specified lands. This land conservation provides important public benefits beyond the scope of applicable State and Federal law or those that could be attained solely through regulatory review.

F. The parties believe that the Agreement advances each and every one of the Principles. The Project presents complex and unique resource issues, and it is not feasible to maximize each and every public value and use incorporated in the Principles. The parties agree that the terms and conditions and other commitments contained herein provide a broad and balanced range of environmental enhancements and other public benefits. The parties also agree that based upon the factual knowledge presently available, the terms and conditions specified in this Agreement satisfy all applicable law as of the date hereof.

Therefore, in Consideration of the mutual covenants contained herein, the parties covenant and agree as follows:

II. General Provisions

A. Definitions -

1. "New England Power" shall mean New England Power Company as constituted on the day of execution of this Agreement.

2. "Project Owner" shall mean New England Power Company and any successor owner of the Project.

3. "Completion of Licensing" shall mean the date upon which all appeal periods have expired for the later occurring of: a) the issuance of a new federal license for the Project, in conformance with the terms of this Agreement; b) the issuance of water quality certification by New Hampshire pursuant to §401 of the Clean Water Act, in conformance with the terms of this Agreement; or c) the receipt of all federal and state approvals necessary for the transfer of the Project to a new owner.

4. "MSL" shall mean feet above mean sea level.

5. "Prorated Passumpsic Gage" shall mean a flow of 1.3 times the reported flow from the Passumpsic River Gage. This proration serves to represent the entire drainage area of the Passumpsic River, Stevens River basins and other minor tributaries entering McIndoes Reservoir.

6. "Project" shall mean the Fifteen Mile Falls hydroelectric project, L.P. No. 2077, consisting of the Moore, Comerford, and McIndoes developments.

B. This Agreement is entered into with full knowledge and understanding by all parties of New England Power Company's intention to sell its fossil-fired and hydroelectric generation business, including the Project, in the near term. The intention of this Agreement is to identify for potential buyers the terms and conditions that will apply to the Project under a new license thus allowing them to evaluate the Project in light of these requirements. The buyer and any successor owner shall be bound by the commitments made herein, and upon the closing of the transaction the buyer (or any successor owner) will assume exclusive responsibility for fulfilling those commitments. Similarly, the Settlement Agreement shall apply to, and be binding on, the Stakeholders and their successors and assigns, but only with regard to the subject matter herein. Each signatory to the Settlement Agreement certifies that he or she is authorized to execute the Settlement Agreement and legally bind the party he or she represents.

C. The Stakeholders further understand that many of the compromises New England Power has agreed to herein would not have been possible but for the impending sale of the Project along with the rest of New England Power's fossil fueled and hydroelectric generation business. Therefore many of the commitments contained herein will not take effect until the Completion of Licensing. Recognizing that it is to the parties mutual advantage to have the Project with a new license in place and under the control of the new owner as expediently as possible, the parties further agree that:

1) The parties will support and take reasonable steps to facilitate the issuance of any licenses, permits and authorizations necessary to implement such transfer of the Project to a new owner;

2) The commitments made herein and the requirements and obligations placed on the Project Owner through applicable laws and regulations fully mitigate and resolve all concerns involving any environmental impacts associated with the transfer of the Project to a new owner; and

3) The contributions to be made hereunder to the Upper Connecticut River Mitigation and Enhancement Fund for the purposes of mitigating tax revenue impacts fulfill any and all responsibility the Project Owner may have to mitigate for local property tax losses resulting from the donation of conservation easements by the Project Owner.

Notwithstanding subsection (2) above, nothing herein shall restrict the Stakeholders from investigating, commenting on, and if necessary objecting to, the qualifications of the buyer based upon the buyer's past financial history or compliance record.

D. The parties have entered into this Agreement with the intent that this Agreement, the performance of all obligations hereunder, and implementation of the measures needed to comply with applicable regulations and requirements will resolve all issues associated with issuance of a new license for the Project involving water flow, fisheries, fish passage, wildlife, water quality, public safety, lands management and control, recreation, aesthetics, and cultural resources to the satisfaction of the parties.

E. The Project Owner agrees to implement the various obligations and requirements set forth herein. The Stakeholders agree to support a new 40 year license for the Project incorporating and implementing the provisions contained herein. This support shall include reasonable efforts to expedite the National Environmental Policy Act (NEPA) process. For those issues addressed herein, except as otherwise provided in Section II.G and II.I, the parties agree not to propose, support or otherwise communicate to FERC or any other Resource Agency with jurisdiction directly related to the relicensing process any comments or license conditions other than ones consistent with the terms of this Agreement. Further, the parties agree not to support any competing license application for the Project. However, this Agreement shall not be interpreted to restrict any party's participation or comments in future relicensing of this Project. Further, this section shall not be read to predetermine the outcome of the NEPA analysis. If such NEPA analysis leads to addition of any license conditions not in conformance with the terms and conditions contained herein, the parties recognize that such addition would trigger the rights of the parties to withdraw from the Settlement Agreement pursuant to Section VII of this Agreement.

F. The parties agree that this Settlement Agreement fairly and appropriately balances the environmental, recreational, fishery, energy and other uses and interests served by the Fifteen Mile Falls Project. The parties further agree that this balance is specific to the Fifteen Mile Falls Project. No party shall be deemed, by virtue of participation in this Settlement Agreement, to have established precedent, or admitted or consented to any approach, methodology, or principle except as expressly provided for herein. In the event that this Settlement is approved by the FERC, such approval shall not be deemed precedential or controlling regarding any particular issue or contention in any other proceeding.

G. Nothing in this Settlement Agreement shall preclude the state and federal resource agencies from complying with their obligations under the National Environmental Policy Act, the Clean Water Act, the Endangered Species Act, the Federal Power Act, the Fish and Wildlife Coordination Act or any other applicable state or federal laws or regulations. However, by entering into this Agreement the Resource Agencies represent that they believe their statutory obligations are, or can be, met consistent with this Agreement.

H. Nothing in this Settlement Agreement shall be construed as binding the USFWS or NPS to expend in any one fiscal year any sum in excess of appropriations made by Congress or administratively allocated for the purpose of this Settlement Agreement for the fiscal year, or to involve USFWS or NPS in any contract or other obligation for the future expenditure of money in excess of such appropriations or allocations.

I. Nothing in this Agreement shall be interpreted to preclude or otherwise limit EPA from complying with its obligations under the Clean Water Act, Clean Air Act, and National Environmental Policy Act, or other federal statutes. Nothing herein shall preclude EPA or the States of New Hampshire and Vermont from fully and objectively considering all public comments received in any regulatory process related to the Project, from conducting an independent review of the Project under applicable statutes, or from providing comments to FERC.

J. The Connecticut River forms the boundary between the States of Vermont and New Hampshire along the historic low water line along the Vermont side. Consequently, this is a shared resource that lends itself to a coordinated approach by the two states with regard to compliance with state water quality standards. As of the date of this agreement, the States of Vermont and New Hampshire each believe that the Project as it would be operated under this Agreement complies with their respective water quality standards. The States of Vermont and New Hampshire intend for a single water quality certification to be issued for this Project by New Hampshire, consistent with this Agreement, and that being consistent with this Agreement, such certification will satisfy the interests of the State of Vermont. In the event that Vermont seeks to issue a 401 water quality certification for the Project independent of the New Hampshire water quality certificate, the Project Owner may withdraw from this Agreement and the Agreement shall be rendered null and void.

K. The parties have entered into the negotiations and discussions leading to this Settlement Agreement with the explicit understanding that to the fullest extent allowed by law, all offers of settlement and the discussions relating thereto are privileged, shall not prejudice the position of any party or participant taking part in such discussions and negotiations, and are not to be used by any entity in any manner, including admission into evidence, in connection with these or any other proceedings related to the subject matter of this Agreement

L. By entering into this Settlement Agreement, the Stakeholders shall not be considered to have accepted any legal liability related to the Project.

M. This Agreement shall be effective upon execution and shall remain in effect (unless terminated as otherwise provided herein) through the term of a new license for the Project issued in conformance with this Agreement and any subsequent annual licenses issued for the Project. However, many of the commitments made herein have other conditions precedent which must occur prior to their implementation. The Parties intend that this Agreement be filed with FERC as an Offer of Settlement in conjunction with the filing of the Application for New License for the Project.

N. This Agreement may be amended at any time with the unanimous consent of all parties for a period of 5 years after the Completion of Licensing and may be thereafter amended, after notice to all parties, with the consent of three fourths of the parties still in being, provided however, that no amendment will be effective which does not have the consent of the Project Owner and the State and Federal agencies.

III. Water Management

A. Water Management Protection, Mitigation and Enhancement Measures

1. Moore Development

a. Moore Reservoir Operation: Moore Reservoir elevations will be consistent with Historic Operation except as otherwise modified by the management constraints specified herein, including the provision of minimum flows. Moore's Historic Operation is defined by Attachment 1 which shows a frequency distribution of 20 years of weekly reservoir elevation data. The Maximum Operating Level of Moore Reservoir will be 809 MSL. In order to facilitate bass spawning (and other spring spawning fish) Moore will be operated to achieve an elevation of at least 802 MSL, with a target elevation of 804 MSL, by May 21 of each year. For the period from May 21 through June 30 the reservoir will not be drawn more than 2' below any elevation previously attained in said period.

b. Moore Dam Minimum Flows: A minimum flow of 320 CFS or inflow, if less than 320 CFS, will be provided from Moore Station throughout the year.

2. Comerford Development

a. Comerford Reservoir Operation: Comerford Reservoir elevations will be consistent with Historic Operation except as otherwise modified by the management constraints specified herein, including the provision of minimum flows. Comerford's Historic Operation is defined by Attachment 2. The Maximum Operating Level of Comerford Reservoir will be 650 MSL. In order to facilitate bass spawning (and other spring spawning fish) Comerford will be operated to achieve an elevation of at least 645 MSL, with a target elevation of 647 MSL, by May 21 of each year. For the period from May 21 through June 30 the reservoir will not be drawn more than 2' below any elevation previously attained in said period.

b. Comerford Dam Minimum Flows: Minimum flows will be provided from Comerford Station in accordance with the following schedule. All minimum flows at Comerford will be guaranteed from storage. The Project Owner will develop an operating plan addressing how reservoir storage will be utilized to provide guaranteed flows while minimizing the impact on the environment and public use. Said plan will be developed in consultation with USFWS, VANR, NHFGD, and NHDES and will be included in the license application.

818 CFS for the period of June 1 through September 30
1145 CFS for the period of October 1 through March 31
1635 CFS for the period of April 1 through May 31

3. McIndoes Development

a. McIndoes Reservoir Operation: McIndoes Reservoir will be operated with a normal Maximum Operating Level of 451 MSL. In cases where inflow exceeds the McIndoes Dam discharge capability the reservoir will surcharge. At elevation 451 MSL the Development discharge capability is estimated to be 30,600 CFS (station discharge and available spillway discharge). The reservoir may be drawn a maximum of 3.5' to a minimum operating elevation of 447.5 MSL

b. McIndoes Dam Minimum Flows: Minimum flows will be provided from McIndoes Station for the period from June 1 through March 31 in accordance with the following schedule. During this period inflow shall be defined as the sum of the applicable Comerford Station minimum flow and the Prorated Passumpsic Gage flow. Minimum flows will be:

1105 CFS or inflow, if less than 1105 CFS, for the period of June 1 through September 30; and

2210 CFS or inflow, if less than 2210 CFS, for the period of October 1 through March 31.

c. McIndoes Dam Spring Spawning and Incubation Flows: During the period from April 1 through May 31, a minimum flow of 4420 cfs or, inflow if less, shall be released from McIndoes Development. During this period inflow shall be defined as the sum of the applicable Comerford Station minimum flow and the Prorated Passumpsic Gage flow. If dry conditions are predicted to result in Moore and Comerford Reservoirs failing to fill by the end of the Spring runoff, the minimum flow below Comerford Development can be reduced to no less than 50% of the Dalton gage flow. In such an event, the corresponding minimum flow below McIndoes Development will be the sum of the Prorated Passumpsic Gage flow and no less than 50% of the Dalton gage flow. In order to preserve the flood control benefits of the Project, if the minimum flow at McIndoes is expected to contribute to flows in excess of 50,000 CFS at Bellows Falls or in excess of 10,000 CFS at Wilder, the minimum flow at McIndoes may be reduced to 2210 CFS. If future operational or structural changes at the downstream projects reduce the adverse impacts of flows at or above these levels, the need to restrict minimum flows at McIndoes under these circumstances will be reviewed.

d. McIndoes Dam Maximum Flows: In the period from 6/1 through 2/28 the maximum discharge from McIndoes shall not exceed 5800 CFS for more than 7% of the hours during the period. This restriction shall not apply if Moore and Comerford reservoirs are at their Maximum Operating Limit, or when the sum of the Prorated Passumpsic Gage and Dalton gages exceeds 8000 CFS. There is no restriction on McIndoes maximum discharge during the months of March, April and

May.

B. General Water Management Considerations

1. Emergency Conditions - The parties recognize that the Project's operation is often dictated by the size and frequency of natural precipitation events and the timing and distribution of seasonal runoff. The parties have addressed flood and drought conditions at least in part by including the special operating conditions in Section III.A.3. Occasionally, emergency conditions beyond the control of the Project Owner including but not limited to anticipation of, or the occurrence of extreme runoff events, or droughts, ice conditions, equipment failure or flood storage requirements may result in conditions such that the operational restrictions and requirements contained herein are impossible to achieve or are inconsistent with the prudent and safe operation of the Project. Under such extreme conditions operation at variance with the commitments made in this Section shall not be deemed to violate the Settlement Agreement. This section shall not be interpreted as providing the Project Owner broader authorization to operate at variance with the requirements provided herein than is provided for in the FERC license issued pursuant to this Agreement.

The Project Owner shall notify USFWS, VANR, NHFGD, and NHDES as soon as practical of such an emergency event and shall prepare and provide each agency a report of each incident, identifying the variances from normal operations that occurred, and identifying ways of avoiding future occurrences.

IV. Upper Connecticut River Mitigation and Enhancement Fund

A Fund established.

An Upper Connecticut River Mitigation and Enhancement Fund (the "Fund") will be established by the States of New Hampshire and Vermont or by their designee (e.g. the Northern New Hampshire Foundation of the New Hampshire Charitable Foundation). The Project Owner will contribute money to the fund in accordance with the following schedule. Contributions shall be nonrefundable once made by the Project Owner in accordance with the following schedule. Except as otherwise noted, all dollar amounts in the following schedule will be in 1997 dollars and will be adjusted for inflation.

1 Within 120 days of the Completion of Licensing, the Project Owner will

contribute a one-time initial payment of $3,000,000 to the Fund.

2. Each year thereafter for the duration specified herein, within 180 days after the close of the Project Owner's fiscal year, an annual contribution to the Fund will be made in the amount of the greater of $100,000 or 10% of the gross revenues of the Project over a Base Amount. The Project gross revenues, for purposes of this Agreement will be determined by using Clearing Price Indices established by ISO New England or its successor entity. The Project Owner shall apply those indices to hourly accounting of energy actually generated at the Project during each fiscal year, and to all products and services generated by the Project which are sold, traded, exchanged or otherwise involved in a transaction during each fiscal year. The Base Amount shall be $14,000,000.

3 These annual contributions shall continue until the total amount of annual contributions (not including the initial contribution of $3,000,000) equals $13,500,000 or for fifteen years from the Completion of Licensing, whichever occurs first . In the event that upon the fifteenth year the total amount of annual contributions amounts to less than $7,500,000, then annual contributions (calculated as set out in subparagraph 2 above) shall continue to be made until the total amount of all annual contributions reaches $7,500,000.

4. If, at the end of the new license term, the total amount of all annual contributions is less than $7,500,000, then a one time contribution in the amount of the difference between the total amount of all annual contributions and $7,500,000 shall be made.

If at the end of the new license term, contributions and any accrued interest and dividends remain unexpended, they will be retained in the Upper Connecticut River Mitigation and Enhancement Fund and may be expended for the purposes and in the manner set forth herein.

B. Purposes and Uses of the Fund

The Fund shall be used for the following purposes in the Upper Connecticut River Watershed (the Connecticut River Watershed north of the confluence of the White River but may include the White River Watershed in situations deemed to have exceptional environmental benefits not available in the Upper Connecticut River Watershed):

Funding Project conservation easement establishment, monitoring and enforcement (See Section V). (up to $500,000 from the initial $3,000,000 payment to the fund) These funds will go to surveying the properties involved, conducting whatever legal work is necessary, and setting up an endowment to pay for ongoing monitoring and enforcement of the terms of the easements.

The remainder of the initial $3,000,000 payment and the annual contributions shall be allocated to the following purposes in the percentages shown:

2. River restoration work including but not limited to the following work on the Upper Connecticut River Watershed (50% of the funds available):

   Dam removal/acquisition of development rights and property;
   Fish passage at nonhydro dams, unlicensed hydro facilities, and natural obstructions; and
   Other riverine habitat improvements, including water quality improvements or improvements in aquatic habitats.

   River restoration projects shall be targeted to developing premier salmonid fisheries; increasing and improving habitat for resident salmonids and Atlantic salmon (e.g., improving the structure of fish habitats, water temperatures and other similar measures); providing improved passage for migratory aquatic species; increasing or improving habitat for riverine dependent species; and improving water quality including reducing sedimentation and nonpoint source pollution.

3 Restoration, protection, and enhancement of wetlands and adjacent protective buffer areas. (20% of the funds available) The goal is to restore or enhance an amount of wetlands outside of the project area (both upstream and downstream) to compensate for the wetlands either lost or adversely affected as a result of the project. If sufficient wetland values cannot be compensated for through restoration or enhancement, wetlands and their protective buffer areas may be acquired by outright purchase or protected through perpetual easements.

4. Riverine shoreland protection by restoring naturalized buffers along the river and/or streams in the drainage and stabilizing eroding shorelands both up and downstream of the FMF project area, to reduce water quality problems and serve other purposes, such as establishing or maintaining riparian wildlife habitat and wildlife travel corridors. (20% of the funds available) Funds may be used to acquire, establish and protect riparian corridors and to implement

measures to reduce shoreline erosion in such corridors. The emphasis in these latter efforts shall be maintaining or re-establishing forested shoreland buffers and on bioengineering rather than structural solutions to shoreline stabilization. This category also includes protecting unique or unusual natural areas, and areas of cultural significance including historic and archaeological resources where they occur in riverine shorelands and important recreation lands and scenic features.

5 Mitigate tax revenue impacts in the communities where lands in the Upper Connecticut Valley to be covered by conservation easements pursuant to this Agreement are located. (10% of the funds available) These funds are to be allocated in equitable proportions to be determined by the above towns with the assistance of the regional planning commissions, who shall act as the final arbiters before the dispersal of these funds. These funds are expressly not intended to compensate these municipalities for the impact of re-evaluation of the Project Owner's other properties (e.g. the power generation and transmission facilities) whose value is being reduced by matters unrelated to this settlement (e.g. changes in energy prices) and the restructuring of the electric utilities industry.

Consistent with these purposes, these funds are intended to be used to contribute to fulfillment of regional resource management goals, plans, and priorities as articulated by the responsible agencies.

The fund is expressly not intended to be used to defray the Project Owner's costs in conducting and implementing the resource studies, and management plans called for in section VI herein, unless otherwise agreed to by all Parties.

C. Fund Administration

1 Use of Funds. Decisions on the use of the Fund, including any accrued interest or dividends (excepting that portion identified in Section IV.B.5 which may be used by the receiving towns as they see fit) will be made by a committee of resource agencies, regional and local interests, nongovernmental organizations, and the Project Owner ("Committee"). The Committee shall develop bylaws governing its function. The Committee may solicit proposals from nonprofit organizations, educational institutions, units of government, and officially appointed commissions within or serving New Hampshire or Vermont for projects which address any of the above purposes, and may target a specified

portion of the funds to specific protection, mitigation or enhancement objectives or to specific areas which are encompassed within the purposes and geographic scope defined above.

2. Membership. The Committee shall be comprised of twelve members, including a representative or designee of The Project Owner, plus one representative from each of the following: USFWS, NPS, VANR, a NH resource agency (to be rotated between the NHFGD and the NHDES, an Historic Preservation Agency (to be rotated between the NH and VT Historic Preservation Agencies), the North Country Council, the Northeastern Vermont Development Association, the Connecticut River Joint Commissions, the AMC, the CRWC, and TU.

V. Watershed Land Protection

A. Conservation Easements

1. **Lands Included**: Within one year of the Completion of Licensing, The Project Owner agrees to take the steps necessary to implement and subsequently, to donate permanent conservation easements on the following land holdings in the upper Connecticut River Basin (the basin in N.H. and VT);

   a. Lands within the Fifteen Mile Falls Project Boundary, estimated to be approx. 4000 acres;

   b. Non-Project Lands contiguous to the Fifteen Mile Falls Project Boundary not used for or reserved for transmission system purposes, estimated to be approx. 4200 acres. (As part of the process of divesting the generation business, The Project Owner is in the process of identifying the land used for or reserved for transmission purposes that will be retained by New England Power Company. These lands will not be part of the sale of the generation business.)

   These lands are shown for illustrative purposes on the map attached hereto as Attachments 3. The Project Owner further agrees to continue the existing lands management programs and not allow any development or use inconsistent with this Section for the period from the execution of this Agreement until said conservation easements are implemented.

2. **Purposes and Uses:** Consistent with the continued use of these lands for electric generation and transmission purposes, these easements shall:

a. maintain these lands as undeveloped;

b. ensure the management of the lands according to a wildlife and forestry management plan, which is developed in consultation with the New Hampshire, Vermont, and federal fish and wildlife management agencies;

c. ensure the protection and management of areas containing rare, unusual and culturally significant plants and plant communities for their maintenance and perpetuation;

d. prescribe conditions and standards for management of lands (by the Project Owner, or any lessee of its lands) to prevent and control erosion and sedimentation, to control nonpoint sources of pollution to the reservoirs and Connecticut River, and for maintenance of buffer strips along reservoir, Connecticut River and tributary shorelines;

e. maintain public access for traditional recreational uses such as hunting and fishing and other forms of recreation where this is compatible with other resource management goals; and

f. ensure the protection and management of areas containing unusual natural features, cultural, historic, and archaeological resources.

The purpose of the easements is to protect the scenic, forestry, and natural resources values of the lands from uses which would conflict with the conservation of these resources. The restrictions would allow for continued use of the property for forestry, educational uses, low impact public recreation, including hunting, fishing and trapping, open space, and electric transmission and generation purposes. Consistent with the management plans to be developed pursuant to this Agreement, the easements would also allow for the continuation of existing leases for agricultural uses which are not detrimental to the scenic, recreational, or wildlife habitat values of the surrounding area, and which utilize agricultural practices which control erosion and otherwise protect the water quality of adjacent rivers and streams. Guidelines for forestry and agricultural activities are attached as Appendix A. Subdivision of the property would not be allowed except when necessary to carry out the aforementioned purposes and only when consistent with the intent of the easements including maintaining forestry productivity and preventing fragmentation of wildlife habitat. The Project Owner will work to minimize, to the extent practicable, conflicts between the use of the restricted lands for generation and transmission purposes and the goals for which the easements were established. By allowing for the use of the restricted lands for generation and transmission purposes, the Stakeholders take no position as to whether any specific project would be appropriately located on the restricted lands.

The lands would be managed under a timber management program in accordance with the following goals: protection of riparian zones along rivers and reservoirs, protection of visual quality within important public view sheds and along trail corridors, protection of fragile or highly erodible soils and prevention of excessive nutrient depletion of low productivity soils, avoid clear cutting whenever possible while maintaining the health, vigor and values of the forest as determined in the management plans, minimizing interference with low impact recreational use and enjoyment, and preservation of wildlife habitat. The Project Owner agrees to develop and implement a forest management plan consistent with guidelines attached in Appendix A.

3. **Easement Holder**: These easements will be donated to a qualified land conservation organization(s) to provide for the continued preservation of these lands in a natural state. The easement holder(s) shall be selected by majority vote of a committee composed of a representative from the Connecticut River Joint Commission, VANR, NH Department of Resources and Economic Development, USFWS, NPS, the North Country Council, the Northeastern Vermont Development Association, the AMC, the CRWC and TU. The easement holder also must be acceptable to the Project Owner, in its sole discretion. The intent in selecting the easement holder(s) is to consolidate the holdings and management of the easements as much as

possible.

The holder(s) of the easements shall not transfer the easements if any of the above named selection committee members or the Project Owner objects. Any member may in its sole discretion object to said transfer.

4. **Exclusions and Exceptions:** The easement holder(s) may choose to exclude any lands from the easement which are not suited for the conservation purposes specified (e.g. already developed lands) or lands which may present a liability exposure (e.g. contaminated areas).

   With the Project Owner's concurrence, the easement holder may permit the use or development of specific parcels for a public purpose which is consistent with the management objectives of the parcel as defined by the management plans prepared pursuant to Section VI of this Agreement, if applicable. If the specific parcels are not covered by the management plans prepared pursuant to Section VI, then the easement holder may permit the use or development of such parcels for a public purpose which is consistent with the management objectives of a similarly prepared plan approved by the committee identified in V.A.3.

5. **Funding for Easement Monitoring:** The Upper Connecticut River Mitigation and Enhancement Fund will support all costs associated with the Easement Holder's activities in establishing, monitoring and enforcement of these easements.

B. Donation of Sumner Falls

The Project Owner agrees that upon Completion of Licensing to expediently donate for conservation and recreation purposes, its land known as Sumner Falls located in Hartland, VT and Plainfield, NH to the USFWS, or other suitable grantee, selected by the committee created in Section V.A.3.

VI. Studies and Management Plans

The parties agree that the studies and plans provided for in this section will provide the necessary biological and ecological information to complete the application for a new license for the Project and that barring extraordinary results, that additional studies will not be needed and will not be requested.

The studies, plans and mitigation measures to be performed pursuant to this section shall not be financed through the Upper Connecticut Valley Mitigation and River Enhancement Fund, but shall be the Project Owner's sole obligation. The Project Owner shall develop and implement measures over which they have control, necessary to address the issues identified in the specific study and necessary to comply with applicable laws and requirements, along with a schedule for implementation of such plans. Such plans and schedule shall be mutually agreed to by the Project Owner and the appropriate parties. The Project Owner has estimated the costs of the studies , plans and mitigation measures to be about $3,000,000 (in 1997 dollars, adjusted for inflation), excepting costs associated with implementing fish passage. Costs, excepting fish passage implementation costs, substantially in excess of this amount may trigger the Project Owner's right to withdraw from the Agreement pursuant to Section VII.C.

A. Water Quality

1. Effects of discharges - In preparing the license application, The Project Owner will conduct a study of effects on downstream fish and aquatic life from dissolved gas, turbidity and temperature conditions in flow discharges from project generation facilities. This study shall be prepared in consultation with state and federal fishery and water quality agencies and will identify any measures needed to comply with applicable regulations and requirements. The Project Owner will incorporate an implementation plan for any such measures in the license application.

2. Oxygen depletion in hypolimnetic waters - In preparing the license application, the Project Owner will conduct a study of the causes of oxygen depletion in the deep water portions of the project impoundments. The study and an analysis and evaluation of mitigation alternatives shall be included in the license application.

3. Toxins - In preparing the license application, the Project Owner will conduct a study of the mercury levels in fish present in the reservoirs, and an assessment, based on other similar research being conducted in New England, of whether the projects are contributing to higher mercury levels in the biota of the reservoirs. If so, the Project Owner shall evaluate and implement cost justified, reasonable options for mitigating for this impact. The study and mitigation plan shall be included in the license application.

B. Fisheries Mitigation and Enhancement

1. Fisheries Management Plan - In preparing the license application, the Project Owner will develop and propose in the application to implement a plan for the protection, enhancement and management of fish populations in project impoundments, tailraces and riverine areas. This plan shall address, among other topics, tributary access for spawning fish during impoundment drawdowns and a schedule for implementation. The implementation plan shall include a structural enhancement plan for the Moore and Comerford tailwaters designed to capitalize as fully as possible on the salmonid potential of these areas by providing suitable habitat. Planning to achieve these goals will give consideration to both the fisheries resource and hydropower production. Any plans resulting from this section shall be prepared in consultation with the USFWS, VANR, NHFGD, and TU.

2. Downstream Fish Passage - The Project Owner will provide downstream fish passage developed in consultation with state and federal fishery agencies and the Connecticut River Atlantic Salmon Commission (CRASC) at McIndoes within 2 years of the Completion of Licensing. Facilities will be designed in consultation with the USFWS, VANR, and NHFGD and approved designs will be included in the license application. The Project Owner will also conduct an assessment, acceptable to the state and federal fisheries agencies, of Atlantic salmon smolt migration through the Moore and Comerford impoundments. Said assessment shall be included in the license application. If an Atlantic salmon stocking program is undertaken upstream from Moore and Comerford, the Project Owner shall provide for downstream passage measures at Moore and Comerford acceptable to state and federal fisheries agencies within two years after being notified by the agencies that such passage is needed.

3. Upstream Fish Passage - The Project Owner will provide upstream fish passage at McIndoes when 20 Atlantic salmon migrating upstream reach the Ryegate Dam for two consecutive years and CRASC and the fishery agencies duly finds that the need for upstream passage is justified, or at a later date if so determined by CRASC and fisheries agencies. At the discretion of CRASC and the fisheries agencies, the passage may consist of facilities located at McIndoes Dam or participation in trap and truck facility construction and operation at East Ryegate Dam. At this same time The Project Owner will, if so directed by the CRASC and fisheries agencies, install a fish trap at the base of the Comerford Dam and operate a trap & truck operation. Atlantic Salmon

caught in this trap will be trucked to a destination or destinations specified by the fishery agencies so long as such destination is legally authorized. This plan and schedule may be modified upon agreement between the USFWS, VANR, NHFGD and CRASC and the Project Owner. Designs of passage measures will be developed in consultation with the fishery agencies.

4. American Eel Passage - The Project Owner agrees to initiate consultation on the issue of passage for American eels at the project dams upon a duly made finding by the USFWS, VANR and NHFGD that such passage is necessary. Within 1 year of such a finding, the Project Owner agrees to develop plans for upstream and downstream eel passage measures or plans for studies to address eel passage at the project, and a schedule to implement the proposed measures or studies. The passage measures and/or studies will be developed in consultation with the fishery agencies. The measures or studies will be implemented according to a schedule agreed to with the fishery agencies.

5. Flow Evaluation - In preparing the license application, the Project Owner will prepare a flow/habitat study to assess the habitat that will be available under the proposed flow regime below Comerford and below McIndoes. The study will be prepared in consultation with USFWS, VANR and NHFGD.

C. Wildlife Management

Wildlife and Forest Management Plan - In preparing the license application, the Project Owner will develop and subsequently implement a plan for the management of timber resources and the protection, enhancement and management of wildlife resources and habitats for its lands either wholly or partially within the project's boundaries. The plan shall coordinate with the management of other lands, near the Project but wholly outside of the Project boundary, that will also become subject to a permanent conservation easement under Section V of this Agreement. The plan shall address the following concerns:

pesticide and herbicide use;
restoration of riverside forests within the Project;
timber management practices to benefit wildlife and protect other important resources;
protection and management of deer wintering areas;

evaluation of the need for and provision of osprey nesting platforms around the FMF impoundments, if appropriate;
evaluation of the need for and provision of loon nesting platforms around the FMF impoundments, if appropriate;
evaluation of the need for and provision of wood duck boxes around the FMF impoundments, if appropriate;
evaluation of and implementation of measures to protect the turtle nesting area in the Comerford development at an abandoned sand pit near the Pine Grove recreation area;
plans to prevent nonnative nuisance species from being introduced to the Project lands and waters
a schedule for implementation

This plan shall be prepared in consultation with the VANR, NHFGD, USFWS and private organizations, if appropriate, such as the NH Loon Preservation Committee, the NH Audubon Society and the VT Institute of Natural Science

2. Wetlands - In preparing the license application, the Project Owner will complete a study evaluating the impacts of Project operations on wetlands and littoral zone communities, including the expected wetlands impacts of the modified operating level at McIndoes Reservoir. The study will be conducted in consultation with USFWS, VANR and NHFGD.

D. Rare and Unusual Plants and Plant Communities

1. Rare and Unusual Plant/Plant Community Management Plan - Within two years of the Completion of Licensing, the Project Owner will conduct an inventory of medicinal plants and other plants of cultural significance to Native Americans, and any other rare and unusual plants or plant communities not adequately covered by existing inventories; and shall develop and subsequently implement a plan for the protection, enhancement, and management of rare and unusual plants and plant communities for its lands either wholly or partially within the Project boundaries. This plan shall be prepared in consultation with the USFWS, the nongame heritage programs of both NH and VT, and the NH and VT chapters of The Nature Conservancy and shall contain a schedule for implementation.

The plan shall specifically address the protection of the following rare plant habitats and communities, most of which are presently protected under an existing agreement between the Project Owner and The Nature Conservancy.

This agreement will be assumed by the future owner of the Project.

1. At Nine Islands(above McIndoes Falls Dam): a rare floodplain forest community located near the mouth of the Passumpsic River; this is one of the best examples of this forest type found in Vermont and New Hampshire.

2. The wooded slope downstream of the Moore Dam, a high quality example of rich northern hardwood forest containing abundant uncommon wildflowers and a seep with calcareous rich soils from the limestone bedrock (includes Wild Leek (Allium triccum), Grass-of-parassus (Parassia glauca) and Variegated Horsetail (Equisetum variegatum)).

3. On the east side of the river adjacent to the Comerford Dam tailrace area: a natural "Northern New England Calcareous Seep and Fen", including Equisetum variegatum, scattered Northern White Cedar (Thuja occidentalis), Showy Lady's-slipper (Cypridedium reginae), Shining Ladies' - tresses (Spiranthes lucida), Grass-of-parassus (Parassia glauca), Sticky False asphodel (Tofieldia glutinosa) and Kalm's Lobelia (Lobelia kalmii).

4. At the northern end of the east side of the Comerford tailrace area, on a hillside under the power lines: a small, very steep hillside seep, saturated with calcareous groundwater, managed by New England Power, including the indicator species Grass-of-parassus (Parassia glauca).

5. On the west side of the river below Comerford: "New England Riverside Seep Community" including Neglected Drop-seed (Sporobolus neglectus), Variegated Horsetail (Equisetum variegatum), Dwarf Ragwort (Scenecio pauperculus), Golden Sedge (Carex aurea) and Garber's Sedge (Carex garberi).

6. Below Comerford Dam at the ledges along the shore line near the mouth of the Passumpsic River: a population of Bog Wintergreen (Pyrola asarifolia), a state threatened species.

7. A small isolated area on the northwest shore of Moore with the structure and characteristics of old growth forest.

8. At Nine Islands, Round or Indian Island which has the largest superstory pines in the FMF area.

E. Threatened and Endangered Animal and Plant Species or Plant Communities

1 Management Plan for Threatened and Endangered Species - In

preparing the license application, the Project Owner will inventory the habitat for and occurrence of threatened and endangered species located on the lands within the Project boundaries. The Project Owner will develop a plan, including implementation schedule for the protection, enhancement, and management of threatened and endangered animal and plant species or plant communities affected by the project or located on Project lands. This plan shall be prepared in consultation with the USFWS and the nongame heritage programs of both NH and VT, and must comply with the provisions of the Endangered Species Act and applicable state statutes and regulations.

The plan shall specifically address the following issues:

a.) Assess whether or not the dwarf wedge mussel occurs within the project and whether it is affected by project operations.

b.) Protect superstory white pines and buffer areas around the pines as potential nesting sites for bald eagles.

c.) Assess the need and feasibility to construct an eagle nest or nests on Moore reservoir.

F. Recreational Use

1. Recreational Facilities and Management Plan - In preparing the license application, the Project Owner will develop a recreational management plan. The plan will include a schedule for implementation. The plan shall cover:

New or improved facilities (if needed) and other recreational opportunities including but not limited to:

- Car top boat access to the McIndoes impoundment;
- Facilities needed for multi-day canoe trips with portages at all dams and with specially designated camp sites for through paddlers with permits;
- Improved bank angler access;
- Development of more hiking trails, including possibly the use of the old railroad bed below Comerford for a trail;
- Facilities and opportunities for site and resource interpretation/education;

Improved tourism opportunities including environmental and heritage tourism; and
Other facilities which while consistent with the management polices specified below would encourage tourism in the region.

Improved safety provisions (if needed) including but not limited to:

- Angler safety at and below tailraces;
- Management of trails/safety warnings for snowmobiles; and
- Compliance with ADA.

Plans for operations and maintenance.
A schedule for all improvements planned.

This plan shall be prepared in consultation with the NPS, the regional planning commissions serving this area, the NH Department of Resources and Economic Development, the NHFGD, VANR, the AMC, the CRJC, the CRWC and TU .

2. Recreation Management Policies - The plan shall be prepared consistent with the following policies:

Management of the area will maintain its existing undeveloped character and the natural resources as well as the character and quality of recreational experiences available to visitors. Consistent with this overarching goal management will:

Provide free access to project waters for low impact, passive, nonfacility use, recreation and hunting;
Allow for through passage for canoeists and kayakers;
Provide facilities and management which assure low-impact use, protection of wildlife values and the area's remote character, and discourage uses such as marinas which would disrupt the existing character and use of the area; and
Promote and encourage tourism opportunities relating to the natural, environmental, and historic values of the project.

G. Cultural Resources

1. Cultural Resources Management Plan - In issuing a new license for the

Project FERC is obligated to comply with Section 106 of the National Historic Preservation Act and 36 CFR 800, regulations developed by the Advisory Council on Historic Preservation to implement Section 106. FERC is expected to accomplish this through use of a Programmatic Agreement and by requiring as a license condition that a Cultural Resources Management Plan be developed. The Project Owner will develop and implement a Cultural Resources Management Plan to reasonably inventory, evaluate, consider, maintain and protect cultural, historic, and archaeological resources eligible for inclusion in the National Register of Historic Places. The Plan should include but not be limited to the following issues and concerns:

- Phase IA studies and cultural resource management plans for all lands within the project boundaries;

- Contingency plans to mitigate burial sites that are found to be disturbed by Project operations;

- Identification of areas of archaeological or historical significance within the project boundary that are being affected by erosion, and development and implementation of short and long-term streambank stabilization and protection program for these areas; and

- Ongoing monitoring of archaeologically sensitive areas for erosion.

VII. Approval of the Settlement, Dispute Resolution and Termination of Agreement

A. The parties have entered into and will jointly submit this Settlement Agreement with the express condition that FERC approves and accepts all provisions herein and issues a new project license in conformance with the terms of the Settlement Agreement. In the event that FERC changes, conditions, modifies, or supplements any provision contained herein in its order issuing a new license, whether through its own action or through incorporation of conditions of a §401 Water Quality Certification, the Settlement Agreement shall be considered modified to conform to the FERC order unless any party to the Settlement Agreement within 30 days of FERC's action provides written notice by certified mail to the other parties that it is withdrawing from the Settlement because of the modification, change, or condition. The parties will then work to resolve the issue through the dispute resolution process described in Section VII.D, below. During this process a party may seek rehearing on the FERC action to meet the FERC procedural time limits; however, the Request for Rehearing shall be withdrawn if agreement is reached on modifying the Settlement.

B. In the event that any study required by Section VI documents or predicts that operation of the Project in accordance with Section III (Water Management) will cause environmental impacts which are not mitigated by this Agreement and/or which result in noncompliance with the Clean Water Act or the applicable Water Quality Standards, the affected state and/or federal agencies may withdraw from this Agreement.

C. The Project Owner has estimated that the costs of studies to be performed under Section VI, and costs of implementation (with the exception of fish passage implementation) of resulting mitigation to be about $3,000,000 (in 1997 dollars, adjusted for inflation). In the event any study required by Section VI requires the imposition of additional or modified conditions on the Project that would result in material additional costs, or revenue reductions, beyond what is expected under this Agreement, the Project Owner may withdraw from this Agreement and it shall become null and void.

D. No party may exercise its right to withdraw pursuant to paragraphs A, B or C of this section, nor shall any party seek to modify the license issued for the Project pursuant to this Agreement through use of a license reopener, unless such party:

has attempted to reach consensus with the other parties by engaging in good faith negotiations for a period of at least 60 days, with a minimum of two meetings to be held during the 60 day period; and

b. in the event the negotiations fail, has attempted to reach consensus with the other parties through a nonbinding alternative dispute resolution (ADR) process. The ADR process shall utilize a neutral mediator to be jointly selected by the parties, and shall run for no less than 60 days.

E. If any appeal, petition for rehearing, or other form of appellate review is filed by an entity other than the Project Owner against a new Project license, the water quality certification, or other such license or action involving a new Project license, with the purpose of preventing the issuance of a new Project license containing terms consistent with this Agreement, the Project Owner may deduct up to 50% of its reasonable and verifiable costs of litigation defending this Agreement from future payments to be made to the Upper Connecticut Valley Mitigation and Enhancement Fund, provided the following: (1) no such costs shall be deducted from the one time initial payment of $3 million to the Fund; (2) no more than $50,000 may be deducted from annual Fund payments in any given year; and (3) no more than a total of $250,000 may be deducted from Fund payments pursuant to this provision over the license term.

F. If pursuant to the terms of the Agreement a party withdraws from the Settlement, the party shall not be bound by any provision contained herein except those provisions limiting the use of the Settlement materials. If a party withdraws the Project Owner may at its option choose to let the Settlement stand and the Project Owner and the remaining parties shall continue to be bound by the terms of the Settlement, or the Project Owner may choose to withdraw from the Settlement. If the Project Owner withdraws from the Settlement, the Settlement will be deemed null and void and neither the Project Owner nor any party shall be bound by the terms contained herein, except those provisions limiting the use of Settlement materials.

G. In the event that the Settlement is withdrawn, to the fullest extent allowed by law, the Settlement, and all drafts, work papers, and notes related to its development shall be deemed settlement materials and shall not constitute a part of the record in any proceeding, nor be admissible into evidence in any proceeding related to the subject matter of this Agreement. Notwithstanding, this provision shall not preclude the use of the studies prepared pursuant to Section VI (and the accompanying consultation record, if any) from being used in the relicensing process for the Project.

H. Notwithstanding any other provision of this Agreement, any party may seek relief in any appropriate forum for noncompliance with this Agreement by any party hereto.

Intending to be legally bound, the parties have executed this Agreement through their duly authorized representatives.

New England Power Company
John W. Rowe
Chairman

New England Power Company
Lawrence E. Bailey
Vice President, Generation Operations

State of New Hampshire
Jeanne Shaheen
Governor of New Hampshire

State of Vermont
Howard Dean, M.D.
Governor of Vermont

New Hampshire Fish and
Game Department

Wayne E Vetter

WAyne E. Vetter
Exc. Director

Vermont Agency of
Natural Resources

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Barbara Ripley
Secretary

New Hampshire Department of
Environmental Services
New Hampshire Water Resources
Council

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Robert Varney
Chairman of the Council

United States Fish and
Wildlife Service

Ronald E. Lambertson

Ronald E. Lambertson
Regional Director, Northeast Region

United States Environmental
Protection Agency

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John DeVillars
Regional Administrator
EPA - New England

National Park Service

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Marie Rust
Field Director

Appalachian Mountain Club

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Connecticut River Joint
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New Hampshire Fish and
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New Hampshire Department of
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Robert W. Varney
Commissioner

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Chairman of the Council

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To Mark Slade	From K. Mendik
Co./Dept. NEP	Co. NPS
Phone # 2859	Phone # 6172235299
Fax # 508 389 2463	Fax # 5164

United States Fish and
Wildlife Service

United States Environmental
Protection Agency

Ronald E. Lambertson
Regional Director, Northeast Region

John DeVillars
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for Marie Rust
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Appalachian Mountain Club

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New Hampshire Fish and
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Marie Rust
Field Director

Appalachian Mountain Club

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WATER S. GRAFF
DEPUTY DIRECTOR

Connecticut River Joint
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Regional Administrator
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Marie Rust
Field Director

Appalachian Mountain Club

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Connecticut River Joint
Commissions

COMMISSIONER, CHAIR FMF COM

Connecticut River Watershed Council

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Tom Miner, Executive Director

New Hampshire Rivers Council

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North Country Council

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Northeastern Vermont Development Association

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New Hampshire Council of Trout Unlimited

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Connecticut River Watershed Council

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New Hampshire Rivers Council

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North Country Council

[signature]

EXECUTIVE DIRECTOR

Northeastern Vermont
Development Association

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New Hampshire Council of Trout Unlimited

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Connecticut River Watershed Council

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New Hampshire Rivers Council

George [signature]

TREASURER

North Country Council

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Northeastern Vermont Development Association

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New Hampshire Council of Trout Unlimited

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Connecticut River Watershed Council

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New Hampshire Rivers Council

North Country Council

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Northeastern Vermont
Development Association

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Kevin W. Geiger

New Hampshire Council of Trout Unlimited

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Connecticut River Watershed Council

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New Hampshire Rivers Council

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North Country Council

Northeastern Vermont
Development Association

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New Hampshire Council of Trout Unlimited

Dayton Goudie

DAYTON GOUDIE

COUNCIL REPRESENTATIVE

Final FMF Settlement Agreement
August 6, 1997

The undersigned entity concurs with and endorses the Fifteen Mile Falls Settlement Agreement, and seeking to lend its support to the timely implementation of the Settlement Agreement and to thereby share in the benefits the Agreement will provide, agrees to be bound by its terms.

Stanley Swain

TROUT UNLIMITED VERMONT

Date: 8 / 12 1997

Final FMF Settlement Agreement
August 6, 1997

The undersigned entity concurs with and endorses the Fifteen Mile Falls Settlement Agreement, and seeking to lend its support to the timely implementation of the Settlement Agreement and to thereby share in the benefits the Agreement will provide, agrees to be bound by its terms.

Conservation Law Foundation, by its
Attorney, Stephen L. Saltonstall

Date: 9/2/97

Appendix A:

Guidelines for Forestry and Agricultural Management Plans

FORESTRY

Forestry shall be performed, to the extent reasonably practicable, in accordance with the following goals, and in a manner not detrimental to the purposes of this Easement.

protection of fragile or highly erodible soils and maintenance of soil productivity;
protection of water quality, wetlands, and riparian zones;
appropriate application of the clearcutting reproduction method;
maintenance or improvement of the overall quality of forest products;
conservation of scenic quality;
protection of unique or fragile natural areas;
protection of unique or historic and cultural features; and
conservation of native plant and animal species.

The intent is to allow forest management operations while ensuring that lands critical to maintaining aquatic and terrestrial wildlife habitat, recreational experiences, and long-term forest productivity are protected.

Forestry on the property shall be performed in accordance with written comprehensive forest management plans prepared by licensed professional foresters or other qualified persons. The plan shall include a statement of landowner objectives and shall specifically address the long-term protection of those values for which this easement is granted, as specified in the guidelines herewith. Said plans shall have been prepared not more than ten years prior to the date any harvesting is expected to commence. Grantor shall provide Grantee for review, copies of management plans as they are prepared or revised. Timber harvesting shall be conducted in accordance with said management plans. At least thirty (30) days prior to harvesting, Grantor shall submit a written certification to the Grantee, signed by a licensed professional forester or other qualified person that the harvesting complies with the terms of these Guidelines. Timber harvesting shall be supervised by a licensed professional forester or other qualified person.

Management Provisions
The forested lands covered by this agreement will be managed with the following provisions:

Riparian Protection

- Riparian management zones will be established along streams, ponds, and non-forested wetlands as follows:
  - 600' along both sides of 4th Order and greater rivers.
  - 300' along both sides of 3rd Order rivers and along shores of ponds and non-forested wetlands greater than 10 acres in size.
  - 100' along both sides of 1st and 2nd Order streams and along shores of

ponds and non-forested wetlands less than 10 acres in size.

Zones should be expanded as necessary to encompass all vegetative communities subject to flooding, slopes greater than 35%, or soils classified as highly erodible that are adjacent to the water body or wetland.

These zones may be adjusted as appropriate to utilize natural topographic breaks or other features as boundaries.

- Management within these zones shall be as follows:

  Within the larger management zones (300'+), no harvest will take place within 100' of the shoreline of the river or lake, or within 25' of the non-forested wetland, along which the zone is established. Management within the remainder of these zones will utilize an uneven-aged system that maintains a residual stand with 70% crown closure or B-line stocking as recommended in silvicultural guides. Canopy openings shall be limited to 1/4 acre or less except in areas dominated by Spruce/Fir in which openings will be limited to 1 acre or less. New truck roads and log landings should be located outside of riparian management zones except where doing so will result in greater overall impact, except when the property boundary limits ability to place road or landings outside this zone or greater environmental impact would result.

Visual Aesthetics

- Stands that are within the viewshed of major public use areas (rivers, lakes, hiking trails, and highways) shall be managed, to the extent possible, so as to minimize visual degradation and maintain aesthetic quality.

Soil Erosion

- All operations shall follow guidelines outlined in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* (1996 revision), or similar successor publications.
- No harvesting will be performed on any SCS-classified histosols (bog soils).
- For soils listed by SCS as having severe equipment limitations due to wetness (i.e., poorly drained soils) and soils rated severe for erosion hazard , harvesting shall be limited to winter periods when the soil is frozen or utilizing a suitable alternative harvesting method and plan which prevents erosion.

Site Productivity, Nutrient Depletion

- For stands in which the site indices (SI) for existing desirable and management species are below SI-40, no whole-tree harvesting will be allowed.
- For stands in which the site indices for existing desirable and management species are between SI-40 and SI-60, whole-tree harvesting will be limited to partial cuts removing no more than 50% of the basal area over any 10-year period and designed to leave a well-distributed stand of trees.

All dead woody debris (both standing and down) shall be left on-site. The following exceptions are recognized: 1) The salvage of merchantable dead material resulting from fire, insect outbreak, large-scale windthrow, or other major disturbances; 2) The removal of dead material for firewood or other purposes on an individual non-commercial basis.

Clearcutting

- Clearcuts will be limited to a maximum of 20 acres in size for stem-only harvests and 10 acres for whole-tree harvests.
- Areas meeting the definition of a clearcut shall at no time occupy more than 10% of the total area under conservation easement. No more than 25% of any management block shall be clearcut over any 20 year period.
- Clearcutting is prohibited on soils rated severe for erosion hazard when slopes are greater than 25% measured over a distance of 100 feet or more.
- All clearcuts will be separated by strips at least 300' wide in which a residual stand with at least 70% crown closure is maintained. Additional harvesting within these buffers may take place when the adjacent clearcut no longer meets the definition of a clearcut given below but no sooner than 10 years after the initial harvest.
- Definition: A "clearcut" is any timber harvesting operation greater than 2 acres in size which results in the average residual basal area of trees over 6" in diameter is less than 30 square feet per acre, unless the average residual basal area of trees over 1" in diameter is greater than 30 square feet per acre and the average residual basal area of trees over 6" in diameter is greater than 10 square feet per acre.

Management of Significant Ecological Resources

Management considerations regarding significant ecological resources (including but not limited to wildlife habitat, rare plants and unusual natural communities) will be included in all stand management prescriptions and shall consider management guides provided by State or Federal wildlife and natural resource management personnel. At a minimum, specific guidelines for the management of the following resources must be included:

- Deer wintering areas
- Mast stands
- Cavity, den and nest trees
- Coarse woody debris
- Rare plants and natural communities
- Vernal pools
- Old-growth or late-successional forest stands

Catastrophic Events

In the event of a catastrophic occurrance, such as an insect or disease epidemic, forest fire or windstorm which significantly impacts the forest resource, the Grantor may submit a salvage harvest plan to the Grantee which deviates from the management plan for the area or management provisions specified herewith. If this plan includes the removal of standing live trees, written approval must be obtained from the Grantee prior to commencing any salvage harvest. If the Grantee has not responded to this plan within 30 days of the receipt of this plan, harvesting may commence. Such approval shall not be unreasonably withheld. If Grantee does not approve of salvage harvest plan, the parties will attempt in good faith to reach a mutually agreeable plan.

Future, Alternative, Desirable Management

The owner of the lands intends to abide and follow above listed provisions. However over the term of this settlement agreement, unforeseen circumstances, future management techniques, public policy and alternative, desirable resource considerations may justify and require actions otherwise prevented by the above listed provisions. The owner will continue to manage its forest land in an ethical, steward-like manner, and will not alter this philosophy. Alternatives and exceptions to the above provisions will only be enacted if other, presently unforeseen, desirable resource management objectives dictate such and the overall management goals are met. If the owner wishes to pursue such exceptions and/or alternatives, however, it first shall amend the forest management plan with the approval of the easement holder.

Forestry shall be carried out in accordance with all applicable local, state and federal laws and regulations, and, to the extent reasonably practicable, in accordance with then-current, generally accepted best management practices for the sites, soils and terrain of the Property. For references, see "Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire" (J.B. Cullen, 1996), and "Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire" (New Hampshire Forest Sustainability Standards Work Team, 1997), or similar successor publications.

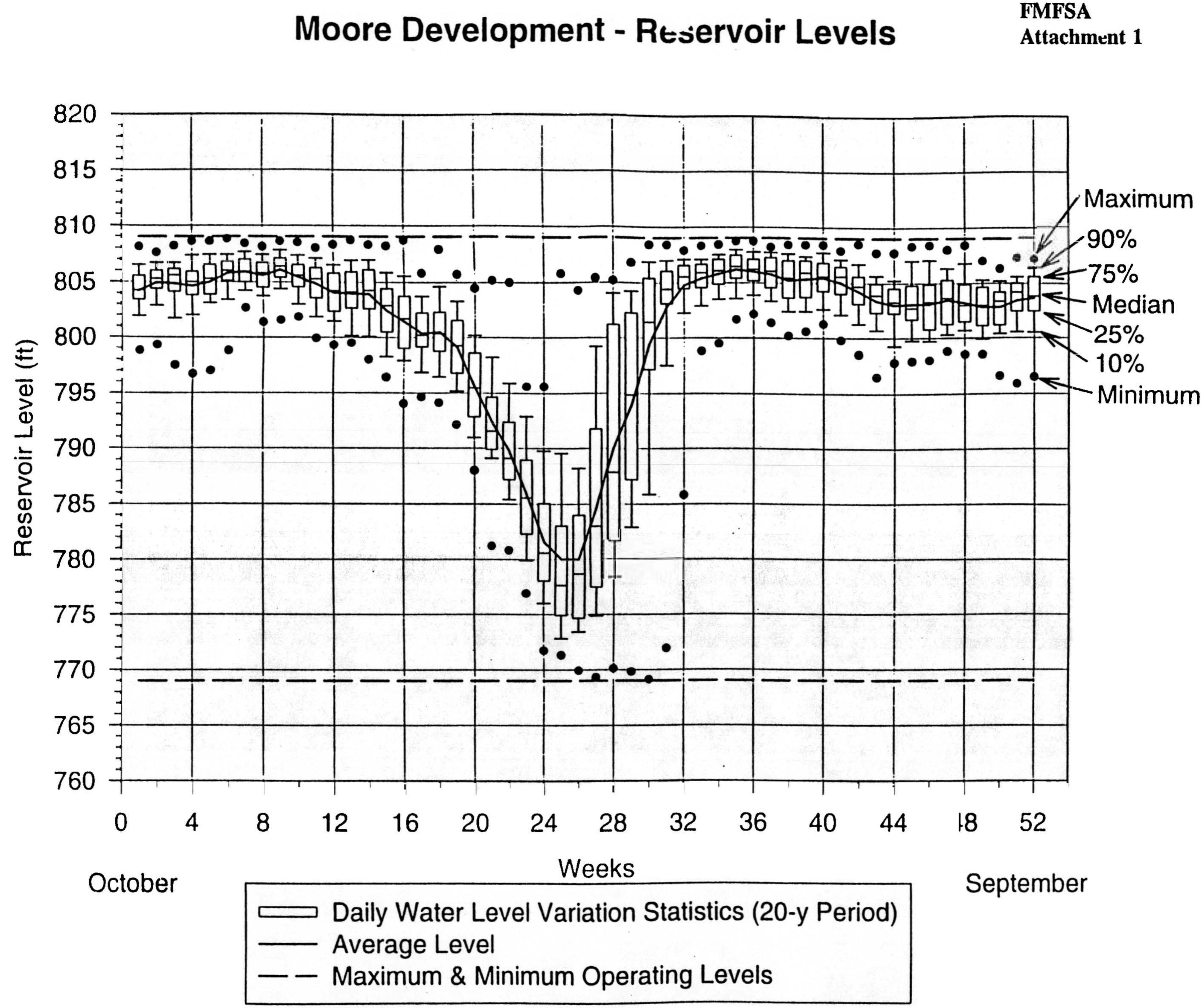
In areas used by, or visible to, the general public, forestry shall be carried out, to the extent reasonably practicable, in accordance with the recommendations contained in "A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners" (Geoffrey Jones, 1993) or similar successor publications.]

AGRICULTURE

For the purposes hereof, "agriculture" shall include animal husbandry, floriculture, and horticulture activities; the production of plant and animal products for domestic or commercial purposes; the growing, stocking, cutting and sale of Christmas trees or processing and sale of products produced on the Property (such as pick-your-own fruits and vegetables and maple syrup)

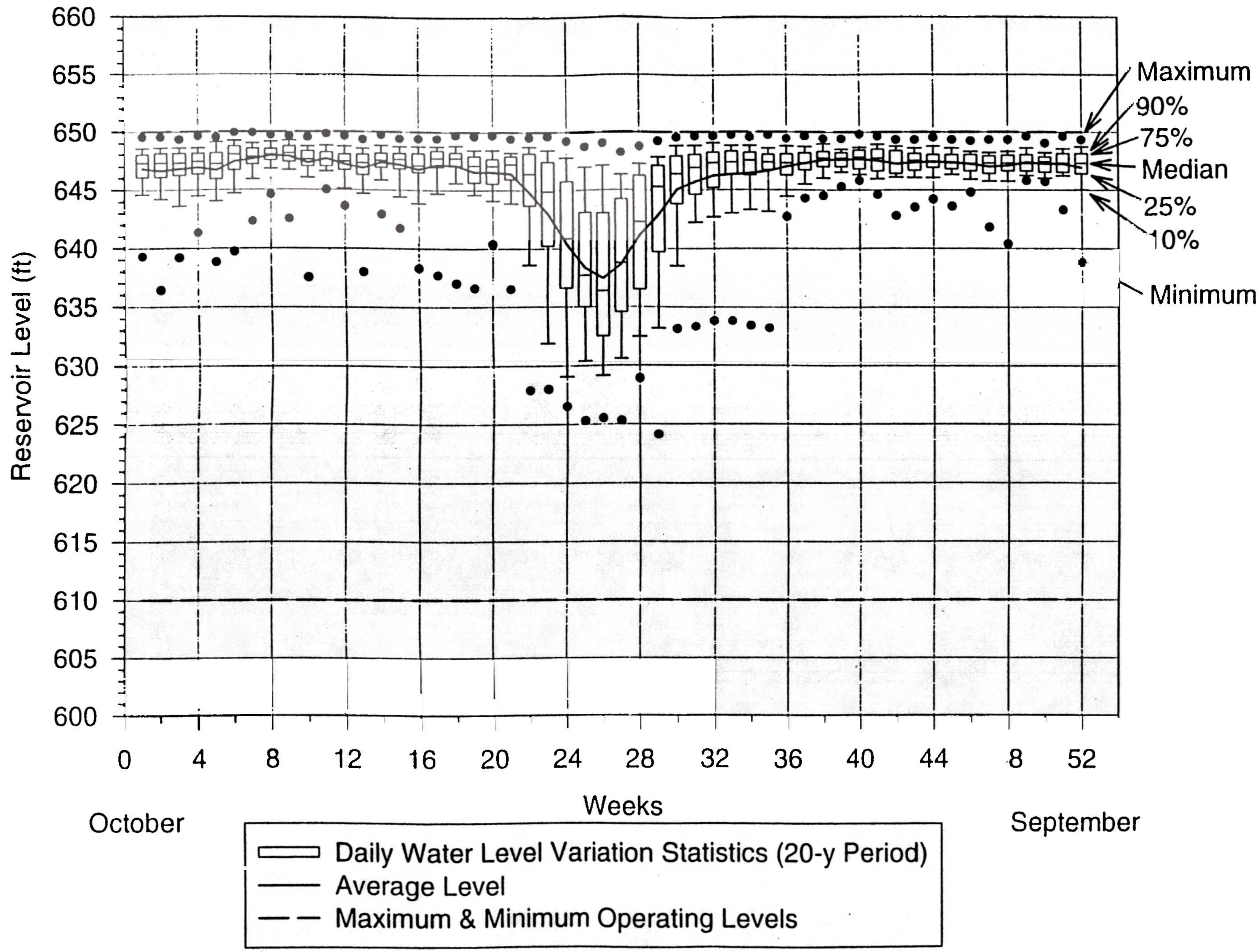
Agriculture shall be performed, to the extent reasonably practicable, in accordance with a coordinated management plan for the sites and soils of the Property. Agricultural management activities shall be in accordance with the then-current scientifically based practices recommended by the UNH Cooperative Extension, U.S. Natural Resources Conservation Service, or other government or private, nonprofit natural resource conservation and management agencies then active. Such management activities shall not be detrimental to the purposes of this Easement, nor materially impair the scenic quality of the Property as viewed from [public waterways, great ponds, public roads, or public trails].

FMFSA
Attachment 1



FMFSA
Attachment 2

Comerford Development - Reservoir Levels



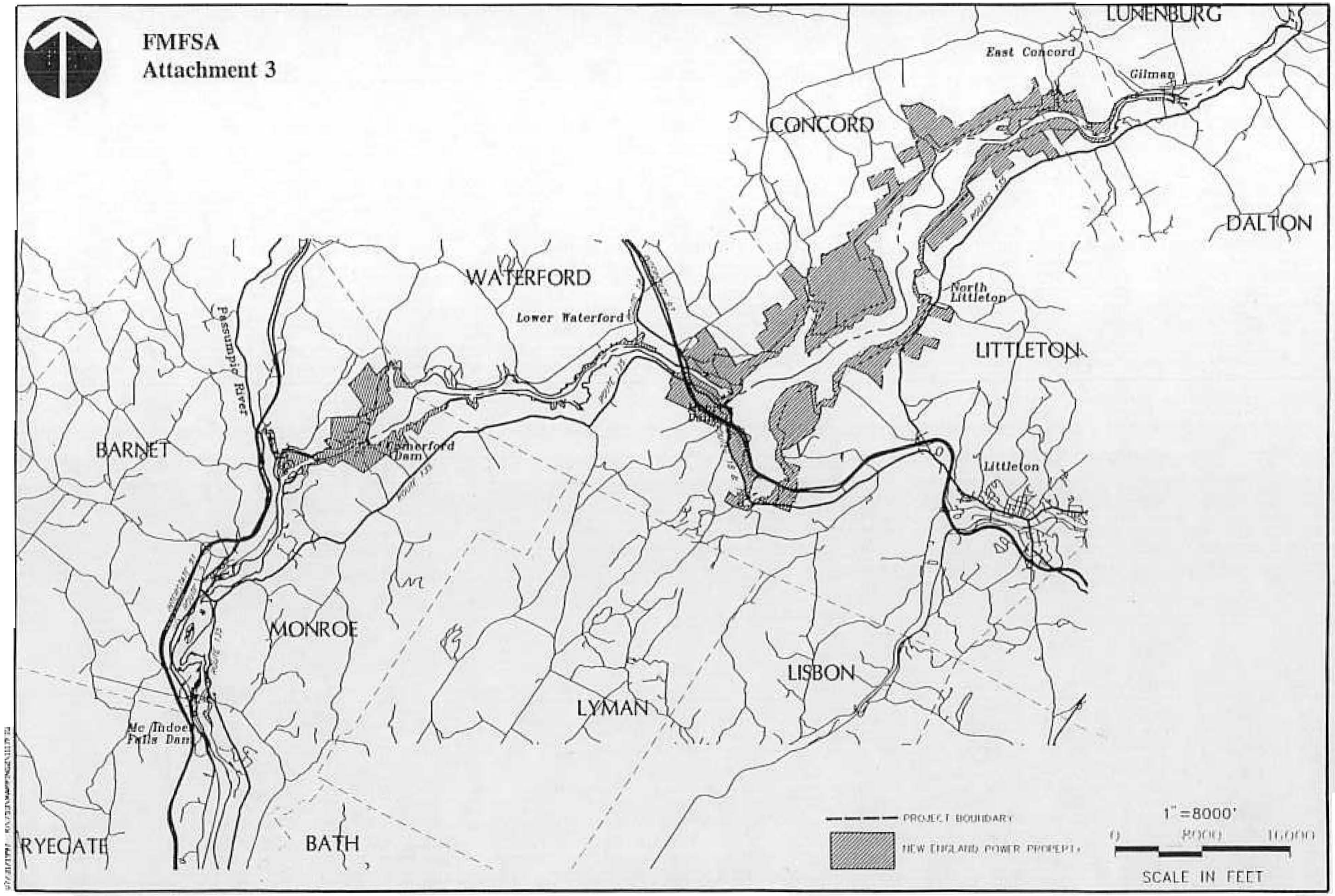


Figure No.
New England Power Lands to be Subject to Conversation Easements
New England Power Co. - Fifteen Mile Falls Project - LP # 2077

BERGER & ASSOCIATES,

6.4 Photographs

Moore impoundment, dam and tailrace looking east upstream.

Moore impoundment, dam and tailrace looking south upstream.

Moore impoundment, dam and tailrace/Comerford impoundment looking downstream.

Pattenville picnic area.

Fishing access trail to the Moore tailrace/Comerford impoundment.

Moore primitive camp site.

Comerford impoundment, dam and tailrace looking upstream.

Comerford impoundment, dam and tailrace looking downstream.

Comerford picnic area and boat launch looking south.

Comerford picnic area and boat launch looking northwest.

Display inside Comerford Station of the button pushed by President Hoover that initiated operation of the Development.

McIndoes impoundment, dam and tailrace looking downstream.

McIndoes impoundment, dam and tailrace looking upstream.

McIndoes picnic area downstream of the powerhouse looking northeast.

6.5 Table of deviations since last LIHI renewal

Event Date	Development - Event	GRH Filing	FERC Response Letter	FERC Decision	Notes
2/7/14	McIndoe minimum flow reduction	2/17/14	3/31/14	No Violation	The station tripped off-line due to equipment malfunction. Minimum flow was interrupted for 95 minutes before station service was restored and a Tainter gate opened.
3/14/14	McIndoe minimum flow reduction	3/24/14	4/16/14	No Violation	The station tripped off-line due to equipment malfunction and minimum flow was interrupted for 38 before station service was restored and a tainter gate opened.
6/5/14	McIndoe minimum flow reduction	6/16/14	9/2/14	No Violation	The station tripped off-line due to equipment malfunction and minimum flow was interrupted for 53 min before station service was restored and a generating unit brought on-line.
7/8/14	Moore and Comerford minimum flow reduction	7/14/14	9/2/14	No Violation	The stations tripped off-line when thunderstorms caused a fault in National Grid's 230KV transmission line between the two stations. Minimum flow was interrupted for 1 h 55 min before service was restored and a gate opened.
7/13/14	McIndoe minimum flow reduction	7/23/14	9/2/14	No Violation	The station tripped off-line due to equipment malfunction and minimum flow was interrupted for 56 min before station service was restored and a tainter gate opened.
7/23/14	Comerford min flow reduction	7/31/14	9/2/14	No Violation	The stations tripped off-line when thunderstorms caused numerous National Grid switch yard breakers and a 115KV line to trip. Minimum flow was

					interrupted for 1 hr 25 min before station service was restored.
9/30/14	Comerford min flow reduction	10/10/14	11/19/14	No Violation	The station was shut down for 62 min to allow clean-up, via boom deployment, of an oil sheen in the tailrace.
10/1 – 10/21/14	McIndoes and Comerford. Temporary modification of minimum flows under Article 401 and with Agency concurrence.	10/10/14 and 10/22/14	10/28/14	No Violation	Seasonal low inflows to the project coupled with low Moore reservoir elevation conditions caused a decision not to increase the minimum winter flows on Oct. 1.
11/16/14	McIndoes min flow deviation	11/24/14	12/22/14	No Violation	Failure of a voltage transformer on National Grid's 34.5KV line caused voltage reduction and opened breakers isolating McIndoes station. National Grid requested an immediate station shut-down to enable a reset of the 34.5 KV line. Minimum flow was interrupted for 40 min due to the voltage failure and station shut down.
4/1 – 4/5/15	McIndoes and Comerford. Temporary modification of minimum flows under Article 401 and with Agency concurrence.	4/13/15	6/3/15	No Violation	Seasonal low inflows to the project coupled with low Moore reservoir elevation conditions caused a decision not to increase the minimum spring flows on April 1.
8/22/15	McIndoes min flow deviation	8/31/15	10/15/15	No Violation	The station tripped off-line due to equipment malfunction and minimum flow was interrupted for 51 min before station service was restored.

8/24/15	McIndoes min flow deviation	9/1/15	10/15/15	No Violation	The station tripped off-line due to a transmission line fault and minimum flow was interrupted for 30 min before a tainter gate opened under emergency power.
2/3/16	McIndoes min flow deviation.	2/12/16, 4/4/16, and 8/31/16	5/19/16 and 11/10/16	Violation – no further enforcement action taken	With two units running, one unit was shut off resulting in the3 h 25 min minimum flow deviation. Inattention by the primary operator was the cause. Corrective action was taken as described in subsequent letters.
7/18/16	McIndoes min flow deviation.	7/28/16	9/20/16	No Violation	The station tripped off-line due to failure of fire detection/protection equipment on station service breakers. Minimum flow was interrupted for 21 min. The equipment was replaced.
7/1/17	McIndoes elevation limit exceeded.	7/11/17	11/2/17	No Violation	Inflow rose very rapidly due to natural inflow from a heavy rain event and unforeseen failure of a section of pin flashboards at the upstream Comerford Dam. The station was out of service for maintenance, so gates were used to pass inflow and the exceedance was limited to 35 minutes without adding to high water conditions downstream.
10/16-10/25/17	Comerford. Temporary modification of minimum flows under Article 401 and with Agency concurrence.	11/9/17	1/08/18	No Violation	Extremely low natural inflows to the project caused a decision to reduce minimum flows until natural inflow increased.
4/22/18	McIndoes elevation deviation.	5/2/18	7/2/18	No Violation	The upstream Comerford Development was discharging minimum flow when an

					additional unit came online. The travel time for the additional flow was underestimated and therefore did not arrive on time to maintain elevation at McIndoe dam. Flow at McIndoe was reduce to minimum, but it did not prevent the 0.06 ft deviation below minimum operating elevation.
4/26/18	Comerford min flow deviation.	5/2/18	7/2/18	No Violation	An unanticipated transmission line operation tripped the single unit operating at the time resulting in an 11 min deviation.
7/12/18	Comerford min flow deviation.	7/20/18	11/16/18	No Violation	A cracked insulator on the unit bus caused the single unit operating to trip. Station service to two other units did not fully transfer due to a failed electronic controller. Low pressure gate manually activated to restore flow after 31 min deviation.
7/23/18	Comerford min flow deviation.	8/2/18	11/16/18	No Violation	Unit tripped due to a transformer electrical cable fault. Minimum flow restored after 17.5 min deviation.
9/9-9/12/18	McIndoes. Agency approved, planned reservoir drawdown.	9/21/18	11/2/18	No Violation	Drawdown was necessary to conduct repairs to the spillway flashboard deicing system. Conducted in accordance with License Art. 401.
7/23/19	McIndoes min flow deviation.	8/1/19	10/16/19	No Violation	An unanticipated transmission line issue tripped the station and min flow was disrupted for 29 min, 30 sec before it was restored.
8/17/19	McIndoes min flow deviation.	8/27/19	10/16/19	No Violation	A localized thunderstorm caused a transmission problem that tripped the

					station. Minimum flow was disrupted for 42 minutes.
7/15/20	McIndoes min flow deviation.	7/28/20	9/17/20	No Violation	An unanticipated transmission line issue tripped the station. Minimum flow was disrupted for 42 minutes and 33 seconds.
8/18/20	McIndoes min flow deviation.	8/28/20	11/25/20	No Violation	An unanticipated transmission line fault tripped the station resulting in a minimum flow disruption lasting 29 minutes and 20 seconds.
9/25-10/18/20	Comerford. Temporary modification of minimum flows under Article 401 and with Agency concurrence.	10/29/20	12/18/20	No Violation	With state agency concurrence, minimum flow was reduced to 600-650 cfs for 23 days. Historic low flows and drought conditions resulted in depleted storage for downstream minimum flows. Reducing minimum flow at Comerford allowed for reasonable resource flows through the system while limiting adverse conditions for future reservoir management heading into winter.
6/21-6/30/21	Moore. Temporary elevation deviation under Article 401 with Agency concurrence.	7/12/21	12/17/21	No Violation	Due to lower-than-normal conditions in the area a conflict occurred meeting the Comerford Development minimum flow constraint and the Moore Development elevation constraint. It was agreed that Moore reservoir would gradually be drawn down as necessary to pass the required minimum flow of 818 cfs at Comerford. The maximum drawdown deviation was less than 1.6 feet below the 2-foot limit.
10/1-10/26/21	Comerford and McIndoes.	11/5/21	*(No response from FERC*	*(No response from FERC*	With state agency concurrence, summer minimum flow was continued through

	Temporary modification of minimum flows under Article 401 and with Agency concurrence.		*before submittal to LIHI)*	*before submittal to LIHI)*	October 26 rather than increasing to winter minimum flows on October 1. Low flows and drought conditions resulted in depleted storage at the Project. Continuing summer minimum flow at Comerford and McIndoes allowed storage recovery to normal historic operations at Moore reservoir.

6.6 CONFIDENTIAL Moore minimum flow unit (U5) drawings

This report contains confidential design drawings and will be provided under separate cover.
(6 pgs)

6.7 CONFIDENTIAL USFWS list of RTE species

This report contains sensitive location information and will be provided under separate cover. (6 pgs)

6.8 CONFIDENTIAL NH list of RTE species

This report contains sensitive location information and will be provided under separate cover.
(52 pgs)

6.9 CONFIDENTIAL VT list of RTE species

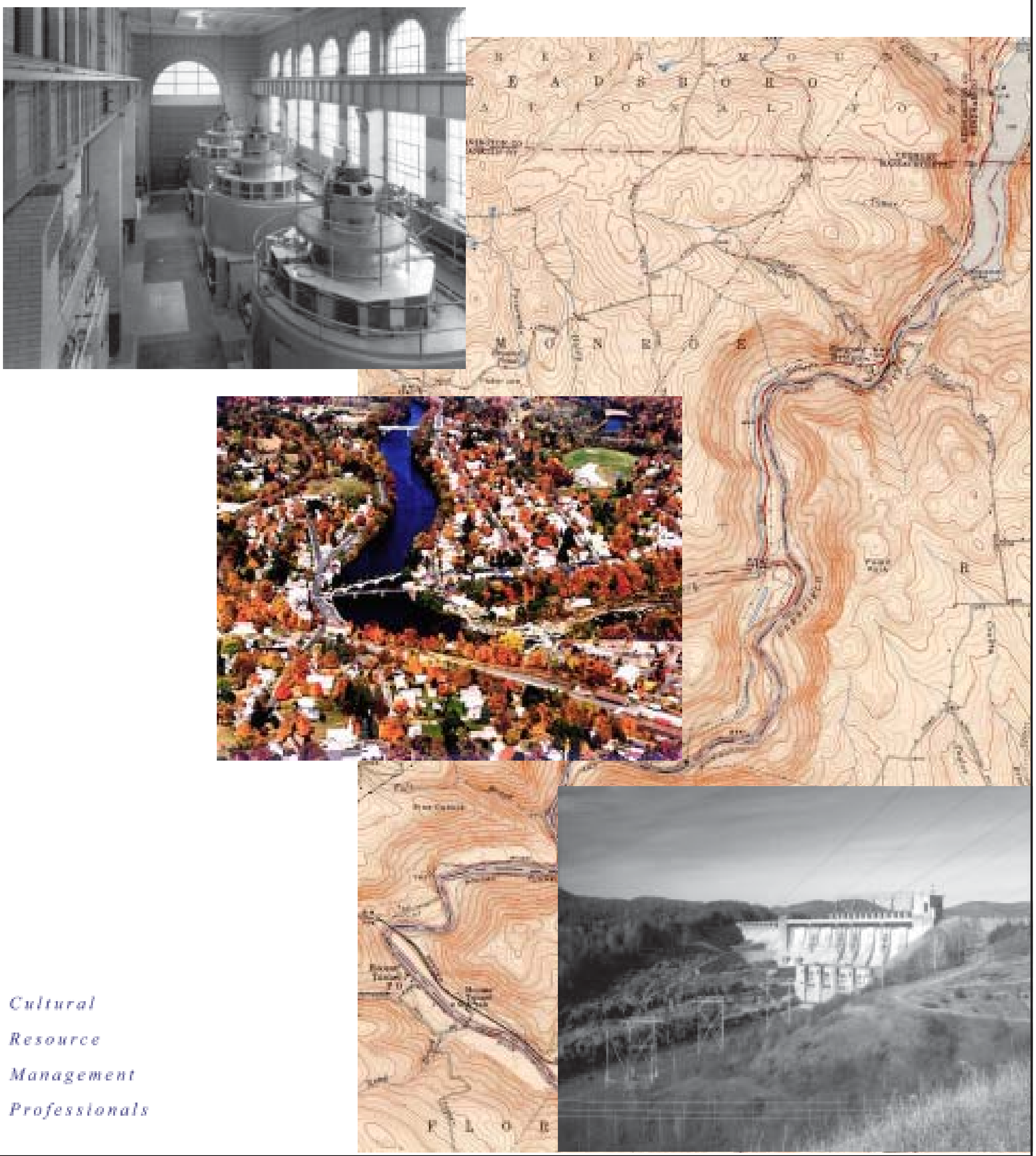
The maps and Excel table provided in this file were generated by GRH from GIS data provided by VT. This report and the accompanying Excel table contain sensitive location information and will be provided under separate cover. (9 pgs and Excel table).

6.10 CONFIDENTIAL Sample RTE inquiry for NH timber harvest

This report contains sensitive location information and will be provided under separate cover. (9 pgs)

6.11 History of Hydroelectric Development on the Connecticut and Deerfield Rivers

HISTORY OF HYDROELECTRIC DEVELOPMENT ON THE CONNECTICUT AND DEERFIELD RIVERS



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Cultural Resource Management Professionals

HISTORY OF HYDROELECTRIC DEVELOPMENT ON THE CONNECTICUT AND DEERFIELD RIVERS

INTRODUCTION

In 1903, Malcolm Greene Chace (1875-1955) and Henry Ingraham Harriman (1872-1950) established Chace & Harriman, a company that, in its many incarnations over the course of the following decades, grew into one of the largest electric utility companies in New England. The company built a series of hydroelectric facilities on the Connecticut and Deerfield rivers in Vermont, New Hampshire and western Massachusetts, which were intended to provide a reliable and less expensive alternative to coal-produced steam power. Designed primarily to serve industrial centers in Massachusetts and Rhode Island, the facilities also provided power to residential customers and municipalities in New England. Chace & Harriman eventually evolved into the New England Power Association (NEPA) in 1926, which became the New England Electric System (NEES) in 1947. In the late 1990s NEES was purchased by the U.S. Generating Company and the hydroelectric developments were placed in a division of the company called USGen New England, Inc (USGenNE). (Landry and Cruikshank 1996:2-5, 29, 39, 67, 141; Cook 1991:13).

The history of electrical power generation in the United States is characterized by several stages of development. From about 1880 to 1895, direct current was produced by steam and/or hydroelectric stations and transmitted over small geographic areas, providing power to arc and incandescent lights. Improvements in the 1890s initiated a second phase of development, which focused on the potential of hydroelectric power for the transmission of alternating current over long distances. In the 1920s, the industry matured, equipment and designs became more standardized, and the structure of management companies became increasingly complex. While the Depression limited further growth of the industry, a new era emerged after World War II, with streamlined management structures and increased regulations and government involvement (Cook 1991:4; Landry and Cruikshank 1996:2-5). The first of the 14 hydroelectric facilities built on the Connecticut and Deerfield rivers by Chace & Harriman and its successors were developed in the early 1900s, shortly after the potential of hydroelectric power was realized on a large scale. Subsequent facilities were constructed during the maturation of the industry in the 1920s, and two of the stations were completed in the post-World War II era. The history of the companies that built these stations is intrinsically linked with broader trends in the history of electricity, hydropower technology, and industrial architecture in America. As such, the facilities together tell the story of hydroelectric power from its late- nineteenth-century origins to the present day.

EARLY AMERICAN ELECTRICAL HISTORY

Electricity first gained popularity in America in the 1870s with the introduction of the arc lamp by inventor Charles Brush of Cleveland. With their bright light and short life span, arc lamps predominated in commercial applications and public street lighting. Initially these lamps were run on individual generators, called dynamos. As their numbers increased, businesses began to support the construction of urban generating stations that could run up to a maximum of 60 lamps connected in series. These early stations used coal to drive a steam engine, which then turned a generator to produce electricity. The complex technology involved and the small size of the stations kept prices high and demand limited, posing little competition to the established gas-lighting companies. Despite these disadvantages, by 1880 Brush had installed central electric stations in major American cities like San Francisco, New York, Philadelphia, and Boston, and had over 5,000 arc lights in operation (Glover and Cornell 1951:671; Landry and Cruikshank 1996:11-14; Marcus and Segal 1989:143-5).

About the same time, Thomas Alva Edison's Edison Electric Company developed and introduced the enclosed incandescent light. In contrast to arc lamps, a large number of incandescent lights could be wired in parallel with low voltage direct current (DC), lowering the cost of illumination. The enclosed nature of the light, which was composed of a filament within a vacuum tube, also made it suitable for indoor use. While arc lights remained standard for public and commercial exterior use, these two factors immediately increased the demand for electric lights among residential consumers, creating a fierce rivalry with the existing gas companies. When Edison opened his first central generating station in New York City in 1882, the electrical power was initially distributed for free, enticing many converts (Landry and Cruikshank 1996:14-15; Marcus and Segal 1989:145-148).

Although Edison Electric had few rivals in the distribution and production of DC incandescent lighting, the technology had limited application until the development of alternating current (AC). The dissipation of DC electricity over distance caused most stations to be located in downtown areas, neglecting the demand for electricity in rural areas and preventing the exploitation of most potential water-power sites. DC also required a continual expansion in the number of powerhouses, as each quickly reached its maximum capacity.

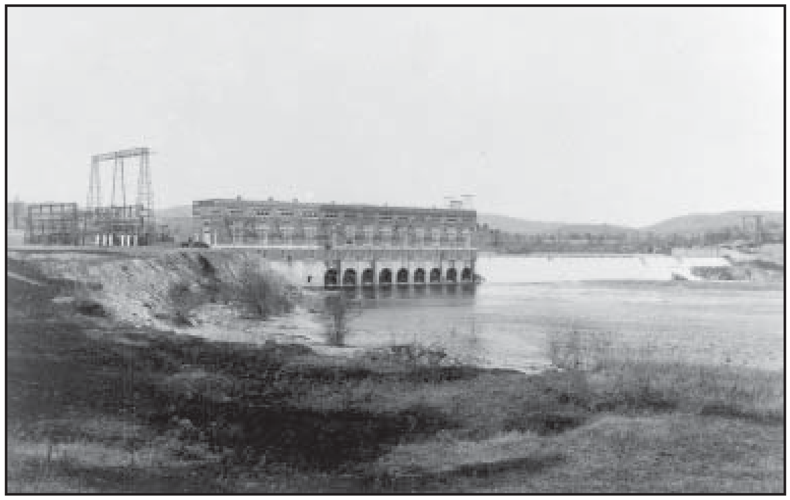
The introduction of AC electricity by George Westinghouse made electrical power more practical for both household and industrial use, allowing variations in voltage as well as decreased energy loss during transmission. At the 1893 World's Fair, Westinghouse won a contest that allowed him to build a generating station at Niagara Falls. His station was a brilliant success, transmitting power over a distance of 26 miles to Buffalo, New York with high profits, thereby triggering a "hydromania" for powerhouse construction and long-distance transmission. AC electricity was quickly embraced by those in thinly-populated areas who had not received DC power because of its prohibitively high cost. With its greater flexibility, lower cost, and unrestricted capacity, AC power began to challenge DC in the cities, encouraging the creation of larger central stations that could spread power throughout the outlying areas (Glover and Cornell 1951:674; Landry and Cruikshank 1996:18-23; Marcus and Segal 1989:149-150).

By the turn of the century, 18 utilities in Massachusetts generated hydroelectric power, although in most cases it was a supplement to, or back-up for, coal-produced steam power. The cost of transporting great amounts of coal to New England was high, however, and as hydroelectric technology improved, it became an obvious alternative. Unfortunately, most rivers were located in northern New England, far from the industrial centers that demanded the power source. Many also lacked the reservoirs needed to ensure a steady flow of water. Within three years demand had grown such that the Massachusetts legislature passed a law allowing special permits for new utility companies. Thus began the odyssey of Malcolm Greene Chace and Henry Ingraham Harriman, who built a series of remote hydroelectric power plants along the Connecticut and Deerfield Rivers, successfully transmitting the new power to the manufacturing centers of the region.

NEP HYDROELECTRIC POWER DEVELOPMENT ON THE CONNECTICUT AND DEERFIELD RIVERS

In 1903 Chace, the son of a textile worker, and Harriman, whose father was a judge and textile machinery inventor, formed Chace & Harriman with the intent of exploiting hydroelectric power in Maine. In 1907 a potential site was identified, not in Maine, but rather at Vernon, Vermont, on the

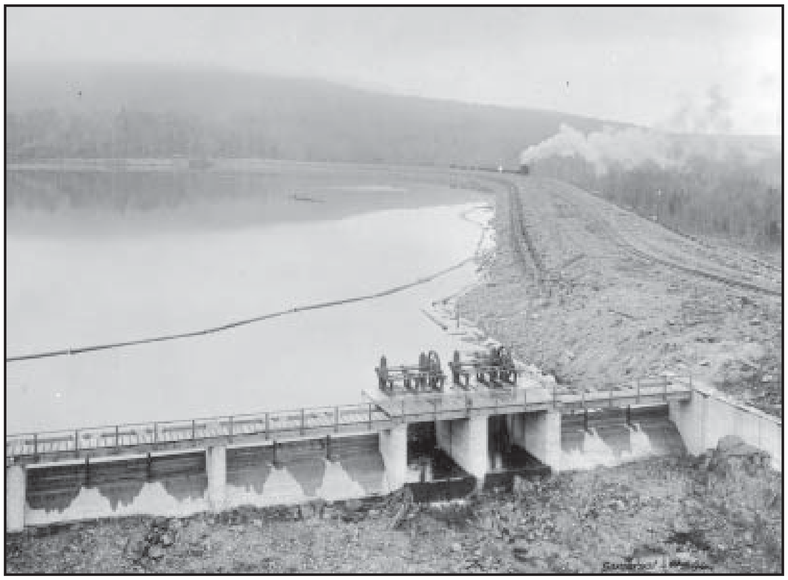
Connecticut River. This river, which flows approximately 400 miles from Third Lake in northern New Hampshire to Long Island Sound, drops 2,000 feet over the course of its journey. With its many falls, the river had attracted mills since colonial times. Local investors already had plans for its development as a hydroelectric power source by the time Chace & Harriman took over the project in 1907. The design of the Vernon Development was largely the work of the mechanical engineering firm of Charles T. Main, Inc., of Boston. An 1876 graduate of the Massachusetts Institute of Technology, Main was an authority on water and steam power and his firm, established in 1907, had been involved in the design of over 80 hydroelectric facilities by the time of his death in 1943. The construction of the Vernon station was completed by J. G. White & Company of New York, with 450 workers assigned to the project (Landry and Cruikshank 1996:26-35; Cook 1991:18-19).



Vernon Development, Hinsdale, NH/Vernon, VT, built 1907–1909, 1920. View looking northeast from the Vermont side of the Connecticut River, showing from left to right, the switchyard, powerhouse, and dam (undated photo). When completed, Vernon was the largest hydroelectric plant east of Niagara Falls, and was the first northeastern U.S. hydroelectric plant to deliver load via long-distance transmission lines.

Vernon was an ambitious facility that required raising the river 30 feet, flooding all or parts of 150 farms. Construction was finished within two years, however, and Chace & Harriman attempted to secure rights-of-way for transmission into north-central Massachusetts. After many complicated financial arrangements, including the creation of a holding company and a subsidiary company (Connecticut River Power Company of Maine and Connecticut River Transmission Company of Massachusetts, respectively), they received special permission to enter Massachusetts markets, provided sales were restricted to bulk customers. The first generator at the Vernon station went on line on July 27, 1909, supplying 60-cycle AC power at 19 kilovolts to the Estey Organ Works in Brattleboro, Vermont. By 1910 eight generating units produced a total of 20 megawatts, sent at 66 kilovolts a distance of over 60 miles, dwarfing the output of all other stations in the east. The unprecedented voltage and distance of transmission, as well as the construction of a line into Worcester, Massachusetts, quickly secured large customers such as the American Steel and Wire Company and Worcester Electric Light Company (Landry and Cruikshank 1996:26-35).

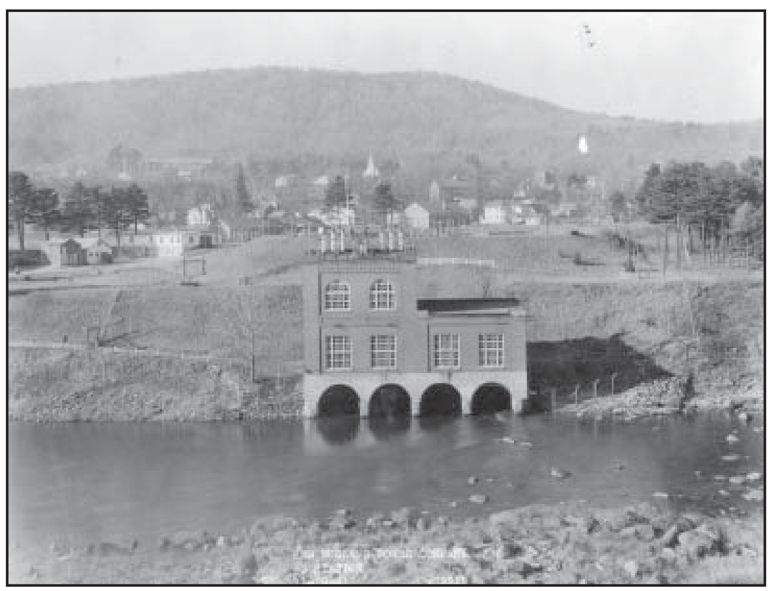
As demand grew and Vernon became unable to provide enough power during the dry season, Chace & Harriman focused their attention on the Deerfield River, which runs through southern Vermont and western Massachusetts before joining the Connecticut River below Turners Falls. Twenty miles southwest of Vernon, in Shelburne Falls, Massachusetts, the river drops 300 feet, creating an ideal location for a series of generating stations, provided a large reservoir could be built to regulate the flow and prevent flooding. Chace & Harriman created a Massachusetts-based company, New England Power, to oversee the construction of the Deerfield facilities, with financial backing from New England Power of Maine. The Power Construction Company, a subsidiary created by New England Power and headed by George Bunnell, managed the construction of the facilities. J. G. White & Company and Charles T. Main, Inc., both of whom had worked on the Vernon station, were employed as design consultants on the Deerfield River projects (Landry and Cruikshank 1996:38-40; Cook 1991:18-19; Cavanaugh et. al. 1993a; Cavanaugh et. al. 1993b).



Somerset Development, Somerset, VT, built 1911–1913. View of 2,100-ft-long, 110-ft-high modified hydraulic earth fill dam looking south with spillway in foreground. Construction railway track and steam locomotive pulling dump cars are visible on dam crest (ca. 1913).

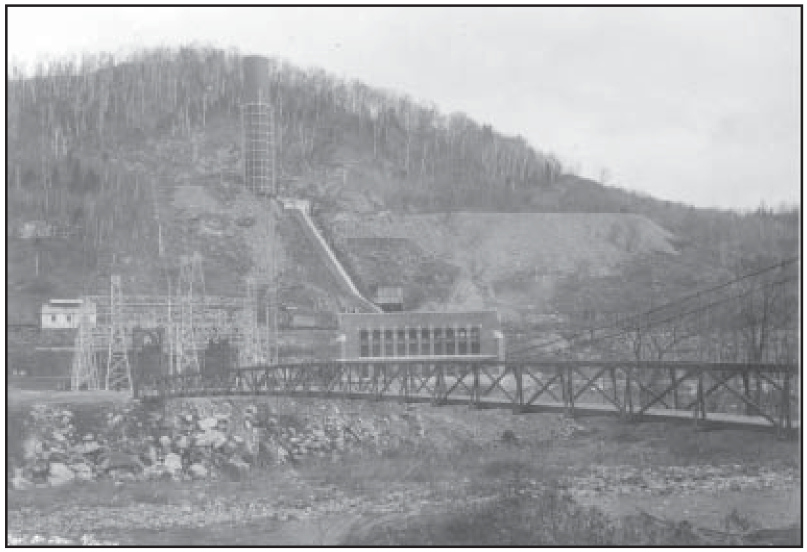
In 1914, Chace & Harriman's various companies were consolidated into the New England Company, a Massachusetts voluntary trust. At this time the company was the largest power provider in Massachusetts, providing more than all other companies in the state combined, Boston Edison aside. Rather than providing competition to steam power stations, however, the hydroelectric generating stations provided a convenient counterbalance to their output. In the winter, when more power was needed because of shorter daylight hours, water was more plentiful, while in the summer, when demand decreased, so did the flow of water. Advances in electric motor development also increased daytime industrial usage, expanding overall demand and distributing consumption more evenly over a 24-hour period. As the New England Company became more dominant in its position and demand continued to grow, it became evident that

By 1911, a three-mile-square (2.5 billion cubic foot) reservoir with a 456-foot long earthen dam had been built in Somerset, Vermont, north of Shelburne Falls. At the same time three standardized stations (Deerfield No. 2, Deerfield No. 3, and Deerfield No. 4) were built, each with its own concrete dam. These stations came online in 1912 and 1913, providing a total capacity of 18 megawatts. A fourth station, Deerfield No. 5, was built slightly upstream to provide power to the Hoosac Tunnel, a 4.75-mile-long railroad tunnel in the Berkshire Mountains that connected Boston with the Hudson River Valley. This station had a larger capacity of 15 megawatts, allowing it to accommodate the demand for sudden large bursts of wattage. Thus with the creation of the Deerfield transmission line and the addition of a full switching station at Millbury, Massachusetts, the transmission network was able to operate as a Vernon-Worcester-Millbury-Shelburne Falls-Vernon loop, allowing a broad customer base (Landry and Cruikshank 1996:38-40).



Deerfield No. 3 Development, Buckland/Shelburne, MA, built 1912 et seq. View of powerhouse looking south across Deerfield River from Shelburne Falls to Buckland (November 25, 1941photo). View shows turbine outfall arches below powerhouse. Deerfield No. 3 was the administrative and maintenance center for the Lower Deerfield developments, and several of the workshops and storage buildings are visible behind the powerhouse to the left.

the company needed to find its own seasonal steam-power backup, as well as build more stations. Satisfying these needs would require contracts with steam power producers, large investments in land, and costly reservoir construction (Landry and Cruikshank 1996:42-43).



Harriman Development, Whitingham/Readsboro, VT, built 1924 et seq. View of Readsboro facility looking east across Deerfield River, showing from left to right, switchyard, surge tank, powerhouse, and footbridge (November 26, 1924 photo). The Harriman Development incorporated several major works of engineering and was the showpiece of the Deerfield River developments.

World War I caused severe shortages and a drastic increase in the cost of power. The price of coal doubled and the workforce was severely reduced, inspiring a push towards conservation and the adoption of daylight savings time. New construction was limited to connections to areas of strategic military importance, forcing small utilities to buy power from larger utilities, which were better able to balance power distribution to accommodate shifting needs. Despite rate increases caused by wartime shortages, annual kilowatt sales between 1916 and 1920 grew from 246 million to 431 million. The war also fostered an interconnection of transmission lines among utilities, and by 1920 the New England Company controlled 300 miles of line, a fivefold increase from a decade earlier, creating a network that stretched from Lake Erie to the Atlantic Ocean (Landry and Cruikshank 1996:52-53).

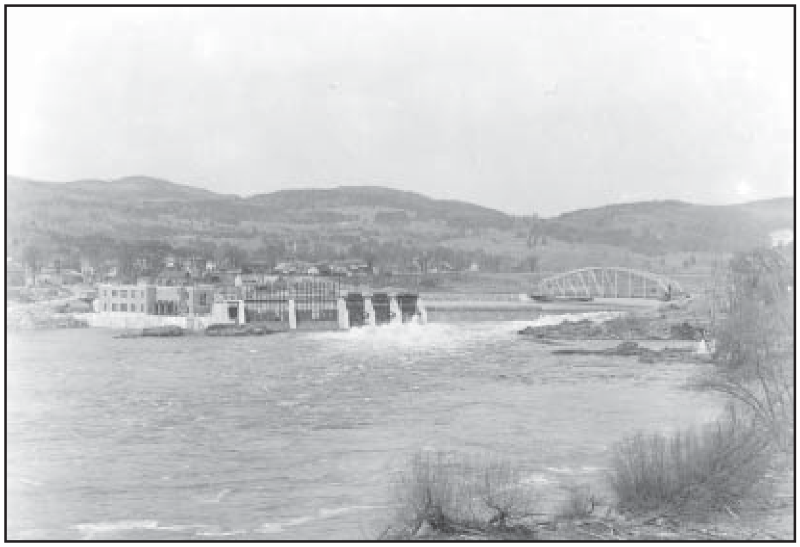
To ease the wartime power shortage, the U.S. Department of the Interior agreed to work with the company to pay for the Davis Bridge Development (later named Harriman) in Whitingham, Vermont. Called the "White Coal Project," this endeavor included an expanded powerhouse and two 4.2 megawatt generators at Vernon, nearly doubling its peak-hour capacity, as well as a 5-megawatt station and dam at Searsburg, Vermont. Despite Vernon's increased capacity, it was soon to be dwarfed by the Harriman station. Approximately 1,200 people worked on the $10 million project, which included the construction of a large powerhouse, a concrete spillway, and a 2,200-acre reservoir, creating the largest man-made lake in Vermont, with double the storage capacity of the Somerset reservoir. At 1,300 ft long and 215 ft high, the dam was the highest earthen dam built at the time of its construction. Previous Deerfield River projects regulated the western branch of the river; with the addition of the Harriman station, the eastern branch was brought under control as well. Together with the Somerset dam, the Harriman dam was one of the earliest structures outside of the Panama Canal to employ the hydraulic fill method of construction, which involved dumping material into two dikes, and then washing the dikes with water to filter the fines into the ditch between them. This procedure produced a dam with an impervious core. When it opened in 1924, the Harriman Development, named in honor of its founder, was the largest hydroelectric facility east of Niagara Falls and supplied 40,000 kW, almost doubling the total output of the Deerfield River. Its large size necessitated the construction in 1927 of a smaller hydroelectric station downstream at Sherman to even out any sudden discharges. After the construction of both stations was complete, power was transmitted from Harriman to Millbury, Massachusetts, on a 110 kilovolt line, the first to exceed the 66-kilovolt standard (Landry and Cruikshank 1996:38-40, 54-59; Cavanaugh et. al. 1993b).

Bellows Falls Development, North Walpole, NH/Rockingham, VT, built 1925–1928. View of powerhouse looking north with transformers at right (November 3, 1941 photo).

Despite the large scale of Harriman, demand for electricity continued to increase beyond the available supply. Much of this demand came from residential customers who were beginning to use electric appliances as well as electric lights. In 1918, less than one-third of American homes were wired for electricity. By 1929, however, the number had grown to over two thirds. Therefore, as soon as Harriman was finished, the company broke ground at a site 30 miles north of Vernon at Bellows Falls, the downtown location of a small subsidiary known as the Bellows Falls Power Company. This company had been created by Chace & Harriman in 1912 through the purchase and reorganization of a canal company and two small hydroelectric companies. In 1918 they decided to rebuild the canal and build a new power station, guaranteeing the Fall Mountain Paper Company (partial owners of the water rights) a supply of electricity. Within eight years the paper company shut down and sold their water rights to Bellows Falls Power. The construction of a new hydroelectric station began immediately, despite delays caused by the flood of 1927. While the old canal provided one million gallons per minute and produced 10,000 horsepower, the new canal was able to send 4.2 million gallons per minute to the turbines providing 60,000 hp to produce 49,000 kW. This dramatic increase in water capacity was achieved through the construction of a new dam, which was slightly higher than its predecessor. Although the head was only 60 feet, the power capacity of the Bellows Falls station matched that of Harriman (Landry and Cruikshank 1996:59-62, 72).

After World War I, the New England Company was desperately in need of financial backing and feared the loss of their customer base to the larger holding companies that had emerged in the prosperous years after the war. To assuage these worries, Chace & Harriman decided in 1926 to sell most of their company to the International Paper Company. While the International Paper mills were no longer economical paper producers, they were still capable of creating hydroelectric power. Archibald Graustein, President of International Paper, was open to replacing his failing paper empire with a power empire. At the same time, Chace & Harriman were anxious to get an infusion of equity capital from International Paper, thereby allowing the company to launch a counterattack against bigger companies and establish a larger customer base. Therefore, Graustein, Chace & Harriman developed the New England Power Association (NEPA), which was essentially a compilation of its old holding companies and all of its subsidiaries. International Paper, Northeastern Power, and Stone & Webster were ceded a majority position in the enterprise in exchange for $20 million, and Chace & Harriman retired to the board. This reorganization was followed by a wave of acquisitions handled by the newly-hired President, Frank Comerford. Even with the increased efficiency and capacity of the existing hydroelectric stations, the most efficient power sources continued to combine steam and water power, leading Comerford to purchase a gas company, multiple retail units, and more steam plants before the onset of the Depression (Landry and Cruikshank 1996:65-84).

Harriman had purchased the rights to an area known as Fifteen Mile Falls on the Connecticut River in 1910. At the time, the Falls' low volume made development impractical, and Harriman soon sold his rights. Immediately after the company's reorganization in 1926, however, NEPA was more confident and re-purchased the site. Its power potential was high, allowing for two large reservoirs of an extremely high volume. Unfortunately, NEPA's customer base was not large enough to justify building at such a large, yet cost-efficient size. To solve this problem, Comerford arranged a deal with Boston Edison in which they would buy one-third of the station's output (150 million kilowatts) at $2 million per year for 20 years. Thus began one of NEPA's greatest engineering feats. To divert the river, reshape the old river bed, and build the dam, the company excavated more than 1 million cubic yards of rock, mixed and poured 300,000 cubic yards of concrete, and consumed 5,000 tons of structural steel. A small town of workmen emerged on a hillside in Barnet Township, Vermont, to construct the complex, which doubled NEPA's peak capacity for hydroelectricity by adding 160 megawatts and saving the 200,000 tons of coal that would have been needed for steam power. Water first spun the turbines in September, 1930, after a month of accumulating in the reservoir behind the dam. Aptly named "Comerford," the station transmitted power to a switching station in Tewksbury, MA, traveling a distance of 126 miles, through 2,000 steel towers, and over 800 miles of aluminum cable (Landry and Cruikshank 1996:87, 90-91).



McIndoes Falls Development, Monroe, NH/Barnet, VT, built 1931. View looking northwest from the New Hampshire side of the Connecticut River, showing, from left to right, the powerhouse and dam (April 13, 1931 photo). McIndoes Falls, one of three facilities in the Fifteen Mile Falls Development, was built as a run-of-river facility to even out discharge flows from the larger Comerford Development upstream.

NEPA had planned three developments at Fifteen Mile Falls. The second project was located seven miles downstream from Comerford. A small auxiliary plant, the new facility was designed to even out any sudden discharges of water. This plant, called McIndoes Falls, came on line in 1931, one year after Comerford, bringing the Fifteen Mile Falls capacity to a total of 175,300 kW. The stations at Comerford and McIndoes Falls were both designed by Charles T. Main. The development of the third site at Fifteen Mile Falls was postponed until a further increase in demand warranted the investment (Landry and Cruikshank 1996:90-91, Cook 1991:18-19).

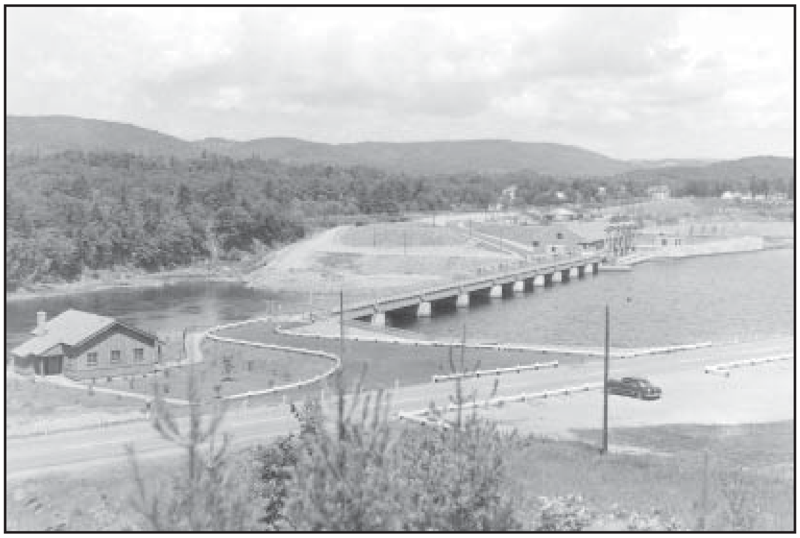
NEPA's period of expansion in the early 1930s came to a halt with the Depression, as the company struggled to pay for McIndoes Falls. Investors were scared off, emergency taxation was introduced, and NEPA was plagued with cumbersome finances, an overly complicated organization, overcapitalized holdings, as well as several new businesses. A series of natural disasters also plagued the company during the 1930s, including the great flood of 1936 and the Hurricane of 1938, both of which caused damage to several of NEPA's facilities. In 1932 the company's retail sales, which had always risen, declined for the first time and employment levels fell. When enraged investors forced the government to investigate utilities after the market crash, NEPA's convoluted financial organization was disclosed and the company was forced to implement an immediate simplification of the corporate structure. The Federal Trade Commission then passed the "Public Utilities Holding Company Act," which prohibited holding companies that unnecessarily complicate corporate structure and gave the Federal Power Commission the power to regulate interstate utilities. After working carefully together with the government on this issue, Harriman resigned, Comerford became president of Boston Edison, and International Paper and many of its subsidiaries were liquidated.

The Depression also spurred several positive changes, allowing NEPA to emerge as a stronger company when the economy finally bounced back. Government intervention made NEPA once again independent by 1947 and created a simpler organizational structure. The lower demand forced a decrease in rates, as well as an intensification of "load-building" programsCaggressive marketing and merchandising programs designed to increase residential demand. NEPA sold appliances to increase household electrical use and pushed for rural electrification by encouraging the agricultural use of utilities. By 1940 demand was again rising and employment was up, allowing NEPA to incorporate line extensions and upgrades (Landry and Cruikshank 1996:93-119).

With the onset of World War II, NEPA began strengthening those operations that had slackened during the preceding decade. Many employees were sent off to war, and those that remained were under pressure to meet the heavy demands of the many military and war-related factories despite severe shortages of labor and materials. Many of NEPA's employees also worked with the government to speed the transition of new weapons from experimental to operational. This advanced technical involvement gave NEPA the experience that would later give it a prominent role in post-war energy planning. As the economy began an upswing, civilian energy use remained limited and many furnaces were converted from oil (the newer fuel source) back to coal. During this time NEPA also saw an influx of new executives, including President Irwin Moore and Vice-President William Webster (Landry and Cruikshank 1996:121-135).

On June 3, 1947, NEPA was renamed New England Electric System (NEES), creating a new holding company and refinancing all other assets, including three wholesale companies, 36 retail companies, one service company, a street railway, and four miscellaneous companies. At the same time, a number of large shoe and textile manufacturers began to close, bringing unemployment to New England and threatening load growth. As increasing numbers of businesses were forced to close, the public began to blame utilities, which were consistently more expensive in New England than elsewhere in the country. Contrary to popular belief, utilities were expensive because of the higher costs of transporting fossil fuels over a large distance and the need for materials to withstand harsh weather. In addition, the failure of businesses was due less to high utility bills, and more to increases in unionization, wages, and taxation. The public also failed to acknowledge its increasing use of electricity, noting only the rising total cost. Regardless of the facts, dissatisfaction quickly led to the demand for public utilities. As the economy became more diversified, however, new jobs were offered at higher wages, increasing load and eventually silencing the public utility scare (Landry and Cruikshank 1996:137-149).

Despite the fact that hydroelectric power remained economical, post-war development included only two new hydroelectric plants, both on the Connecticut River. These complexes were the last conventional hydroelectric stations brought into the NEES system. In 1950, a $16 million, 33-megawatt plant went on-line in Wilder, Vermont, 40 miles north of Bellows Falls. This plant replaced an earlier facility called Olcott Falls, and drew substantial local opposition. The new 2,000-foot-wide dam raised the water level 15 feet, extending the existing pond 27 miles upstream toward the McIndoes station. Steep banks kept flooding to a minimum, affecting only 1,200 acres of land and submerging 335 acres of farmland. To ease tensions NEES agreed to pay for the flooded land and to move any utilities, such as railroads or roads, that were affected (Landry and Cruikshank 1996:149-151).



Wilder Development, Lebanon, NH/Hartford, VT, built 1950. View looking northwest from the New Hampshire side of the Connecticut River, showing from left to right, the visitors' center, dam, and powerhouse (July 17, 1952 photo). This development was the first built on the Connecticut River after World War II. It replaced a preexisting plant and was constructed to meet increasing peak period electricity demands.

The new Wilder complex covered some of the increasing peak demand, but in 1952 a dark forecast was issued by a group of utility executives known as the Electric Coordinating Council of New England. They predicted that peak load requirements would more than double over the next 20 years, from 3,800 megawatts to 8,000 megawatts. The generous reserve margins of the depression era had dropped to 16 percent, meaning that even more peak-load power would be needed. Bob Brandt, the head of power planning in the 1950s, worked with the Federal Power Commission and neighboring utilities to ensure that the New England region would remain covered. Only one potential site remained undeveloped: the property at the upper part of the Fifteen Mile Falls area, originally purchased in the 1920s. Whereas the site's development would have been excessive and impractical several decades ago, NEES was now criticized for taking so long to build an additional station. The new Samuel C. Moore station (named after President Irwin Moore's father and the company's longtime general manager) resembled Comerford in size and construction, with a massive concrete and earth core dam that created a reservoir covering 3,500 acres. The powerhouse, with four identical turbines producing 190 megawatts at full capacity, was located below the dam. The $41 million project took three years to complete, and employed 500 people. It was $9 million below budget and began producing electricity in 1957. This large conventional hydroelectric development allowed the Connecticut River to operate as a hydropower delivery system, combining multiple reservoirs and powerhouses. As the river wound from Moore to Vernon, each cubic foot of water produced 37 kilowatt-hours for the system. Downstream stations added an additional 530 megawatts and the Deerfield tributary another 110. No other river of comparable length in the country could equal the Connecticut for hydropower development (Landry and Cruikshank 1996:149-150).

In 1954, President Eisenhower signed Senator John Pastore's bill allowing the private development of nuclear power. NEES' Vice President, William Webster, who had returned from consulting on the wartime Atomic Energy Commission in 1951, was convinced that nuclear power was the energy of the future. He arranged a consortium of nine northeastern and midwestern companies to study the commercial applications of nuclear fission. With preliminary research behind him, he announced the formation of the Yankee Atomic Electric Company as soon as the bill was passed. His desire was for all of the regional utilities to share in the benefits, as well as the risks, inherent in the development of the new technology. Nine other utilities, as well as key government officials, businesses, and the press, decided to back the project. In 1957, after the completion of a smaller experimental facility by Westinghouse and Stone & Webster at Shippingport, Pennsylvania, construction began on the first full-scale demonstration plant, situated in Rowe, Massachusetts in the Deerfield River Valley. The plant went online in 1960 at a cost of $39 million, well below the $57 million estimate. It was the second commercial atomic plant in the country, setting many of the standards for subsequent reactors (Landry and Cruikshank 1996:162-167).

In the following decade, regional prosperity and lower-cost power combined to put NEES in a stronger operating position than in previous decades. Substantial savings from continual consolidation and the growing use of computers simultaneously allowed for wage increases and a decrease in rates. These two factors combined with tax cuts to allow New England to reach the national average in economic and load growth despite its low population increase. By 1962, NEES' electric properties had been consolidated along functional lines into one retail company, a single power wholesaler, and a service company in each state. Webster, president of the company since 1959, saw three possibilities for increased prosperity: lower costs through newer plants, economies of scale through higher loads, and lower fuel costs. Therefore, he began to try to license increasing numbers of nuclear plants, whose capacity dwarfed that of hydroelectric plants. In response to the blackout of 1965, Webster also participated in the philosophy of power pooling with other regional utilities, sharing resources in times of natural disaster. Consequently, the New England Power Exchange (NEPEX) was organized in 1967, linking all utilities to prevent shortages or blackouts. Shortly thereafter the New England Power Pool (NEPOOL) was formed to develop region-wide power dispatching (Landry and Cruikshank 1996:170-195).

The beginning of the fuel crisis was marked by a sharp increase in the price of imported oil in 1973. Escalating inflation exacerbated the crisis, causing many power companies to return to burning coal despite an increased sensitivity to pollution. In response to these problems, NEES began a large-scale initiative to cut back costs, improve finances, and develop a new customer relations strategy. Nuclear plants, which had been the hope of the future, were no longer tenable because of high interest rates, skeptical investors, and grass-roots environmental opposition. Thus NEES began a new strategy based on conservation and domestic fossil fuels, concentrating on domestic oil exploration. A large Research and Development department was created to explore alternate fuel sources and ways to reduce pollution. Other changes included the establishment of conservation and load management to minimize capacity requirements, the diversification of energy sources, and the decision to purchase power from plants that ran off of renewable energy sources such as trash, solar, and wind. Together, these changes reduced dependence on imported oil, allowing the country and the company to weather the crisis (Landry and Cruikshank 1996:199-229).

When prosperity returned in the 1980s, the focus on cost-consciousness and conservation remained. Most of the steam-generating units had been converted to coal and fuel prices fell dramatically. NEES emerged from the 1980s poised to face any future restructuring with stronger finances, an improved generating position, and slow load growth. The ever increasing environmental awareness, however, caused a number of small, yet significant changes. While hydroelectric plants are on balance non-polluting, they can prevent fish from migrating upstream to spawn. In the early 1980s, state wildlife officials required NEES to construct fish ladders, which channel fish around dams and turbines. These bypass mechanisms, built at a cost of $10 million each, were installed at Vernon in 1981, and later at Bellows Falls and Wilder, allowing anadromous fish such as Atlantic Salmon and shad to reproduce. By the 1990s the fish population in the Connecticut River had again reached healthy levels (Landry and Cruikshank 1996:231-242). Fish ladders are currently being installed at the Deerfield complexes.

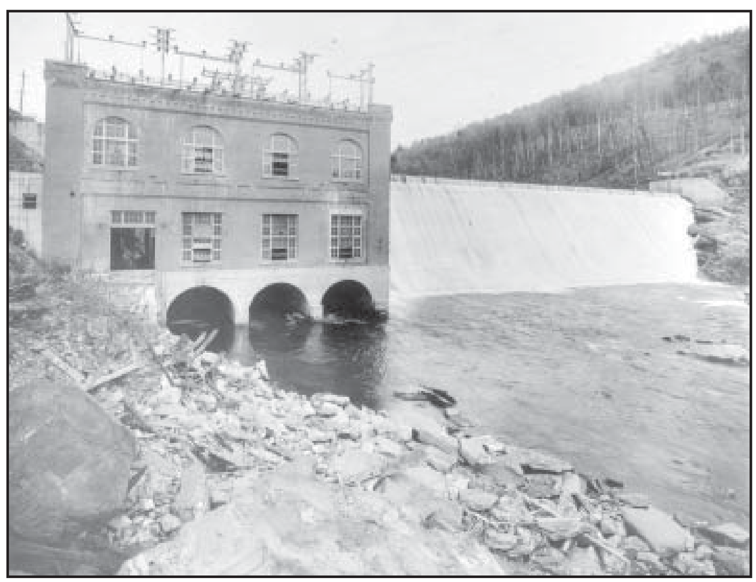
In the 1990s deregulation became a dominant theme in the restructuring of the power generation industry. It created a more competitive power-generating market that allows private power producers to utilize extant transmission and distribution systems, thereby providing consumers with a wider choice of producers. This development caused a number of large utilities, including NEES, to agree to separate power generation from transmission and distribution, recreating Chace & Harriman's initial arrangement. In 1998, USGenNE acquired the hydroelectric generating facilities on the Deerfield and Connecticut rivers. As part of the agreement NEES retained control of the transmission facilities. USGenNE was subsequently acquired by the PG&E Corporation and became part of the company's PG&E National Energy Group (PG&E NEG). In 2003, PG&E NEG and its subsidiaries, including USGenNE, declared bankruptcy. As part of the companies restructuring effort, PG&E NEG was separated from the parent company and changed its name to the National Energy and Gas Transmission, Inc. (NEGT). USGenNE continues to operate the hydroelectric developments on the Deerfield and Connecticut rivers as a subsidiary of NEGT.

HYDROPOWER TECHNOLOGY ON THE CONNECTICUT AND DEERFIELD RIVERS

At the end of the nineteenth century, hydroelectric generating technology was in its infancy, and utilized equipment configurations adapted from textile mill practice and other water-powered industrial applications. During the first quarter of the twentieth century, hydroelectric engineers developed a variety of water delivery systems, and standardized mechanical and electrical equipment that allowed generating capacity to meet growing demand. USGenNE's Connecticut and Deerfield river developments incorporate a range of water delivery infrastructure and generating equipment reflecting the history of hydropower technology from its earliest forms to mature industry standards.

The Vernon Development (1909), Chace & Harriman's first hydroelectric station, was conceived as a single project. Vernon was important technologically as the first northeastern U.S. hydroelectric plant built remote from a load center and to deliver its load via long-distance transmission lines. Transformers at Vernon raised the electricity to 66 kV, enabling it to be transmitted over 60 miles to Gardner and Fitchburg, Massachusetts, a voltage and distance that were unprecedented in the northeast. When Chace & Harriman turned their attention to the Deerfield River (1911-1927), they envisioned developing the whole river drainage as an integrated, multi-station system, much like the Big Creek and other hydroelectric systems being developed in California at that time. Upstream reservoirs at Somerset (1911) and Harriman (1924) insured a reliable, regulated flow of water, and run-of-river facilities like Sherman (1927) evened out sudden discharges from larger powerhouses. This integrated, river-as-system approach was also taken by the New England Power Association and New England Electric System with their development of the three Connecticut River developments at Fifteen Mile Falls, Comerford (1930), McIndoes Falls (1931), and Moore (1957), where McIndoes absorbed surges of water from Comerford.

Hydroelectric facilities incorporate two types of water delivery systems, concentrated-fall, and divided-fall. In a concentrated-fall system the dam



Deerfield No. 2 Development, Conway/Shelburne, MA, built 1912–1913. View of powerhouse and dam looking north from Conway side of the Deerfield River (ca. 1913 photo). Deerfield No. 2 is a concentrated fall facility, where the dam and powerhouse are integral.

Searsburg Development, Searsburg, VT, built 1922. View looking south across Deerfield River showing surge tank (above) and powerhouse (below) (June 29, 1923 photo). Searsburg is a divided-fall facility, where the dam and powerhouse are separate. Water from the Searsburg dam is directed to the powerhouse through a 3.5-mile-long, banded wood stave penstock.

and powerhouse are integral or closely spaced, and the impoundment behind the dam acts as a forebay, providing water directly to the powerhouse. In a divided-fall system, the dam and impoundment are located at some distance from the powerhouse. Divided-fall systems are usually found in more rugged terrain, such as in the Deerfield River Valley, and concentrated-fall systems are more typical of flatter areas, such as the Connecticut River Valley. On the Deerfield River, the large Somerset and Harriman storage reservoirs were built to provide a constant, regulated flow of water to a series of mostly divided-fall generating stations downstream, some of which received their water through a variety of delivery systems. On the wider Connecticut River, which has a greater, more regular flow, most of USGenNE's hydroelectric developments are of the concentrated-fall type.

At some of the Deerfield River developments, the water delivery systems involved considerable feats of engineering. On the Deerfield River, large dams were built at Somerset, Searsburg (1922), Hariman, and Sherman. These dams were constructed in whole or in part using variations on the hydraulic-fill method, where a series of parallel dikes of rock and earth were built up with dump cars or railroad cars, and water was sluiced over the dikes to wash the loose material into the space between them to form a core that was impervious to water (Hay 1991:53). The Harriman dam was the largest semi-hydraulic earth-fill dam built to date when it was completed, and created the largest man-made body of water in Vermont (New England Power Company 1992: AHarriman Development). Most of the dams at the USGenNE developments incorporate ogee-profile, gravity-type spillway sections. Gravity dams rely on their own weight on their bedrock foundation to hold back the water behind them. The first concrete gravity dam was built in San Mateo, California in 1887 (Hay 1991:xix). This type of dam was a departure from the rock-filled wooden crib dams that were typical in New England at the time, and came into standard use in the region during the first quarter of the twentieth century (Cook 1991:18-19). USGenNE's gravity dams are typical in their linear form and ogee profile. These dams incorporate a variety of types of height-regulating equipment including flashboards and sluice gates. Most of the larger dams use tainter-type gates, however, the Bellows Falls dam (1928) is unique on USGenNE's Deerfield and Connecticut rivers for its use of roller-type gates.

Some of the water delivery systems were comparable to those employed in hydroelectric developments in California and the rugged American west (Hay 1991:44, 53-58). At Searsburg, water was conveyed from the dam to the powerhouse via a sinuous, 18,412 ft long, 8 ft diameter, wood-stave conduit that provided 230 ft of head. The utilization of this type of water conduit was made possible by the invention of the surge tank, a type of large standpipe that equalized pressure differences within a pipeline that could potentially damage the system when turbine gates were closed rapidly (Hay 1991:58-59). At Searsburg, the New England Power Company incorporated a Johnson differential surge tank in the conduit system to regulate system pressure. The Deerfield No. 4 Development (1912) included a 1,514 ft long tunnel blasted out of bedrock to connect the dam to the forebay above the powerhouse. The Harriman Development incorporated two additional engineering feats. A 12,812 ft long, 14 ft diameter bedrock tunnel was built to connect the dam and powerhouse, providing 390 ft of head. The 180 ft deep vertical shaft spillway was the deepest such structure built up to that time. The Harriman water delivery system also incorporated a 184 ft high surge tank. Rock tunnels were also part of the Deerfield No. 3 and No. 5 developments, with the latter also incorporating a 2.8 mile long canal/conduit/tunnel water delivery system.

In addition to constructing new water delivery infrastructure, preexisting industrial waterpower infrastructure was adapted and modified for subsequent hydroelectric development. This was not an unusual practice in New England, where many major waterpower privileges had been developed for industry (Hay 1991:44). Examples include the use of the International Paper Company's mill rights and power canal at the Bellows Falls Development, the development of the Lamson & Goodnow Manufacturing Company's dam site at the Deerfield No. 3 Development (1912) and the use of the former James Ramage Paper Company's dam at the Deerfield No. 5 Development (1913).

One of the most important improvements in hydroelectric technology was the development of the modern vertical-shaft turbine-generator unit, which dictated the configuration of powerhouse infrastructure including the penstocks, generator room, and foundation substructure. Around 1900, most turbines were set vertically, which was a more efficient orientation hydrologically, however, the thrust bearing technology required to practically link vertical turbines and generators had not yet been developed, and most electrical generators were designed for horizontal shaft operation. Early vertical-shaft hydroelectric turbine-generator configurations consisted of single- or multiple-runner Francis-type fixed-blade turbines set into open flumes, where the weight of the water in the open flume pressing against the turbine blades spun them by force of gravity. Horizontal Francis turbine-generator settings placed the turbine in a cylindrical steel case that was prone to efficiency-robbing turbulence and made maintenance of submerged bearings problematic. These were the limitations of the two basic turbine-generator configurations at the time that Chace & Harriman began to plan their hydroelectric developments.

Deerfield No. 3 Dam, Buckland/Shelburne, MA, built 1912, The dam was constructed on an existing water priviledge initially developed in the nineteenth century by the Lamson & Goodnow Manufacturing Co. (undated photo).

The first practical direct-connected vertical turbine-generator units were developed in 1905 by Gardner S. Williams and placed into service in a hydroelectric plant at Sault Ste. Marie, Michigan. This new technology may have influenced the choice for vertical units at Chace & Harriman's 1909 Vernon powerhouse, which incorporated vertical turbine settings with triple Francis runners in open flumes for the first eight units installed. These generating units were a hybrid of new and old technology. They incorporated new vertical bearing technology with open flumes and stock pattern turbines, which were typical of lower-efficiency, late- nineteenth-century mill waterpower technology (Hay 1991:65-67).

Early vertical thrust bearings were, however, maintenance-prone as they employed mechanical ball, cone, or roller bearings, which wore out rapidly. This may have prompted Chace & Harriman to choose horizontal shaft settings for Deerfield 2, 3, and 4 developments, built between 1911 and 1913. The turbines at these developments were set in cylindrical, riveted sheet steel "boilerplate" cases, with the shaft passing through a stuffing box into the powerhouse where the generators are located.

Subsequent improvements in vertical thrust bearings incorporated pressurized oil films, although these systems required pumps and extensive piping. In 1898 Albert Kingsbury developed the pressure-wedge thrust bearing, which did not require pumped oil. This bearing saw its first application in 1912 at the McCalls Ferry hydroelectric station on the Susquehanna River in Pennsylvania. The introduction of pressurized oil-film and Kingsbury pressure wedge-type bearings resulted in a dramatic change in hydroelectric plant design, as it made possible vertical-shaft turbine and generator settings of much greater size. The vertical setting swept hydroelectric plant design, and by 1915 many plants were being built with vertical settings (Hay 1991:71-75). The Deerfield No. 2, 3, and 4 developments are USGenNE's only horizontal-shaft units. The remainder of the Deerfield River and all the Connecticut River developments incorporate vertical shaft turbine settings using variations on oil-film bearings.

The development of successful vertical-shaft turbine settings led to advances in turbine efficiency. New powerhouse substructures began to be built with specially designed scroll cases surrounding the turbines. These spiral-shaped cast concrete or metal channels directed water into the turbine blades in a spiral motion, increasing the efficiency of the turbines. Improved elbow-shaped draft tubes were also developed to improve the efficiency of tailraces that carried water way from the turbines (Hay 1991:80-85).

In 1920 the New England Company added two new generating units to the Vernon powerhouse, consisting of two vertical-shaft, Francis-type, single fixed-runner turbines set into concrete substructures with scroll cases and draft tubes. The improved efficiency of this new technology prompted the New England Company to reequip units 5-8 with improved wheel cases and runners to improve efficiency in 1921-1922. Between 1923 and 1925, units 1-4 were radically redesigned, their triple-runner turbines replaced with single-runner units and updated substructures. All units were subsequently outfitted with improved, Gibbs-type vertical thrust bearings. The variety of turbines and substructures installed at Vernon is evidence of efforts to keep its equipment in line with industry advances over time (New England Power Company 1992: "Vernon Development," New England Power n.d.: Vernon Station).

During this time, increasingly large and powerful vertical shaft turbine-generator units with improved thrust bearings and scroll case/draft tube substructures were employed on the Deerfield River at Searsburg, Harriman, and Sherman. At the time of its completion, the Harriman Development was the largest hydroelectric power development east of Niagara Falls, supplying power on a 110-kV line to Millbury, Massachusetts. This line was the first to exceed the 66-kV standard. In total Harriman produced 140 million kV annually, almost doubling the previous output of the Deerfield River (New England Power Company 1992: "Harriman Development," New England Power n.d.: Davis Bridge Development). The Harriman Development, notable for its major engineering feats in its water delivery system, was also important for its powerhouse design, which represented the culmination of progress in hydroelectric generating made during the first quarter of the twentieth century. Its multiple-unit, vertical-shaft, large-diameter, single-runner, Francis-type turbine arrangement, combined with oil-pressure bearings and special scroll cases and draft tubes, were a mature expression of hydropower technology and infrastructure, and was the mode adopted for the New England Power Association's expanding development of the Connecticut River starting with the Bellows Falls Development in 1928, which incorporated the same technology and types of equipment.

After Bellows Falls was completed, the Connecticut River developments increased dramatically in physical size and generating capacity. These developments include Comerford, McIndoes Falls, Wilder (1950), and Moore. The increase in generating capacity was due to ever-increasing power of head, turbine runner diameter, and generator size. Technologically, these Connecticut River developments are typical of hydroelectric generating facilities of the mid- twentieth century that incorporated standardized equipment configurations that were interconnected to provide electricity to larger areas (Cook 1991:4, Hay 1991:xi-xii). The powerhouses incorporate the major elements that characterize large-scale hydroelectric generating technology during this period, including multiple, vertical-shaft, single-runner, large-diameter, high-horsepower, low-rpm turbines with scroll cases cast into their foundations, vertical thrust bearings, and improved tailrace draft arrangements. The technological advances incorporated in the Connecticut River developments mainly consisted of changes in turbine blade design and speed control governors.

The Comerford Development was a massive undertaking and the largest hydroelectric development in New England when completed. The powerhouse generated 162,300 kW, twice the combined capacity of the three previous New England Power Association Connecticut River hydroelectric developments. The high generating capacity of these large units is evidence of the ability of technological advances to meet increased electrical demand. The Comerford turbine-generator units incorporate fixed-blade, Francis-type turbines. Although this type of turbine has its origins in nineteenth-century technology, the runners at these later powerhouses are of modern design incorporating highly-efficient vane contours, and are appropriate for their high-head water sources, which provide flows of little variation (Hay 1991:78-80).

In 1931 the McIndoes Development was built downstream from Comerford as a run-of-river station to even out any large releases of water from Comerford. It is not a high-capacity station. The most significant technological feature of the McIndoes Falls Facility was its use of variable-pitch, Kaplan propeller-blade turbines, a first for New England (Cook 1991:26). The first Kaplan-type propeller runner in the U.S. was installed at the Lake Walk powerhouse in Del Rio, Texas, in 1929 (Hay 1991:xix). Kaplan-type turbines were smaller, lighter, less prone to debris damage, operated at higher speeds, and were more economical for low-head applications like McIndoes, where the volume of water was more variable (Hay 1991:79). The low-head Wilder Development also incorporated Kaplan-type, variable-pitch propeller turbines.

During the mid-1930s a significant change took place in the technology of governor mechanisms that controlled turbine runner speed. Turbine governors utilized a feedback-loop system with a speed sensor attached to the generator shaft that actuated a hydraulic arm that controlled the wicket gate openings on the turbine, thus regulating its speed. All USGenNE Connecticut River and Deerfield River powerhouses up to and including the McIndoes powerhouse incorporated hydraulic systems with traditional flyball-type

mechanical governors. By the 1920s the Woodward Company of Rockford, Illinois, had come to dominate the market for this type of equipment. During the mid-1930s, Woodward introduced governors with electromagnetic speed sensors attached to generator shafts. This no longer required that governors be located close to turbines, and "cabinet" type governor stands could be placed almost anywhere near the unit (Hay 1991:88-89). The original hydraulic, flyball governor units are in place and in varying states of modification at

McIndoes Falls and all other earlier powerhouses. The first-generation cabinet governor control units are still in place at Wilder and Moore, although they have been superceded by more modern equipment. Comerford's early governor cabinets have been removed and are stored at the Moore powerhouse (Cultural Resource Consulting Group 1997:15).

The Moore Development, completed in 1957, has a generating capacity of 191,300 kW, and remains the largest single development of a natural resource for power production in New England. Like Comerford, it utilizes conventional, although large, Francis-type, fixed-blade turbines appropriate for its high-head setting (New England Power 1992: "Moore Development").

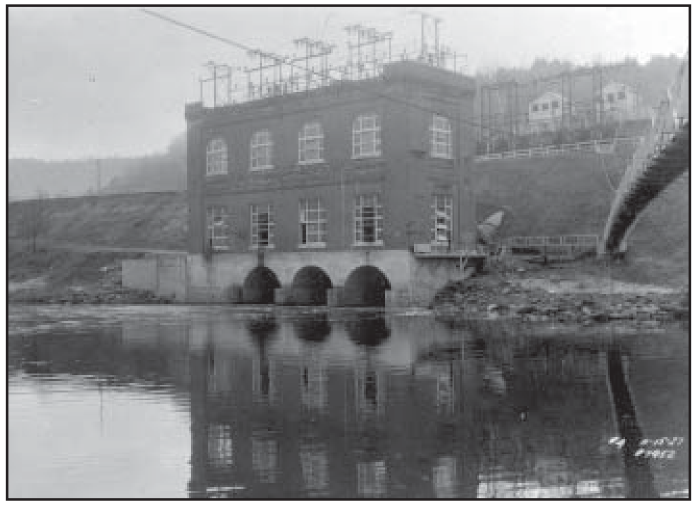
Automation and remote control are also part of the hydropower technology on USGenNE's Connecticut and Deerfield hydroelectric systems. When completed in 1922, the Searsburg hydroelectric power facility was said to be the largest fully automated plant in the United States, producing 25 million kilowatt-hours per year. It was designed for non-attendant automatic operation run off a time clock that allowed the turbine to be opened at a certain time and carry a predetermined load, and shut itself down. It was also designed to carry load based on pool height behind the Searsburg Reservoir by means of an electric float switch (Cavanaugh et al.1993). Most other developments on USGenNE's Deerfield River and Connecticut River systems were designed for full-time manned control, and have been automated over time. All Deerfield River developments are now controlled from the Harriman powerhouse. On the Connecticut River, the Moore and McIndoes developments are controlled from Comerford, and Vernon, Bellows Falls, and Wilder remain manned facilities.

USGenNE's Connecticut River and Deerfield River hydroelectric developments encompass the full range of hydroelectric generating technology developed and utilized from the late-nineteenth to mid- twentieth centuries. Turbine settings range from the triple-runner, vertical-shaft, open-flume configuration still in use in several units at Vernon; through horizontal-shaft, double-runner, "boilerplate"-case units at Deerfield Nos. 2, 3, and 4; to modern vertical-shaft settings with specially-designed scroll cases and draft tubes at the remaining developments. Conventional, fixed-blade Francis-type turbines predominate. However, Kaplan-type fixed and variable-pitch propeller type turbines are in use on the Connecticut River at the McIndoes Falls and Wilder powerhouses. The developments include a range of types of dams, spillways, gate mechanisms, water delivery systems, governors, and other mechanical and electrical equipment. The Deerfield River system incorporates particularly dramatic engineering solutions, and a landmark early automated powerhouse at Searsburg. The showpiece Harriman Development, which culminated the development of the Deerfield River, included engineering superlatives including its earth-fill semi-hydraulic dam, vertical shaft spillway, underground tunnel, and powerhouse with its mature expression of hydroelectric generating technology.

HYDROPOWER ARCHITECTURE ON THE CONNECTICUT AND DEERFIELD RIVERS

Architecturally, American powerhouses represent a synthesis of constant, highly specific functional and structural requirements, and changing popular corporate architectural styles. Powerhouses are a specialized derivative of the "erecting shop," a type of industrial building designed to house moveable cranes for building large, heavy machines. These buildings required wide, open interior spaces unobstructed by interior support columns, and incorporated steel-framed outer walls and trussed roofs, often enclosed in a masonry skin. The dimensions of powerhouses are primarily dictated by the size and number of generating units required, and the volume of the interior open space required for the structurally-integral traveling crane that is used to install and maintain the interior equipment.

As most early twentieth-century heavy manufacturing buildings were privately-owned, out of the public eye, and designed to be purely functional, they exhibited little, if any, significant decorative elements. Early powerhouses, however, were often more visible, provided a public service, and were constructed by concerns eager to promote an image of strength and reliability. Examples of early twentieth-century precedents for elaborate clear-span-interior structures intended to convey a positive public image included buildings such as banks and large urban railroad terminals, which were often modeled after historical building types ranging from medieval fortresses to Roman baths.



Deerfield No. 4 Powerhouse, built 1912. The powerhouse is an example of the Classically inspired architecture used in the designs of the early twentieth century hydroelectric facilities on the Deerfield and Connecticut rivers (November 15, 1927 photo).

Throughout the history of powerhouse construction, the regular spacing of wide structural bays and the need for large quantities of natural interior light have inspired a variety of stylistic architectural surface treatments. Early twentieth-century powerhouse architecture was clearly influenced by a lingering Victorian historicism. Most of the architectural schemes for these powerhouses were spare and Classically-derived. Examples of this phase of powerhouse architecture include the Deerfield No. 2, 3, and 4 (1912-1913), and Searsburg (1922) powerhouses. These powerhouses were designed in a restrained Renaissance Revival-style scheme most evident in the large, repeated arched windows and decorative brickwork.

Some early twentieth-century powerhouses were more decorative, and incorporated elements of other architectural styles including the Romanesque, seen at Vernon (1909) and Gothic, at Harriman (1924) and Bellows Falls (1928). The Vernon Powerhouse was designed in a restrained Renaissance Revival-style scheme, and its decoration includes elements of the Romanesque, notably the triple machicolations repeated in the cornice in the west and south elevations. The Harriman and Bellows Falls powerhouses incorporated a variety of mostly Classical details, but also included skewed Gothic buttresses with cast stone trim at the corners.

By the late 1920s, this "Powerhouse Renaissance" style was slowly abandoned in favor of a "Stripped Classicism" that incorporated rectangular windows rather than the previously ubiquitous arched ones, and retained a more limited selection of masonry embellishments, such as Sherman (1927) and McIndoes Falls (1931). The Sherman Powerhouse was designed in a transitional style that combines the restrained Renaissance Revival style popular in earlier powerhouses with the emerging stripped Classical Revival-style scheme that was becoming more common for large utility and industrial buildings of its period. The building does incorporate a Spanish terra cotta tile roof, a typical Renaissance Revival style roof cladding material, but lacks the hallmark arched windows that are characteristic of true Renaissance Revival powerhouse. The McIndoes Falls Powerhouse incorporates rectangular windows instead of arched windows, and decoration limited to a thin continuous string course below the roofline.

During the 1930s, the influence of the Art Moderne style incorporated in new skyscrapers and institutional buildings led to the adoption of hybrid styles for industrial buildings that emphasized verticality, such as the Collegiate Gothic style chosen for the Comerford Powerhouse (1930). It was designed in a Streamlined Moderne version of the Collegiate Gothic style, the most distinctive elements of which are the flat, pointed Gothic arches in the windows, which are repeated in the downstream face of the Dam, and the general emphasis on verticality. The widespread popularity of the Colonial Revival style also manifested itself in powerhouse architecture, as seen at Wilder (1950), which includes Colonial Revival features including elliptical arches, prominent gable roof returns, mock end chimneys, and ocular gable pediment windows. Ultimately, the functional tenets of Modernism resulted in the abandonment of historical references and decorative elements in powerhouse architecture in favor of buildings incorporating pure geometry and simple materials, such as the Moore Powerhouse (1957), which exhibits bold, sharp, rectangular form; lack of ornamentation; and functional use of metal sash and copings, and glass block windows.

Sources

Cavanaugh, M., A. McFeeters, and V. H. Adams
1993a Massachusetts Building Inventory Forms prepared for the Massachusetts Historical Commission.

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1993b Vermont Building Inventory Forms prepared for the Vermont Division for Historic Preservation.

Cook, Lauren J.
1991 *A Phase 1A Cultural Resources Survey in Association with the Relicensing of Eight Hydroelectric Developments Along the Deerfield River Valley in Vermont and Massachusetts, FERC L.P. No. 2323*. John Milner Associates, Inc. Submitted to New England Power Company, Westborough, MA.

Cultural Resource Group and Louis Berger & Associates, Inc.
1997 National Register Evaluation of Project Facilities: Fifteen Mile Falls Hydroelectric Project. Prepared for New England Power Company, Lebanon, NH.

Glover, John George and William Bouck Cornell
1951 *The Development of American Industries: Their Economic Significance*. Prentice Hall, New York.

Hay, Duncan
1991 *Hydroelectric Development in the United States, 1880B1940*. Edison Electric Institute, Washington, D.C.

Landry, John T. and Jeffrey L. Cruikshank
1996 *From the Rivers: The Origins and Growth of the New England Electric System*. New England Electric System.

Marcus, Alan I. and Howard P. Segal
1989 *Technology in America: A Brief History*. Harcourt Brace Jovanovich, New York.

New England Power
1992 *Hydro Reference Manual.* Lebanon, NH.

New England Power System
n.d. *Description of Generating Stations, Substations, and Important Transmission Lines with Photographs of Interesting Features.* New England Power Company, Worcester, MA.

6.12 CONFIDENTIAL Fifteen Mile Falls Hydroelectric Project (FERC No. 2077) Cultural Resource Management Plan Baseline Conditions Monitoring Update

This report contains sensitive location information and will be provided under separate cover. (117 pgs)

6.13 CONFIDENTIAL Fifteen Mile Falls Biannual CRM Monitoring Report 2019-2020

This report contains sensitive location information and will be provided under separate cover. (29 pgs)

7.0 APPENDIX C – SWORN STATEMENT

All applications for LIHI Certification must include the following sworn statement before they can be reviewed by LIHI:

SWORN STATEMENT

As an Authorized Representative of __Great River Hydro, LLC_____, the Undersigned attests that the material presented in the application is true and complete.

The Undersigned acknowledges that the primary goal of the Low Impact Hydropower Institute's Certification Program is public benefit, and that the LIHI Governing Board and its agents are not responsible for financial or other private consequences of its certification decisions.

The undersigned further acknowledges that if certification of the applying facility is issued, the LIHI Certification Mark License Agreement must be executed prior to marketing the electricity product as LIHI Certified.

The undersigned Applicant further agrees to hold the Low Impact Hydropower Institute, the Governing Board and its agents harmless for any decision rendered on this or other applications, from any consequences of disclosing or publishing any submitted certification application materials to the public, or on any other action pursuant to the Low Impact Hydropower Institute's Certification Program.

PLEASE INSERT ONLY FOR PRE-OPERATIONAL CERTIFICATIONS (See Section 4.5.3)**:**
For applications for pre-operational certification of a "new" facility the applicant must also acknowledge that the Institute may suspend or revoke the certification should the impacts of the project, once operational, fail to comply with the certification criteria.

Company Name: Great River Hydro, LLC

Authorize Representative Name: Erin A. O'Dea

Title: Vice President - Legal

Authorized Signature: [signature]

Date: January 19, 2022