Vernon Hydroelectric Project

Water Quality Certification
(33 U.S.C. §1341)

Vermont Agency of Natural Resources
Department of Environmental Conservation
Montpelier, Vermont
April 17, 2025

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VERMONT AGENCY OF NATURAL RESOURCES
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Water Quality Certification
(33 U.S.C. §1341)

In the matter of: Vernon Hydroelectric Project
Great River Hydro, LLC
69 Milk Street; Suite 306
Westborough, MA 01581

APPLICATION FOR VERNON HYDROELECTRIC PROJECT

Section 401 of the federal Clean Water Act requires that any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates that any such discharge will comply with other substantive provisions of the Clean Water Act. 33 U.S.C. § 1341(a)(1). The certifying State may set forth any effluent limitations and other limitations, and monitoring requirements necessary to assure that any applicant for a federal license or permit will comply with the Clean Water Act and with any other appropriate requirement of State law. 33 U.S.C. § 1341(d). In Vermont, the Agency of Natural Resources is the certifying agency of the State for purposes of Section 401 of the Clean Water Act. 10 V.S.A. § 1004. The Secretary of Natural Resources has delegated the authority to make certification determinations to the Department of Environmental Conservation (Department). The Connecticut River is a boundary water with the state of New Hampshire and a water quality certification application is also being reviewed by the New Hampshire Department of Environmental Services for consistency with the New Hampshire Water Quality Standards.

The Department has reviewed a water quality certification application dated April 18, 2024, and filed by Great River Hydro (the Applicant or GRH) for the Vernon Hydroelectric Project (the Project). The supporting documentation for the certification application includes the Applicant's Federal Energy Regulatory Commission (FERC) final license application (FERC No. 1904) dated December 7, 2020, and the Applicant's amended final license application dated June 7, 2023, the settlement agreement on fish passage filed with FERC on August 2, 2022, and other supporting documents filed by the Applicant in support of the application. The record for this decision includes these supporting documents, including the Applicant's responses to the February 18, 2022, September 2, 2022, and October 4, 2022, FERC Additional Information Requests (AIR); and many other documents related to the Project and its relicensing filed through March 17, 2025. An Environmental Impact Statement for the Project to be conducted by FERC has yet to be completed.

The current application is subject to review under the Vermont Water Quality Standards promulgated by the Agency of Natural Resources and effective November 15, 2022 (Environmental Protection Rule, Chapter 29A) (VWQS or Standards). (Standards, Section 29A-101 Applicability).

The Department held a hearing on March 5, 2025, at 5:30 PM in Brattleboro, Vermont to receive oral comments. The Department also accepted written or voicemail comments through 4:30 PM on March 17, 2025. Comments were received from 20 persons, representing themselves or organizations. Additional information on the final decision, draft decision, application, and any pertinent updates can be found at the Vermont Agency of Natural Resources Environmental Notice Bulletin Board (https://enb.vermont.gov/), by searching for the project name.

The Department, based on the application and record before it, makes the following findings and conclusions.

I. Applicable Statues and Regulations

A. Applicable Provisions of the Vermont Water Quality Standards

1. The applicable 2022 Vermont Water Quality Standards were adopted by the Secretary of the Agency of Natural Resources pursuant to 10 V.S.A., Chapter 47, Water Pollution Control. Section 1252 of Chapter 47 provides for the classification of designated uses as either Class A(1), A(2), B(1) or B(2) and authorizes the adoption of standards of water quality to achieve the purpose of classification.

2. All waters of the State shall be managed to support their designated and existing uses. (Standards, Section 29A-104(b)).

3. The designated uses of waters of the State are: aquatic biota and wildlife that may utilize or are present in the waters; aquatic habitat to support aquatic biota, wildlife, or plant life; the use of waters for swimming and other primary contact recreation; the use of waters for boating and related recreational uses; the use of waters for fishing and related recreational uses; the use of waters for the enjoyment of aesthetic conditions; the use of the water for public water source; and the use of water for irrigation of crops and other agricultural uses. (Standards, Section 29A-104(d)).

4. The affected reaches of the Connecticut River have been classified as Class B(2) for all designated uses.

5. The Antidegradation Policy in the Standards requires that "[a]ll waters shall be managed in accordance with these [Standards] to protect, maintain, and improve water quality." (Standards, Section 29A-105).

6. The Connecticut River is designated as cold water fish habitat. (Standards, Section 29A-308).

7. In waters designated as cold water fish habitat and for which the Secretary determines are salmonid spawning or nursery areas important to the establishment or maintenance of the fishery resource, the dissolved oxygen (DO) standard is not less than 7 mg/L and 75 percent saturation at all times, nor less than 95 percent saturation during late egg maturation and larval

development of salmonids. In all other waters designated as a cold-water fish habitat, the standard is not less than 6 mg/L and 70 percent saturation at all times. (Standards, Section 29A-302(5)(A)).

8. The general temperature standard for all waters is “[c]hange or rate of change in temperature, either upward or downward, shall be controlled to ensure full support of aquatic biota, wildlife, and aquatic habitat uses.” (Standards, Section 29A-302(1)(A)).

9. In waters designated as cold water fish habitat and classified as Class B(2) for the fishing designated use, the total increase from ambient temperature due to all discharges and activities shall not exceed 1.0° F. (Standards, Section 29A-302(1)(B)(iii)).

10. The turbidity standard as an annual average under dry weather base-flow conditions is 10 NTU for cold water fish habitat. (Standards, Section 29A-302(4)(A)).

11. The general criteria applicable to all waters include criteria that shall be achieved regardless of their classification including “[s]ludge deposits or solid refuse. None.” (Standards, Section 29A-303(1)).

12. The management objectives for waters classified as Class B(2) for aquatic biota and wildlife are “[w]aters shall be managed to achieve and maintain good biological integrity.” (Standards, Section 29A-306(a)(3)(A)). The Class B(2) criteria for aquatic biota and wildlife use require “[c]hange from the natural condition for aquatic macroinvertebrate and fish assemblages not exceeding moderate changes in the relative proportions of taxonomic, functional, tolerant, and intolerant aquatic organisms.” (Standards, Section 29A-306(a)(3)(B)).

13. The management objectives for waters classified as Class B(2) for aquatic habitat are “[w]aters shall be managed to achieve and maintain high quality aquatic habitat. The physical habitat structure, stream processes, and flow characteristics of rivers and streams and physical character and water level of lakes and ponds necessary to fully support all life-cycle functions of aquatic biota and wildlife, including overwintering and reproductive requirements, are maintained and protected.” (Standards, Section 29A-306(b)(3)(A)). The Class B(2) criteria for aquatic habitat use in rivers and streams are “[c]hanges to flow characteristics, physical habitat structure, and stream processes limited to moderate differences from the natural condition and consistent with the full support of high quality aquatic habitat.” (Standards, Section 29A-306(b)(3)(B)(i)). Additionally, “[w]aters shall comply with the Hydrology Criteria in Section 29A-304” of the Standards. (Standards, Section 29A-306(b)(3)(B)(iii)).

14. The hydrology policy in the Standards requires that “[t]he proper management of water resources now and for the future requires careful consideration of the interruption of the natural flow regime and the fluctuation of water levels resulting from the construction of new, and the operation of existing, dams, diversions, and other control structures.” (Standards, Section 29A-103(f)(1)).

15. To effectively implement the hydrology policy, hydrology criteria shall be achieved and maintained, where applicable. (Standards, Section 29A-304(a)). The hydrology criteria require for waters classified as Class B(2) for aquatic habitat that “[a]ny change from the natural flow regime shall provide for maintenance of flow characteristics that ensure the full support of uses and comply with the applicable water quality criteria.” Further, the Standards establish “[t]he preferred method for ensuring compliance with this subsection is a site-specific flow study. In the absence of a site-specific study, the Secretary may establish hydrologic standards and impose additional hydrologic constraints, consistent with any applicable Agency of Natural Resources rule or procedure, to ensure compliance with the requirements of this subsection.” (Standards, Section 29A-304(b)(3)).

16. The water level fluctuation criteria for lakes, ponds, reservoirs, riverine impoundments, and any other waters classified as B(2) for aquatic habitat or boating establish that “waters may exhibit artificial variations in water level when subject to water level management, but only to the extent that such variations ensure full support of uses.” (Standards, Section 29A-304(d)(2)).

17. The management objectives for waters classified as Class B(2) for aesthetics are “[w]aters shall be managed to achieve and maintain good aesthetic quality.” (Standards, Section 29A-306(c)(3)(A)). The Class B(2) criteria for aesthetics in rivers and streams are “[w]ater character, flows, water level, bed and channel characteristics, and flowing and falling water of good aesthetic value.” (Standards, Section 29A-306(c)(3)(B)(i)).

18. The management objectives for waters classified as Class B(2) for boating are “[w]aters shall be managed to achieve and maintain a level of water quality compatible with good quality boating.” (Standards, Section 29A-306(d)(3)(A)). The Class B(2) criteria for boating use is “[w]aters shall comply with the Hydrology Criteria in Section 29A-304 of these rules.” (Standards, Section 29A-306(d)(3)(B)).

19. The management objectives for waters classified as Class B(2) for swimming and other primary contact recreation are “[w]here sustained direct contact with the water occurs, waters shall be managed to achieve and maintain a level of water quality compatible with good quality swimming and other primary contact recreation with very little risk of illness or injury from conditions that are a result of human activities.” (Standards, Section 29A-306(f)(3)(A)).

20. The management objectives for waters classified as Class B(2) for fishing are “[w]aters shall be managed to achieve and maintain a level of water quality compatible with good quality fishing.” (Standards, Section 29A-306(e)(3)(A)). The criteria for fishing are “[m]easures of wild salmonid densities, biomass, and age composition indicative of good population levels” and compliance with the temperature criteria in Section 29A-302(B) of the Standards. ((Standards, Sections 29A-306(e)(3)(B)(i) and 29A-306(e)(3)(B)(ii)).

II. Factual Findings

A. General Setting and Background

21. The Connecticut River is the longest river in New England at a length of roughly 407 miles. The sources are the Connecticut lakes located in the town of Pittsford, New Hampshire, just south of the border with Quebec, Canada. The river flows southerly forming the 255 mile border of Vermont and New Hampshire from Canaan, Vermont to the Massachusetts border at Vernon, Vermont and continues through Massachusetts to the Long Island Sound. The river has a drainage area of 11,250 square miles.

22. The Connecticut River has long been used for various economic purposes, such as large log drives beginning around 1865 and continuing through roughly the early 1920s. There were, and continues to be, numerous dams along the Connecticut River for industrial and transportation purposes.

23. The Connecticut River is heavily developed for the production of hydroelectric power. There are 12 FERC-licensed hydropower projects located on the mainstem of the Connecticut River. There are other hydropower projects located on the tributaries to the Connecticut River, in addition to United States Army Corps of Engineers (USACE) flood control facilities.

24. The Vernon Hydroelectric Project (FERC No. 1904) is an existing licensed project located at river mile 141.9 on the Connecticut River in the towns of Vernon, Vermont and Hinsdale, New Hampshire. The Project is located approximately two miles upstream of the confluence with New Hampshire's Ashuelot River, and 7.4 miles downstream of the confluence with Vermont's West River. The drainage area at the Project is 6,266 square miles.

25. The Project was originally constructed in 1909 and expanded to add two additional units in 1925. The original license for the Project was issued by the Federal Power Commission on March 26, 1945. The site was subsequently purchased by New England Power Company in 1955.

26. The original license expired on June 30, 1970. The Project continued to operate on an annual basis until the license was renewed on June 25, 1979. During this renewal process, FERC approved a settlement agreement that authorized downstream fish passage facilities for American Shad (*Alosa sapidissima*) and Atlantic Salmon (*Salmo salar*) between multiple parties, including the Commonwealth of Massachusetts, the states of Connecticut, New Hampshire, and Vermont, the U.S. Fish and Wildlife Service, and four non-governmental organizations.

27. The settlement agreement required the design, construction, and operation of fish passage facilities. Operation of the upstream fish ladder began in 1981. In 1986, the spillway crest was reconstructed to improve water control, which included a trash sluice gate, six Tainter gates, two 50-foot bays in the spillway section, an access deck, and trashrack raking system.

28. In 1990, the licensee entered into a Memorandum of Agreement with the Connecticut River Atlantic Salmon Commission for downstream fish passage. In 1992, the FERC license was amended for the replacement of four 2-megawatt (MW) units with two 14-MW units. Article 403 of the 1993 license amendment required downstream passage facilities, which were constructed at the Vernon Project in 1995.

29. In 1998, FERC approved transfer of the license from New England Power Company to USGen New England, Inc. After extensions of the 1992 amendment, the FERC license was amended again in 2006 authorizing the replacement of four 2.0-MW units with four 4.0-MW units. The redevelopment was completed in 2008.

30. In 2005, FERC approved the transfer of the license to TransCanada Hydro Northeast Inc. In 2017, the license was transferred again to TransCanada Hydro Northeast LLC and after close of a sale process, the licensee was renamed Great River Hydro, LLC.

B. Project and Civil Works

31. The Project boundary encompasses 287 acres including owned land and private land for which flowage rights are retained. Thirty four acres are available to the public for outdoor recreation, 16 acres are used for the power plant and related facilities, 14 acres support local agriculture, and the remaining 223 acres are forested.

32. The dam is a composite overflow and non-overflow ogee type concrete gravity structure that spans the Connecticut River between Vernon, Vermont and Hinsdale, New Hampshire. It is 956 feet long with a maximum height of 58 feet. The power plant is integral to the dam, which is comprised of two sections: a gated section that is about 356 feet long, as well as a 600-foot long concrete overflow spillway section.

33. The spillway is split into 12 sections. From west to east, there is a trash and ice sluice, four Tainter gates, two bays with hydraulic flashboards, three stanchion bays, and then two additional Tainter gates. Additionally, there are eight submerged hydraulic flood gates below the spillway and the larger Tainter gates. Concrete piers separate these sections and support a steel and concrete bridge that spans the dam to provide access to and allow operation of the flashboards. The trash sluice is a gate that allows logs and debris to pass, which are deflected away from the powerhouse by a boom barrier.

34. The impoundment created by the Vernon dam extends approximately 26 miles upstream to roughly the Walpole Bridge (Route 123 Bridge) at Westminster Station, Vermont. However, the exact location of the impoundment extent varies in the FERC record. The impoundment has a surface area of 2,550 acres, about 69 miles of shoreline, and a storage volume of about 40,000 acre-feet of water at an elevation of 220.13 feet at the top of the stanchion boards. If the hydraulic and stanchion flashboards are lowered or removed during high

flow, the water level can drop to the spillway crest at 212.13 feet, which equates to a maximum usable storage capacity of 18,300 acre-feet. Typically, the reservoir operates between elevations of 218.3 and 220.1 feet under normal conditions, which equates to a usable storage capacity of 4,489 acre-feet. The relatively flat terrain limits storage capacity.

35. The powerhouse is integral to the dam and measures 336 feet long, 55 feet wide, and 45 feet high. The powerhouse is comprised of a concrete foundation with steel and brick construction above ground. The powerhouse has ten turbine generator units. Units 1 through 4 are single runner vertical Francis turbines, each with a maximum hydraulic capacity of 1,465 cfs and minimum hydraulic capacity of 400 cfs. Units 5 through 8 are vertical Kaplan turbines, each with a maximum hydraulic capacity of 1,800 cfs and a minimum hydraulic capacity of 300 cfs. Units 9 and 10 are single runner vertical Francis units, each with a maximum hydraulic capacity of 2,035 cfs and minimum hydraulic capacity of 500 cfs. When all units are running at full capacity, and inflow reaches or exceeds the station discharge capacity of 15,400 cfs, the generation capacity of the Project is 32 megawatts.

36. The powerhouse also contains a variety of supporting infrastructure including electrical transformers, switchboard electric infrastructure, a switchboard, machine shop, excitation equipment, emergency generator, air compressor, an overhead crane, offices, storage rooms, and other ancillary equipment. The control room is only used as backup as operations are automated and controlled from the Connecticut River Control Center, which is located next to the Wilder Hydroelectric Project.

37. The intake is a concrete gravity structure that is integral to the powerhouse with three water passages: one for each of Units 9 and 10, and one for Units 1 through 8. Water moves from the forebay intakes into the scroll or wheel cases which are formed into the concrete foundation. The draft tubes discharge into a short tailrace excavated partly in the bank and partly in the bedrock bed of the river.

38. The trashracks for Units 1 through 8 have 1.75-inch clear bar spacing. The trashracks for Units 9 and 10 have 3.625-inch clear bar spacing. A hydraulic rake is used to clear debris from the intakes. It is manually operated and moved to each trashrack on a set of tracks on top of the intake structure. The debris is then conveyed to a trailer for removal. A trash and ice sluice includes a 13-foot by 13-foot skimmer gate in the station forebay that passes logs and other debris deflected away from the powerhouse by a log and ice boom.

39. The electrical facilities owned and operated by Great River Hydro include four step-up transformers, bus structures, switching equipment and switchboard, generator terminals, and an approximately 500-ft, 13.8-kilovolt (kV) interconnection that runs underneath the station to two outdoor 13.8- to 69-kV step-up transformers located in an outdoor substation west of the powerhouse.

40. Non-Project facilities located within the Project boundary include switchgear,

bus work, and a 69-kV interconnection owned by the regional transmission company, New England Power Company, or National Grid.

41. Recreation facilities, provided within the Project boundary, include a boat launch, portage, picnic areas, open space, a fish ladder viewing area, and fishing access.

Fish Passage Infrastructure

42. The Project has both upstream and downstream infrastructure designed for Atlantic Salmon and American Shad. A fish ladder provides upstream passage and a ‘fish pipe’ and ‘fish bypass’ provide downstream passage.

43. The fish ladder is a 984-foot long concrete structure with various accessory electrical, mechanical, and pneumatic equipment that provides upstream fish passage for a vertical distance of approximately 35 feet.

44. Upstream migrating fish enter the tailrace area where they are attracted to entrance weirs at the west end of the powerhouse. Attraction water to the entrance weirs consists of 64 cfs from the fishway and up to 254 cfs through a floor diffuser from a water intake at the fishway exit. A total of 260 cfs of attraction flow is required for the fishway. The amount of attraction flow is dependent upon tailwater elevation and are set by an automated supply gate to regulate fishway elevation between 0.9 and 1.4 feet higher than the tailwater elevation. About 136 cfs of supplemental flow is required when tailwater elevations are between 180 and 185 feet, and 254 cfs is required to supplement the fishway flow when tailwater elevation is between 185 and 192 feet.

45. Fish attracted into the ladder swim through a series of 51 pools created by overflow weirs in the lower section and vertical slot pools in the upper section. The lower section is comprised of 26 overflow weir pools that are 15 feet wide by 10 feet long and 12 inches higher than the prior pool.

46. After the overflow weir section, fish enter a regulating pool that also functions as a counting and trapping area. The water surface elevation is maintained at 208 feet and the 64 cfs fishway flow enters the section where the floor diffuser is located to supplement attraction flow. Fish are guided by flow and crowder screens through an opening that passes two underwater viewing windows where they can be observed and counted. One of the viewing windows is open to the public. Manually operated pneumatic trapping gates also allow for trapping by diversion to a holding pool.

47. From the regulating pool, fish continue to swim through the upper vertical slot section of the ladder. This section consists of 25 pools that are each about six inches higher than the prior pool. At the upper end of the ladder, fish pass through a flume and screens protecting the attraction water intake to a 12-foot wide exit channel, and into the forebay. The exit channel is divided by a concrete pier and includes headgates, trashracks with 11 1/8-inch clear

spacing to allow adult salmon to pass, and slots for wooden stop logs.

48. A public viewing area and underwater window are located south of the powerhouse parking lot.

49. Downstream fish passage is provided by two routes: a "fish pipe" that goes through the powerhouse and a smaller "fish bypass" at the Vermont end of the powerhouse, along with a louver array.

50. The ‘fish pipe’ discharges approximately 350 cfs and passes through the powerhouse between Units 4 and 5. A 156-foot long louver array extends from the forebay to the fish pipe entrance to intercept and direct downstream migrating fish from mid-river and the east shoreline into the fish pipe. The louver array is angled and consists of stainless steel panels with 3/8-inch by 2-inch louver vanes placed 3 inches on center and angled 60 degrees from the direction of the panels. Panels extend to a depth of 12–14 feet.

51. The ‘fish bypass’ is smaller and located near Unit 10. It discharges about 40 cfs and functions as a secondary passage route for fish that are not intercepted by the louver array and enter the western end of the forebay.

C. River Hydrology

52. The Connecticut River is highly developed for hydropower and this portion of the Connecticut River is highly regulated. In addition to regulation from hydropower dams, flow regulation also occurs from the operation of the USACE flood control dams.

53. The northernmost facilities in the Connecticut River watershed are located on Second Connecticut Lake, First Connecticut Lake, and the Murphy dam on Lake Francis. These facilities regulate the lakes that form the headwaters of the Connecticut River and are not governed by FERC licenses.

54. Two FERC regulated facilities, the Gilman (FERC No. 2392) and Cannan (FERC No. 7528) hydroelectric projects are located on the Connecticut River downstream of the Connecticut lakes. Both are run-of-river facilities.

55. Downstream of these facilities is the Fifteen Mile Falls Project (FMF), which is a storage and peaking project that includes the McIndoes, Comerford, and Moore facilities and drains an area of 2,210 square miles.[1] The degree of storage at FMF provides for flow regulation on larger timeframes, up to seasonally.

56. Downstream of FMF is Dodge Falls, a run- of-river facility.[2]

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[1] Fifteen Mile Falls FERC Number 2077 was relicensed in 2002. The Fifteen Miles Falls project consists of McIndoes, Comerford, and Moore dams.

[2] Dodge Falls FERC Number 8011 is a FERC exempt project that was licensed in 1984. A true run-of-river project is one which does not operate out of storage and therefore, does not artificially regulate streamflow below the project’s tailrace. Outflow from the project is equal to inflow to the project’s

57. Between Dodge Falls and the Vernon Project are two hydroelectric projects on the lower Connecticut River that are owned and operated by the Applicant, the Bellows Falls Hydroelectric Project and the Wilder Hydroelectric Project. The Bellows Falls Dam is 43 miles downstream of Wilder Dam and Vernon Dam is 32 miles downstream of Bellows Falls Dam. Each of the Wilder, Bellows Falls, and Vernon projects are undergoing relicensing.

58. At Vernon Dam, the drainage area is 6,266 square miles. Only 852 square miles of the drainage area, or 13.6 percent, contributes inflow that is not regulated. In further characterizing the degree of regulation at the Vernon project, it should be noted that currently the Wilder, Bellows Falls, and Vernon projects are operated together to enhance power production, which results in substantial flow regulation, primarily on an intraday and interday basis.

59. Additionally, Great River Hydro's coordination of their generation facilities includes FMF. Peaking operations at FMF affect flow in the lower Connecticut River. Project operations at the McIndoes facility take approximately eight hours to reach the Wilder Dam. Under normal flow conditions, it takes about eight hours for outflow from the Wilder Dam to reach the Bellows Falls Dam and four hours for outflow from the Bellows Falls Dam to reach Vernon Dam.

60. Downstream of the Vernon Project are the Northfield Mountain Pumped Storage, Turners Falls, and the Holyoke projects located in Massachusetts. The Northfield Mountain and Turners Falls projects are also undergoing relicensing.

61. Based on available information, there is limited use of surface water from the Connecticut River for non-power purposes within the Project area. There are three New Hampshire-registered withdrawals in Hanover, Plainfield, and Westmoreland that take directly from the Connecticut River and are used for irrigation or institutional purposes. The only significant withdrawal from Vermont waters of the Connecticut River was for cooling and service water for the Vermont Yankee Nuclear Power Plant, which ceased commercial operations in 2014. However, the plant continues to withdraw service water at a reduced quantity and rate from the river for non-commercial purposes like non-contact cooling service water.

62. It should be noted that not all water withdrawals may be known. As of 2023, Vermont enacted a water withdrawal registration program. If an individual or applicant withdraws more than 10,000 gallons or more of surface water within a 24-hour period, or 150,000 gallons or more over a 30-day period, that entity is required to register with the state. It should be noted that New Hampshire requires registration for individuals or companies withdrawing more than 20,000 gallons of water a day, averaged over seven days, or more than 600,000 gallons per day in a 30-day period. If an applicant withdraws less

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impoundment on an instantaneous basis. The flow regime below the project is essentially the river's natural regime, except in special circumstances, such as following the reinstallation of flashboards and project shutdowns. Under those circumstances, a change in storage contents is necessary, and outflow is reduced below inflow for a period.

water than New Hampshire or Vermont registration requirements, then it is likely that these locations would remain unknown.

63. There are numerous water gaging stations located on the Connecticut River, and tributaries near their confluence with the Connecticut. The gaging stations located on the Connecticut River as it traverses the border of Vermont include USGS gage No. 01129500 near North Stratford, USGS gage No. 01131500 near Dalton, USGS gage No. 01138500 at the Wells River, USGS gage No. 01144500 at West Lebanon, and USGS gage No. 0115450 at North Walpole. These gages have been in operation since 1990, with some beginning operations in 1988. There are additional gages in the Connecticut River Watershed that are either still in operation or have operated historically but are no longer collecting current data.

64. As noted above, the Connecticut River is highly regulated starting at the First Connecticut and Second Connecticut lakes and continuing through and beyond the boundary with the Commonwealth of Massachusetts. Although the gages on the mainstem reflect regulation, there are a number of gages in the Connecticut River watershed that do not reflect artificial regulation. For this reason, with some assumptions, estimates can be made as to what a natural hydrologic regime in the Connecticut River system may look like.

65. Table 1 below characterizes the hydrologic conditions of the Connecticut River in the vicinity of the Project. The unregulated flows column represents the average flow values of unregulated gages within the watershed upstream of the Vernon Project prorated to the Vernon Dam. The list of gages where hydrologic data was used, the drainage area in square miles, and the period of record is provided in Table 2.

66. The second column in Table 1 is an estimate of the observed regulated flows above the Vernon Project prorated to the dam site. The hydrologic data was collected at USGS gage 01154500 at North Walpole, NH with a period of record from 1980-2023.

67. The last column in Table 1 is an estimate of the observed regulated flows below the Project prorated to the dam site. These data were collected at USGS gage 01161280 near Northfield, MA, with a period of record from 2018-2023.

Table 1. Hydrologic statistics for the Connecticut River at Vernon Dam. Values vary depending on the calculation and gages used. Data presented are in cubic feet per square mile (csm).

$7Q_{10}$[3] or Monthly Median	Unregulated Flows Average (csm)	Pro-rated Observed Regulated Flows Above Dam (csm)	Pro-rated Observed Regulated Flows Below Dam (csm)
$7Q_{10}$	0.14	0.26	0.24*
January	0.88	1.28	1.55
February	0.78	1.18	1.34
March	1.34	1.97	2.12
April	3.74	3.99	3.61
May	2.23	2.27	2.07
June	1.00	1.28	0.71
July	0.54	0.80	0.81
August	0.41	0.63	0.56
September	0.40	0.56	0.60
October	0.69	0.96	0.95
November	1.22	1.49	1.39
December	1.12	1.53	1.85

*Only 6 years of data below Vernon Dam. Insufficient for $7Q_{10}$ calculation. Included lowest 7-day average flow below Vernon for this 6 year period.

Table 2. USGS gages on unregulated streams used to estimate natural flows into the Connecticut River above the Vernon Hydroelectric Project.

USGS Gage Number	USGS Gage Name	Drainage Area (square miles)	Period of Record
1127880	Big Brook near Pittsburg, NH	6.36	1964-1984
1129300	Halls Stream near East Hereford, Quebec	85	1963-1992
1129440	Mohawk River near Colebrook, NH	36.7	1987-2004
1130000	Upper Ammonoosuc River near Groveton, NH	232	August 1940 to November 1980. October 1982-September 2004. July 2009 to current year
1135500	Passumpsic River at Passumpsic, VT	436	1930-2018
1138000	Ammonoosuc River near Bath, NH	395	1936-1981

[3] $7Q_{10}$ is defined as a flow equal to the lowest mean flow for seven consecutive days that has a 10 percent chance of occurring in any given year.

USGS Gage Number	USGS Gage Name	Drainage Area (square miles)	Period of Record
1139800	East Orange Branch at East Orange, VT	8.95	1959-2018
1139000	Wells River at Wells River, VT	98.4	1941-2018
1141800	Mink Brook near Etna, NH	4.6	1962–1998
01153550	Williams River near Rockingham, VT	112	1987-2023
01152500	Sugar River at West Claremont, NH	269	1929-2023
01150900	Ottauquechee River near West Bridgewater, VT	23.4	1985-2023
01144000	White River at West Hartford, VT	690	1916-2023
01145000	Mascoma River at West Canaan, NH	80.5	1940-1978
01154000	Saxtons River at Saxtons River, VT	72.2	1941-2023
01155000	Cold River at Drewsville, NH	82.7	1941-1978

68. The Applicant developed an operations model as part of the relicensing process (study 5). This study allows for additional metrics to be estimated. The operations model uses an intensive HEC-RAS model with inputs from upstream facilities, operations, and water surface elevation data collected at various nodes within the impoundment and downstream of the facility, and inflow estimates. The inflow estimates allow the Applicant to model inflow equals outflow (IEO) scenario to develop metrics and characterize the flow regime.

69. The model was then used to simulate water flows and level fluctuations in the months of February, June, August, and November. Due to the intensity of the modeling exercises, these months are representative of the different seasons particularly those of biological importance. To evaluate operations during various types of water years, the Applicant used the same model developed in study 5 for four different years, representing the years that are statistically dry to wet water years. The years were 2009, 2015, 2016, and 2017, with 2009 being the wettest and 2015 being the driest. The model routed water starting at the most upstream portion of the Vernon impoundment to the Vernon dam, over roughly 26 miles of river. The water is then simulated to pass through the

Project and is discharged downstream of the dam. Each of the simulations were developed at an hourly timestep. No attenuated flow or nodal water surface elevation (WSE) analysis was performed in the 1.5-mile portion below Vernon because it is also affected by the Turners Falls and Northfield projects downstream.

70. There are a variety of metrics that can be estimated when characterizing the downstream flow regime for IEO operations. These include, but are not limited to daily minimum flow downstream, mean daily amplitude, and the flashiness of the reach downstream.

71. Using the model outputs provided by the Applicant, the minimum daily flow for each target month and year can be calculated. Those values are then averaged over the target month.

72. To calculate mean daily amplitude, the minimum and maximum daily flow value is first calculated. The difference between those two values is then calculated and averaged over the course of the month.

73. The flashiness metric is calculated by using the Richard-Baker Flashiness Index equation to calculate an index value for flashiness. (Figure 1). This index does not account for interannual variability and higher daily flows when calculating flashiness. This index does however account for hourly, or within day, changes in flow. This analysis was calculated on an hourly timestep with the total flow considered over a 24-hour period. Each day, 24-hour period, was then averaged to obtain a monthly value. This was calculated for each year, and scenario provided.

Table I. Metrics used to assess subdaily flow fluctuations based on hourly flow data

Metric	Description	Reference
Richards–Baker flashiness index (RBF)	$R\text{–}B \text{ Index} = \frac{\sum_{i=1}^{n} 0.5(\lvert q_{i+1} - q_i \rvert + \lvert q_i - q_{i-1} \rvert)}{\sum_{i=1}^{n} q_i}$ where q is hourly flow and n is the number of records over the analysis period (24 h). The index is the path length of flow oscillations (sum of the absolute values of hour-to-hour changes in hourly flows) divided by the sum of hourly flows over each 24-h period.	(Baker *et al*., 2004)

Figure 1. The equation used to calculate a flashiness index for each year and month. This image can be found in Zimmerman, J.K.H. et al. 2010. Determining the effects of dams on subdaily variation in river flows at a whole-basin scale. River Research and Applications. 26: 1246-1260

74. While this information is not indicative of the natural flow regime, it does provide estimates of the hydrology of the lower Connecticut River when omitting influences from Project operations. The value for each of the metrics described above, mean downstream flow, mean daily amplitude, and flashiness are provided below. (Table 3).

Table 3. Downstream flow metrics below the Vernon Project without project related alterations, or in an inflow equals outflow mode.

Target Month and Year	Mean Minimum Downstream Flow	Mean Daily Amplitude	Flashiness
2009			
February	5970	2455	0.03
June	8166	1959	0.01
August	8796	1723	0.01
November	10316	1047	0.01
2016			
February	10289	1727	0.01
June	4088	1572	0.01
August	2912	1480	0.02
November	4750	2518	0.03
2017			
February	10178	1788	0.01
June	4090	1595	0.02
August	2902	1490	0.03
November	4591	2470	0.04
2015			
February	4180	3095	0.05
June	11835	1072	0.01
August	3375	2259	0.04
November	5797	2491	0.03

D. Current Operations

Description of Current Operations

75. The Project operates as a peaking project within the bounds of license conditions, agreements, and self-imposed restrictions. As a license condition, the Project is required to pass a flow of 1,250 cfs, or inflow if less, downstream. However, the minimum flow is typically about 1,600 cfs due to more efficient generation at this flow.

76. Project operations are automated and controlled from a consolidated hydro operations control center located in Wilder, Vermont. GRH typically operates the Project in a coordinated manner with the other hydroelectric generating facilities on the Connecticut River that it owns and operates to optimize generation. (Finding 58 and 59).

77. Reservoir drawdown rates are typically 0.1 to 0.2 feet per hour depending on inflow and do not exceed 0.3 feet per hour. Approximately 3,000 cfs per hour equates to 0.1 foot of elevation change. The authorized operating range for the

Project is from elevation 212.13 ft to 220.13 ft, an eight foot range. Under normal operations, the impoundment is typically maintained between elevation 218.3 and elevation 220.1 feet, a 1.8-foot range (NGVD 29).

78. The Project maintains self-imposed restrictions beginning on the Friday before Memorial Day through the last weekend in September. GRH will maintain a reservoir elevation of 218.6 feet at the dam from Friday at 4 PM through Sunday at midnight. GRH maintains a similar elevation during summer holidays.

79. The Project is generally operated on a daily run-of-river basis, meaning over the course of a day, the Project generally passes the daily average inflow. However, on an intraday basis, generation can vary between the required minimum flow and full generating capacity.

80. The Applicant implements “river profile” operations under certain conditions when anticipated inflow to the Project impoundment increases above the generating capacity of the Project. These measures lower the impoundment elevation under high flow conditions. Table 4 specifies the maximum impoundment elevation for specific inflow conditions.

Table 4. Inflow and corresponding elevation targets at the dam in ‘river profile’ operations

6- hour Inflow (cfs)	Maximum Elevation at Dam (NGVD 29)
<17,000	220.13
17,000-45,000	219.6
45,000-70,100	218.6
70,100-105,000	If >218.5, elevation maintained below 220.1 as long as possible, with stanchion board removal as needed
>105,000	All gates, flashboard panels, and stanchion boards are opened/removed. Impoundment elevation increases as inflow increases

81. The Project has a maximum discharge (generation plus spill) capacity of 127,600 cfs at normal full pond. The flood of record is 176,000 cfs in March of 1936. Since the FMF project began operating in the late 1950s and USACE dams were constructed in the 1960s, the highest flow recorded at Vernon dam has been less than 110,000 cfs, with the maximum discharge at the dam occurring during Tropical Storm Irene, when flow reached 102,626 cfs.

82. Under a coordination agreement with the U.S Army Corps of Engineers, the Project is restricted to drawdown rates between 0.1 to 0.2 feet per hour, not to exceed 0.3 feet per hour during high flow events.

Hydrology of Current Operations

83. There are several metrics that can be calculated to characterize the hydrologic effects of hydroelectric operations on a river system. Table 1 provides monthly statistics under current operations and Table 3 provides estimates under an IEO mode without the effects of current operations. Hydrologic statistics can

also be evaluated based on a daily time scale, offering additional detail on operations that mean monthly metrics would otherwise obscure.

Impoundment

84. The Applicant used the intensive HEC-RAS model to model water surface elevations for current operations over a range of years representing varying hydrologic conditions and months representing seasonal considerations. The Applicant subsequently used this data set to calculate hydrologic metrics to characterize the operational regime. One metric is the amount of time the impoundment is stable at a target water surface elevation. Current operations do not require a target elevation to be maintained, but rather require water surface elevation to be maintained within a range. To estimate this metric, an elevation of 219.63 feet (NGVD 29) was used as the target. Additionally, the estimate includes instances when the Project implemented river profile operations as described above. This metric was estimated by comparing the hourly water surface elevation to within 0.1 feet of the target mean water surface elevation as a percentage of a month. (Table 5).

85. The magnitude of fluctuations that may occur within the impoundment provide an indication of the daily variability attributable to operations, in addition to reflecting high flow events. These were estimated by calculating the daily minimum and maximum values during the target months and years, and then calculating the difference between those values. The reported value below is the average difference over the course of a month. (Table 5).

Table 5. Daily hydrologic metrics for current operations within the impoundment of the Vernon Hydroelectric Project for the years and months representing dry years to wet years across seasons.

Target Month and Year	Percent of Time at Target Water Surface Elevation	Mean Daily Change in Impoundment Elevation (feet)
2009		
February	34.4%	0.74
June	27.1%	0.63
August	50.9%	0.47
November	26.5%	0.77
2016		
February	20.2%	0.49
June	33.7%	0.51
August	26.4%	0.73
November	23.2%	0.82

Target Month and Year	Percent of Time at Target Surface Water Elevation	Mean Daily Change in Impoundment Elevation (feet)
2017		
February	20.9%	0.85
June	28.4%	0.67
August	40.5%	0.68
November	24.9%	0.67
2015		
February	20.3%	0.45
June	31.3%	0.52
August	25.6%	0.75
November	22.8%	0.81

Downstream flows

86. In addition to water level fluctuations within the impoundment, the Project also regulates downstream flow in the current peaking mode of operation. Using the HEC-RAS model that allowed for estimates of water surface elevation, the Applicant also estimated downstream flows for current operations. There are a variety of metrics that can be estimated to characterize the downstream flow regime. These include average minimum downstream flow, mean daily amplitude, and flashiness.

87. The minimum daily flow was determined over each target month and year. Those values are then averaged over the target month. (Table 6).

88. To estimate the daily amplitude of downstream flow, the minimum and maximum daily flow value was first calculated. The difference between those two values was then calculated and then averaged over the course of the month. (Table 6).

89. The Richard-Baker Flashiness Index equation (Figure 1) was used to calculate an index value for flashiness. Calculation of the index value was previously described in Finding 73. This metric was calculated for each year and month with results provided in Table 6.

Table 6. Hydrologic metrics for flow downstream of the Vernon Hydroelectric Project under current operations.

Target Month and Year	Average Minimum Downstream Flow	Mean Daily Amplitude	Flashiness
2009			
February	2994	8886	0.14
June	5176	6647	0.07
August	5913	5614	0.05
November	7072	5787	0.05
2016			
February	7354	3946	0.04
June	2055	5309	0.04
August	1169	5464	0.14
November	1501	6624	0.19
2017			
February	7275	4021	0.04
June	2106	5238	0.14
August	1171	5555	0.20
November	1639	6265	0.13
2015			
February	4289	2369	0.05
June	9775	3523	0.03
August	1334	7160	0.21
November	2260	7655	0.15

Fish Passage

90. The ladder for upstream fish passage is operated in accordance with the fish passage notification schedule issued each year by the Connecticut River Atlantic Salmon Commission (CRASC), now referred to as the Connecticut River Migratory Fish Cooperative (CRMFC). Upstream passage is provided in the spring from April 15 through July 15 (start date is based upon counts at the Turners Falls and Holyoke projects downstream) for Atlantic Salmon, American Shad, and Blueback Herring (*Alosa aestivalis*). In the fall, upstream passage is provided from September 15 through November 15 for Atlantic Salmon, if they are present. Upstream fish passage operations include a fishway flow of 65 cfs and an attraction flow of 200 cfs.

91. Downstream fish passage is also operated in accordance with dates set by the CRASC, or now CRMFC, annual fish passage notification schedule. Downstream fish passage is provided for specific species as follows: Adult American Shad from April 15 (or the same date as upstream passage begins) through July 31; Juvenile American Shad from August 1 through November 15; Adult American Eel (*Anguilla rostrata*) from September 1 through November

15. Since February 2016, CRASC no longer required downstream passage operations at Vernon for Atlantic Salmon smolts. Downstream fish passage operations include 350 cfs through the 'fish pipe' and 40 cfs through the 'fish bypass'.

Recreation

92. The Applicant owns and manages four formal recreation sites at the Project, which include: Vernon Glen picnic area; Governor Hunt recreation area and boat launch including fishing access and the fish ladder viewing area; Vernon canoe portage; and Vernon Neck open space. There are informal boat-in campsites in Hinsdale, New Hampshire, and on Stebbins Island (see Findings 416 through 420 for additional details).

93. Safety features are required, which include signs, lights, sirens, boat barriers, and other applicable devices to warn the public and recreationalists of changes in water levels and to protect and guide individuals using the recreational facilities at the Project.

94. The Applicant maintains a phone line and website to provide generation schedules and real time flow information to boaters and anglers, and other recreational users of the river.

E. Applicant's Proposal

95. The Applicant is proposing a new operating regime under which the Project will predominately operate in an IEO mode. This will increase the amount of time the Project maintains a stable reservoir and does not regulate flow. Additionally, the proposed operation would maintain a capability to operate out of storage, or 'flexible operations' at the discretion of the Applicant, but with limitations and constraints. 'Transition operations' would apply to switching between operating modes with additional requirements as specified.

96. Under the Applicant's proposal, the Project could deviate from IEO operations for flexible operation for a limited number of hours each month. The Project could also suspend IEO operation under specific circumstances detailed in Findings 102 and 103.

97. The proposed operational regime is intended to create more stable impoundment water levels by reducing the average duration, frequency and range of impoundment fluctuations. In addition, it will also reduce the magnitude and frequency of sub-daily changes in discharge from the Project.

98. The Applicant is not proposing any capacity upgrades at the Project.

Inflow Equals Outflow Operations

99. The Applicant proposes to implement IEO operations by maintaining a target elevation at the dam of 219.63 feet (NGVD 29) by adjusting station discharge. The Applicant will target this elevation within plus or minus 0.5 feet of elevation

change or ‘bandwidth’. The purpose of providing a bandwidth is to absorb changes in inflow, differences between changes in hourly inflow and hourly discharge, and wave action, not to provide useable storage.

100. To implement IEO operations, the Applicant is proposing to monitor the impoundment water level on at least an hourly basis and adjust station discharge as frequently as necessary to maintain the target elevation. This would ensure an accurate water surface elevation and discharge would be calculated based on unit discharge curves with precision dictated by the accuracy of the unit controls and the sensitivity of setpoints. The Applicant anticipates that station discharge would change no more than once per hour, unless there are rapid changes in inflow.

101. Unlike for the Wilder and Bellows Falls projects, there will not be a pre-winter temporary lowering of the Project impoundment. The purpose of this lowering is to protect identified Dwarf Wedgemussel habitat and none has been identified in the Vernon impoundment.

102. Under the Applicant’s proposal, IEO operations would be suspended under high water operations, emergency systems operations, requirements and audits.

103. Additionally, IEO operations may be suspended for needed maintenance activities. Non-emergency maintenance activities would require consultation with the Department and other relevant state and federal resource agencies to develop a suitable refill plan and schedule prior to initiating a necessary deviation.

Flexible Operations

104. The Applicant proposes restricted discretionary capability to deviate from IEO operations and operate out of storage or ‘flexible operations’. These instances will be at the discretion of the Applicant, but will be governed by restrictions, including: the number of flexible operations hours per month, up-ramping, down-ramping, maximum discharge, and maximum drawdown. These restrictions are further described in the findings below.

105. The Applicant is proposing the following number of hours for flexible operation: December through March, no more than 65 hours in each month; April through June, no more than 10 hours in each month; July, a total of 20 hours with no more than 10 hours from July 1 through July 15; August through October, no more than 20 hours in each month; and November, no more than 42 hours in the month, with no more than 10 hours from November 1- November 15.

106. During flexible operations, the Applicant is proposing a maximum discharge from the Project based on calculated hourly inflow. When hourly inflow is 1,800 cfs or less, maximum discharge during flexible operations is 4,500 cfs. When hourly inflow is greater than 1,800 cfs, maximum discharge during flexible operations is 2.5 times calculated inflow, not to exceed maximum station

generating capacity.

107. During flexible operations, the Applicant will maintain the water surface elevation of the impoundment between 218.3 and 219.63 (NGVD 29). This equates to a maximum drawdown of 1.33 feet.

108. To count flexible hours, the Applicant proposes that for any flexible event that lasts less than one hour, it shall count as one hour. Should a flexible event last longer than 15 minutes past the following hour, then the flexible event lasted for two hours. The end of the flexible operations event for the purpose of accounting for the number of hours used will be when down-ramping begins. The number of flexible hours in a single event does not include the up-ramping hour, down-ramping hours, or number of hours it takes to refill the impoundment.

Transition Operations

109. In addition to flexible operations, the Applicant is proposing 'transition operations' that govern departures from, and returns to, IEO mode. Transition operations would precede flexible operations in specified instances and follow flexible operations in all cases. Transition operations include up-ramping, down-ramping, and refill provisions.

110. Up-ramping would occur over the one-hour period preceding flexible operations when these events are planned in advance, as further specified in Finding 115. The goal is to provide a gradual increase in flow from IEO to the maximum planned discharge of the flexible operations event. For the Project, the Applicant proposes to discharge 1 csm (approximately 6,266 cfs) or the flow that is half-way between the calculated IEO flow and the maximum flexible operations discharge, whichever is less.

111. For down-ramping, the Applicant proposes to reduce discharge by a consistent 70 percent each hour after a flexible operations event. This decrease would continue each successive hour until the discharge from the Project is equal to inflow at the dam. The duration of down-ramping will depend on the maximum discharge from the Project during the flexible operations event and inflow to the Project.

112. The Applicant proposes to refill the impoundment immediately after down-ramping and ending no more than 48 hours later, unless the reservoir is within 0.1 foot of the Target WSE. The Applicant proposes to refill the impoundment by passing 70 percent of inflow and using the remaining 30 percent to store and refill the impoundment, if this flow is greater than the proposed seasonal minimum base flow downstream of the facility. If 70 percent of inflow is less than the applicable seasonal minimum base flow, the minimum base flow will be maintained with the difference between the minimum base flow and inflow available for refill.

113. The minimum base flow below the powerhouse varies depending on the time of

year. At a minimum, the following flows will be provided when not in IEO operations: October 1 through March 31 - 1,600 cfs; April 1 through May 31 - 3,000 cfs; and June 1 through September 30 - 1,400 cfs. When in IEO operations, discharge may be less than the seasonal minimum flow when calculated inflow is less than the applicable flow.

114. The Applicant may temporarily pause refill; however, this time will still be considered part of the 48-hour refill period.

115. The Applicant will follow the proposed transition operations measures including up-ramping, down-ramping, and refill as specified below in Table 7.

Table 7. Application of transition operations measures (up-ramping, down-ramping, impoundment refill) to flexible operation event types.

	Up-Ramping	**Down-Ramping**	**Impoundment Refill**
Flexible Operations, Scheduled	Applied during the hour prior	Applied as Defined	Applied as Defined
Flexible Operations, Un-Scheduled	Not Applied	Applied as Defined	Applied as Defined
High Water Operations	Not Applied	Not Applied	Not Applied
CCA and RPD audits*	Not Applied	Applied as Defined	Applied as Defined
Emergencies and System Emergencies	Not Applied	Not Applied	Not Applied

*Claimed Capacity Audits (CCA) and Reactive Power Demonstrations (RPD). These tests are required as part of participating in portions of the ISO New England power market.

116. If more than two CCA tests per year are needed, the Applicant will notify the Department that it must conduct additional tests and the number of flexible operation hours for each additional test will be determined as described above and counted either in the current or in the allocation for the next month, if none were available in the current month.

Hydrology of Proposed Operations

117. The same model used by the Applicant to model water levels and flows for current operations was used to model proposed operations. The modeling utilized the intensive HEC-RAS model with inputs of known flow and water surface elevation data collected at various nodes within the impoundment and downstream of the facility, inflow estimates, and generation data.

Impoundment

118. The same metrics and methodologies used to characterize current operations were used to characterize proposed operations. (Findings 84 and 85). These are provided in Table 8.

Table 8. Impoundment metrics for proposed operations at the Vernon Hydroelectric Project. The years encompass dry and wet years and the months represent seasonal considerations.

Target Month and Year	Percent of Time at Target Water Surface Elevation	Mean Daily Change in Impoundment Elevation (feet)
2009		
February	63.1%	0.47
June	100%	0.00
August	87.9%	0.25
November	91.5%	0.11
2016		
February	46.6%	0.66
June	96.2%	0.08
August	85.6%	0.23
November	74.3%	0.41
2017		
February	51.3%	0.64
June	96.8%	0.07
August	81.5%	0.25
November	82.1%	0.29
2015		
February	46.5%	0.65
June	96.2%	0.08
August	85.6%	0.23
November	76.4%	0.38

Downstream flows

119. In addition to water level fluctuation in the impoundment, the Project will regulate downstream flow during the flexible and transition modes of proposed operations. Using the intensive HEC-RAS model, the Applicant estimated flows downstream of the Project for proposed operations across a range of hydrologic conditions and for specific months to represent seasonal considerations.

120. The same methodology previously described in Findings 71-73 was used to calculate metrics to characterize the flow regime downstream of the Project under proposed operations. These metrics are presented in Table 9 for each modeled year and month.

Table 9. Hydrologic metrics for flow downstream of the Project under the Applicant's proposal. The years encompass dry and wet years and are broken down by month to represent seasonality.

Target Month and Year	Average Minimum Downstream Flow	Mean Daily Amplitude	Flashiness
2009			
February	5049	6269	0.09
June	8166	1959	0.01
August	8450	2510	0.02
November	9896	2238	0.02
2016			
February	9756	2855	0.02
June	3999	2096	0.02
August	2708	2319	0.03
November	4074	5557	0.05
2017			
February	9626	2957	0.02
June	4001	2120	0.03
August	2699	2329	0.05
November	3915	5509	0.09
2015			
February	4138	3095	0.05
June	11835	1072	0.00
August	3375	2259	0.04
November	5797	2491	0.03

Fish Passage Measures

121. The Applicant proposes to implement the fish passage settlement agreement (Agreement) entered into by GRH, USFWS, the New Hampshire Fish and Game Department, and the Vermont Fish and Wildlife Department executed on August 8, 2022. The portions of this Agreement relevant to the Project are summarized below.

122. The Applicant proposes to develop a Fish Passage Management Plan for the Project in consultation with the Agency and submit this plan to FERC for approval within 120 days after issuance of a new license.

123. The Applicant proposes to operate upstream fish passage measures at the Project from April 1 through July 15 upon license issuance and from April 1 through November 15 upon completion and implementation of enhancements

including interim eel passage measures.[4] The Applicant also proposes to operate downstream fish passage measures from as close to April 7 as possible, but no later than April 15, and through December 1 upon new license issuance.

124. The Applicant notes that the fish passage measures are intended to provide safe, timely, and effective passage for targeted migrating species. At the Project these species are American Eel, American Shad, and Sea Lamprey. For all identified fish passage measures, the first year of operation shall be used to assess if all components of the fish passage facility are operating as intended. The following two years will be used to quantitatively assess the effectiveness of the fish passage measures with studies. Additional years of study may be needed if modifications are needed or if a study season is anomalous. Conversely, a single representative study may be adequate if results clearly indicate measures are effective and agreed to in writing by the relevant agencies.

125. The Applicant is proposing to consult with relevant agencies and reach agreement on study plans and schedules.

126. The Applicant is proposing to consult with relevant agencies and seek approval for fish passage designs. The designs shall meet the USFWS Design criteria, and associated engineering principles, to the extent practicable.

Downstream Passage

127. The Applicant is proposing that no later than January 1 of the second year after license issuance, a hydraulic study or suitable alternative shall be initiated with completion and reports no later than the third year after license issuance.

128. The Applicant is proposing to use the information from the hydraulic study to develop design alternatives to provide safe, timely, and effective downstream passage for targeted species. The licensee proposes to initiate design consultation with the fisheries agencies no later than July 1 of third year after license issuance with final design plans completed no later than December 31 of the fourth year after license issuance. Construction shall be initiated during the fifth year after license issuance and completed no later than December 31 of the sixth year after license issuance. Approved structural facilities and/or operational measures shall be fully operational no later than April 7 of the seventh year after license issuance. The Applicant proposes to conduct effectiveness studies after construction.

Upstream Passage

129. The Applicant proposes to undertake a hydraulic study within the existing fish

[4] The April 1 start date is to accommodate early spring spawners such as walleye and white sucker. The fish ladder at Vernon shall commence operation as close as possible to April 1 annually, but no later than April 15 as long as ice conditions and/or debris conditions allow for fish ladder inspections and the ladders are fully operational.

ladder at the Project and an engineering assessment to inform potential modifications for improved effectiveness for passage of American Eel and Sea Lamprey. The licensee proposes to initiate consultation on study design and assessment scope no later than November 15 of the second year after license issuance. The Applicant proposes to initiate these activities no later than July 16 of the third year after license issuance and complete and report on the study no later than December 31 of the fourth year after license issuance.

130. The Applicant proposes to undertake studies using Passive Integrated Transponder (PIT) tag technology to assess passage performance of American Eel and Sea Lamprey within the Vernon fish ladder during the upstream anadromous passage season of the fifth year after license issuance. Consultation with the fisheries agencies on the PIT study design is proposed to be initiated no later than July 1 of the third year after license issuance with the study itself initiated no later than May 1 and reported on no later than December 31 of the fourth year after license issuance. An additional year of study may be added in consultation with the fisheries agencies, which would take place in the fifth year after license issuance, if deemed necessary.

131. The Applicant proposes to use the information from the hydraulic and PIT studies to develop design alternatives to improve eel and lamprey passage through the ladder during the period from April 7 through July 15. The applicant proposes to initiate design consultation with the fisheries agencies in the fourth year after license issuance with final design plans completed no later than July 15 of the fifth year after license issuance. Implementation of the modifications are proposed to be initiated by July 16 of the fifth year after license issuance, completed no later than April 6 of the sixth year after license issuance, and be operational no later than April 7 of the sixth year after license issuance. If an additional study year is needed, as described in the prior finding, the design timelines are proposed to be extended one year.

132. The Applicant proposes to design, construct, operate, and maintain measures, possibly temporary, approved by the fisheries agencies to pass American Eel for the period from July 16 to November 15. These interim measures are proposed to consist of an eel ramp, trap, or similar design located below the Project in consultation with the fisheries agencies. The Applicant proposes to initiate design no later than January 1 of the second year after license issuance and finalize design no later December 31 of the second year after license issuance. The Applicant proposes to initiate construction of these measures by July 15 of the third year after license issuance with the measures being fully operational no later than July 16 of the third year after license issuance. These interim measures are proposed to be operational until permanent facilities are operational and will include effectiveness monitoring and an obligation to further monitor or adjust the interim measures.

133. The Applicant proposes to use the hydraulic studies and monitoring data to determine by July 1 of the ninth year after license issuance if existing information is adequate to identify permanent upstream eel passage measures. If additional studies are not necessary, the Applicant proposes to identify the

preferred permanent method no later than January 31 of the tenth year after license issuance. The Applicant is proposing to initiate design no later than February 1 of the tenth year after license issuance and complete design no later than December 31 of the tenth year after license issuance. The Applicant proposes complete construction and have the facilities fully operational no later than July 16 of the eleventh year after license issuance.

134. If the existing information is not adequate to identify permanent upstream eel passage measures, the applicant proposes to conduct any necessary studies in the tenth year after license issuance with study design initiated by February 15 and completed by December 31 of the tenth year after license issuance. The Applicant proposes to identify a design approved by the fisheries agencies no later than January 31 of the eleventh year after license issuance. The Applicant is proposing to initiate design no later than February 1 and complete design no later than December 31 of the eleventh year after license issuance. The Applicant proposes to complete construction and have the measures fully operational no later than July 16 of the twelfth year after license issuance.

135. The Applicant proposes to assess the potential for trapping American Shad at the collection gallery below the powerhouse no later than July 16 of the seventh year after license issuance. If the conditions are suitable for trapping, an approved solution is proposed to be implemented no later than April 7 of the ninth year after license issuance.

136. The Applicant also proposes to design and implement improvements to the public viewing window and counting room at the Project. GRH proposes to initiate and complete design during the fourth year after license issuance, initiate improvements in the fifth year after license issuance, and complete the improvements no later than April 1 of the sixth year after license issuance.

137. The Applicant proposes to undertake a hydraulic study and an engineering assessment of the existing fish ladder at the Project to inform potential modifications for improved effectiveness for passage of American Shad. The Applicant proposes to initiate consultation on the design of these studies no later than November 15 of the second year after license issuance. GRH proposes to initiate the study no later than July 16 of third year after license issuance and complete and report on the study no later than December 31 of the fourth year after license issuance. The Applicant proposes to initiate consultation on design modifications to improve shad passage no later than January 1 of the fourth year after license issuance and complete design no later than July 15 of the fifth year after license issuance. The Applicant proposes to initiate construction of the modifications by July 16 of the fifth year after license issuance and complete the modifications no later than April 6 of the sixth year after license issuance. Modifications are to be fully operational no later than April 7 of the sixth year after license issuance.

138. The Applicant proposes to make any necessary repairs to the existing fish trap for full functionality. The Applicant proposes to initiate fish trap repairs in the eighth year after license issuance and complete repairs no later than

December 31 of the ninth year after license issuance.

Recreation Measures

139. The Applicant proposes several specific improvements to recreation facilities at the Project including upstream portage improvements to include a dock, pathway, and boat slide; downstream portage improvements to include trail improvements, new stairs, and a boat slide; improvements to the Governor Hunt and Vernon Glen recreation areas, such as accessibility improvements to the parking and picnic sites; improvements to the Stebbins Island canoe camp site; and updates to the fish ladder window to include lighting and accessibility improvements.

140. The Applicant proposes to maintain and enhance the existing recreational areas at the Project as needed. The Applicant also proposes to continue to make available real-time flow information and the day ahead schedule of operation or predicted flows on a web-based and phone call system. Additionally, the Applicant proposes to include the Wantastiquet-Hinsdale and Stebbins Island canoe rest areas as formal Project recreation facilities.

141. The Applicant proposes to develop a recreation management plan after license issuance in consultation with applicable state agencies and submit to FERC for approval.

Additional Proposed Measures

142. The Applicant proposes to continue to manage undeveloped lands through cooperative agreements with farmers to maintain agricultural land where applicable.

143. The Applicant proposes to develop an agreement for managing historic resources with the state historical preservation office in consultation with Abenaki tribal leaders.

144. The Applicant proposes to design, install and implement tools, equipment, and resources as needed, within the Project boundary, portions of the river affected by project operations, and in the hydro operations control center to assist in inflow monitoring, inflow forecasting, and managing the impoundment to the target water surface elevation to successfully operate the Project under the proposed operation.

F. Current Status of Waters in the Project Area

145. In August 2022, the U.S. Environmental Protection Agency approved a list of waters considered to be impaired based on water quality monitoring efforts and in need of total maximum daily load (TMDL) development to address pollution. The Department submitted this list under section 303(d) of the Federal Clean Water Act.

146. According to the State of Vermont’s 2020 303(d) list of impaired surface

waters, there are waters within or near the project area listed for various reasons. However, these listings are on tributaries and generally due to stressors not linked to operation of the Project. The Connecticut River in the vicinity of the Project area is not listed as an impaired surface water in need of TMDL, impaired water where no TMDL is required, or as an impaired water with a TMDL.

147. The Department issued a four-part list, List of Priority Surface Waters Outside the Scope of the Clean Water Act Section 303(d) in 2022. These waters correspond to Category 4C of EPA's Consolidated Assessment Listing Methodology. To the extent that these listings may be affected by the Applicant's proposal, these waters are described below.

148. Part F lists surface waters affected by flow regulation. The 24-mile reach of the Connecticut River above Vernon dam and below Bellows Falls dam is listed as a priority water on Part F due to artificial flow conditions and fluctuating flows from hydropower production. Additionally, the 5.5-mile reach of Connecticut River below Vernon dam is listed for the same stressor. The impoundment of the Vernon project is also listed due to water level fluctuation at the dam causing dewatered shorelines and wetlands.

149. The Agency's publication, *Hydropower in Vermont - An Assessment of Environmental Problems and Opportunities*, is a state comprehensive plan.[5] The plan describes hydroelectric development as having a significant impact on Vermont streams with power projects usually located on important scenic and ecological sections of streams. Artificial regulation and diversion of natural stream flows were found to have largely reduced the success of state initiatives to restore the beneficial values and uses for which the affected waters are managed under the federal Clean Water Act and Vermont law.

150. The Project area is located within Basin 12, which is covered by the Deerfield River and Lower Connecticut River Direct Drainages Tactical Basin Plan, a state comprehensive plan.[6] The tactical basin plan notes the development of the Long Island Sound TMDL released in 2000. In 2013, Vermont developed a state specific enhanced implementation plan that listed four goals: (1) to identify the Vermont sources of nitrogen as they are currently understood, across broad land use sectors, such as developed, agricultural and forested; (2) to identify the status and trends of important drivers of nitrogen export such as the intensity of agricultural and development activities and investigate how these have changed since the TMDL baseline period of 1990; (3) to identify the management programs, operating at that time, that address these drivers of nitrogen loading that have a significant effect on reducing or preventing nitrogen export; and (4) using a weight-of-evidence approach, to assess the

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[5] DesMueles and Parks. 1988. Hydropower in Vermont. An assessment of Environmental Problems and Opportunities. Vermont Department of Environmental Conservation. Montpelier, Vermont.
[6] Vermont Department of Environmental Conservation. 2020. Deerfield River and Lower Connecticut River Direct Drainages Tactical Basin Plan. https://dec.vermont.gov/sites/dec/files/WID/WPP/Deerfield%20River%20Tactical%20Basin%20Plan%20-%202020.pdf

combined management programs/projects to develop a qualitative evaluation as to whether management efforts are sufficient to meet the original 2000 TMDL of a 10 percent non-point source nitrogen reduction and if these actions are sufficient to maintain that control into the future.[7]

151. It is estimated that 12 percent of the total nitrogen load comes from Vermont, of which Basin 12 contributes approximately 10 percent of Vermont's total load. Approximately 60 percent of Vermont's total load is due to atmospheric deposition. Efforts to reduce this form of nitrogen are occurring through the 1990 Clean Air Act and its applicable amendments. Additional sources of nitrogen in Vermont include wastewater discharges, agricultural lands, developed lands, and forest practices. Specific strategies include nitrogen reduction from wastewater treatment plants, implementation of required agricultural practices and best management practices to reduce nutrient runoff, and implementation of stormwater permits covering construction and roads.

152. The Basin 12 Tactical Basin Plan identifies hydropower production playing a significant role in the basin. It specifically identifies the Vernon dam and its operations as a peaking and daily storage facility. The plan notes that this mode of operation interrupts the natural flow regime and sediment transport throughout a river system and results in the listing of the affected waters as altered due to flow regulation.

153. The Basin 12 Tactical Basin Plan also identifies several species in need of conservation. This includes the Connecticut River population of American Eel and describes management as focused on construction of eel passes (to enable upstream juvenile eel movement around dams) and enumeration of immigrating eels. The plan also identifies American Shad and describes fish passage efforts allowing shad to pass the Holyoke Dam in Massachusetts and the Vernon Dam in Vermont.

154. Strategies within the Basin 12 Tactical Basin Plan that are pertinent to the Application include working through the FERC relicensing process to address river impairments related to flow issues on the Connecticut River listed in Part F - Waters Altered by Flow Regulation and protecting the land and habitat along the Connecticut River to enhance survival of the high concentration of RTE species.

155. The 2015 Wildlife Action Plan is another applicable state comprehensive plan.[8] The plan includes species of greatest conservation need located within the Project vicinity. These species include Sea Lamprey (*Petromyzon marinus*) in the Connecticut River drainage, American Eel, American Shad, Cobblestone Tiger Beetle (*Cicindela marginipennis*), and Dwarf Wedgemussel (*Alasmidonta heterodon*). The plan identifies high and medium priorities for these species. Additional information on each specific species is discussed later in the

[7] Vermont Enhanced Implementation Plan for the Long Island Sound TMDL.
[8] Vermont Department of Fish and Wildlife. 2015. Vermont's Wildlife Action Plan. Montpelier, Vermont. https://vtfishandwildlife.com/sites/fishandwildlife/files/documents/About%20Us/Budget%20and%20Planning/WAP2015/__2015-VT-Wildlife-Action-Plan.pdf

applicable section of this water quality certification (e.g. rare, threatened, and endangered species and aquatic biota sections).

G. Water Chemistry

156. There are numerous wastewater facilities located on the Connecticut River that require a National Pollutant Discharge Elimination System (NPDES) permit. A total of 64 wastewater facilities are located in Vermont and New Hampshire above the Project.

157. There are nine wastewater treatment facilities in the Connecticut River in the reach below the Bellows Falls Hydroelectric Project and above the Vernon Hydroelectric Project. These facilities are in Westmoreland, New Hampshire and Brattleboro, Dummerston, Londonderry, Rockingham, and Vernon, Vermont.

158. The Vernon facility has been issued a NPDES permit by the state of Vermont to discharge minor, non-generation related wastewaters, which includes non-contact cooling water and internal leakage. This permit requires quarterly sampling for temperature, pH, and oil or grease concentrations. Throughout the required monitoring period, the required permit levels have not been exceeded.

159. As part of the integrated licensing process, the Applicant conducted water quality sampling across two efforts, first in 2012 and again in 2015. The goal of these studies was to collect data during low flow and high temperature periods for a minimum of 10 days while the Project was operating.

160. The 2012 baseline study collected temperature, DO, specific conductivity, pH, nutrients and chlorophyll-a at various locations. Data was collected during the summer to be representative of a low-flow, warm weather period at four locations within the Project area, the upper impoundment, mid impoundment, forebay, and tailrace. Temperature, DO, specific conductivity, and pH were continuously measured in the forebay and tailrace, while nutrients and chlorophyll-a were collected in the project forebay as a composite sample. Vertical profiles were collected within the impoundment.

161. The 2015 study followed a similar methodology as in 2012, but additional variables were collected across a wider variety of sites. These included turbidity monitoring, continuous recording of water temperature at all stations, addition of a riverine station upstream of the upper extent of the impoundment, and continuous water temperature monitoring in some of the major tributaries upstream of the Project. The data was collected from April 1 through November 15.

162. In 2012, temperatures gradually warmed and peaked in August and cooled in late summer into early fall, which is the expected seasonal pattern for this region. Temperature warmed with proximity to Vernon Dam with the maximum observed temperature occurring in the forebay at 28.3°C and the lowest occurring in the upper impoundment at 20.2°C. The minimum DO level was 6.3

mg/L or 79 percent saturation in the forebay. Weak stratification was observed in the forebay in late June.

163. Over the course of the 2015 sampling effort, water temperatures ranged from 7.2°C to 27.2°C, following the expected seasonal trend as observed in 2012. The warmest temperatures were observed in the forebay and tailrace stations in August. The coolest temperatures were observed in the upper impoundment and riverine stations in the spring and late fall. On average, as water flows from upstream areas through the impoundment and into the tailrace, water temperature warmed by approximately 0.9°C.

164. For the additional tributary monitoring in the 2015 study, temperature was continuously recorded in the Saxtons and West rivers in Vermont and the Cold River in New Hampshire. For the Saxtons River, a minimum of 0.1°C and a maximum of 26.9°C were recorded. For the Cold River, a minimum of -0.1°C and a maximum of 28.0°C were recorded. For the West River, a minimum of 3.4°C and a maximum of 31.4°C were recorded.

165. Dissolved oxygen was continuously measured in the Vernon forebay and within the tailrace throughout the 2015 monitoring period. From August 30 to September 8, DO data was collected at all mainstem stations. DO followed a nearly opposite trend as water temperature. Seasonally, DO levels were relatively high in June, reached their lowest levels in mid-September, and began to increase again in the fall. DO concentrations within the forebay ranged from 6.9 mg/L to 10.0 mg/L with percent saturation ranging from 82 to 119 percent. Within the tailrace, DO concentrations ranged from 7.3 mg/L to 10.1 mg/L with percent saturation ranging from 86 to 111 percent.

166. Within the mainstem, vertical profiles indicated that the water column was not stratified and was generally well mixed, with some surface warming during the summer. The waters remained oxygenated with values ranging from 7.4 mg/L to 10.3 mg/L and percent saturation ranging from 87 to 114 percent.

167. When considering mean DO concentrations, the upstream riverine and upper impoundment locations had higher levels than those in the middle impoundment and forebay locations. Across all locations mean DO concentration was 7.8 mg/L or higher and mean percent saturation was 91 percent or greater.

168. Table 10 includes the minimum, maximum, and mean statistics for the DO vertical profiles collected in 2015. The table also includes the minimum, maximum, and mean values for the continuous measurements in the Vernon forebay and tailrace in 2015.

Table 10. Statistics for the vertical and continuous dissolved oxygen monitoring at locations within the Vernon project area collected during the 2015 water quality study. Maximum (max), Minimum (min) and Mean or average values are provided.

Location	Dissolved Oxygen (mg/L)			Dissolved Oxygen (Percent Saturation)		
	Max	Min	Mean	Max	Min	Mean
Vertical profile locations						
Upstream Riverine	10.2	7.6	8.9	112	88	101
Upper Impoundment	10.3	7.6	9.2	114	88	103
Middle Impoundment	10	7.4	8.6	106	87	98
Forebay	9.9	7.1	8.4	105	85	95
Tailrace	10.1	7.9	8.9	112	95	103
Continuous monitoring						
Forebay	10.0	6.9	8.3	120	82	96
Tailrace	10.1	7.3	8.7	111	86	101

H. Aquatic Biota

169. “Aquatic Biota” means all organisms that, as part of their natural life cycles, live in or on waters. (Standards, Section 29A-102(5)). Aquatic biota includes fish, aquatic invertebrates, amphibians, and some reptiles such as turtles.

170. The Connecticut River is classified by the State of Vermont as Class B(2) for the aquatic biota designated use and is designated as cold water fish habitat.

171. There is a wide variety of resident fish species located in the Vernon impoundment and the riverine reach downstream from the dam. The resident species in the Vernon impoundment include Spottail Shiner (*Notropis hudsonius*), Yellow Perch (*Perca flavescens*), Fallfish (*Semotilus corporalis*), Bluegill (*Lepomis macrochirus*), Tessellated Darter (*Etheostoma olmstedi*), Golden Shiner (*Notemigonus crysoleucas*), Smallmouth Bass (*Micropterus dolomieu*), Rock Bass (*Ambloplites rupestris*), White Sucker (*Catostomus commersonii*), Pumpkinseed (*Lepomis gibbosus*), Black Crappie (*Pomoxis nigromaculatus*), and Eastern Silvery Minnow (*Hybognathus regius*) amongst other species in lesser proportions. The resident species in the Vernon riverine reach include Smallmouth Bass, Bluegill, White Sucker, Yellow Perch, Spottail Shiner, slimy sculpin (*Cottus cognatus*), Fallfish, Channel Catfish (*Ictalurus punctatus*), Banded Killifish (*Fundulus diaphanus*), Brook Trout (*Salvelinus fontinalis*), Walleye (*Sander vitreus*), and Northern Pike (*Esox lucius*) amongst other species in lesser proportions.

172. In addition to resident fish species, multiple diadromous fish species, specifically American Eel, American Shad, and Sea Lamprey are known to migrate through the Project area, have been documented using the fish passage infrastructure, and utilize habitat in the project affected area for spawning and rearing. All of these species must be able to pass upstream and

downstream of the Vernon Dam to complete their lifecycle.

173. The Vermont Fish and Wildlife Department does not currently stock any species directly into the Connecticut River. However, tributaries to the Connecticut River in the vicinity of Vernon, for example the West River, are stocked with Rainbow Trout.

174. Macroinvertebrates and mussels, which are typically associated with benthic zones, also inhabit reaches affected by the Project. The mussel species include Eastern Elliptio (*Elliptio complanata*), Eastern Lampmussel (*Lampsilis radiata*), Eastern Floater (*Pyganodon cataracta*), Alewife Floater (*Anodonta implicata*), Triangle Floater (*Alasmidonta undulata*), and Creeper (*Parthenocissus*).

175. Additional aquatic biota in the area affected by the Project likely include beaver, muskrat, a variety of frogs, and turtles.

176. Fishery management goals for the Connecticut River that are applicable to the Project include: restoration of American Eel by improving flow regimes below hydroelectric generation and flood control projects; increasing and/or maintaining available habitat in terms of quantity and quality required for all life stages; providing safe, timely, and effective upstream and downstream fish passage to allow upstream migrants access to spawning and juvenile rearing habitats and expedite outmigrants to sea; and operating and maintaining existing fishways for peak passage performance.

Protection Measures for Aquatic Biota

177. Downstream fish passage from the Vernon impoundment is provided via the “fish pipe” that discharges between units 4 and 5 and the louver array, and secondarily via the “fish bypass” by unit 10. While downstream fish passage provides a means to pass by the dam, fish impingement and entrainment and associated injury and mortality can occur.

178. Properly sized and positioned intake screening is necessary to minimize impingement and entrainment. Operation of a hydroelectric project without adequate exclusionary screening may subject fish to impingement on the trashracks or entrainment through a turbine, which conflicts with the management objectives for aquatic biota.

179. The Applicant conducted a fish impingement and entrainment study (study 23). This study used existing information including, but not limited to, known turbine specifications, the assemblage of resident fish species from study 10, their associated life histories and general habitat preferences, and the Electric Power Research Institute (EPRI) database.

180. The fish assemblage study was used to select target species from the Vernon impoundment. The target species were identified to be representative of the overall fish assemblage based on a combination of life history strategies,

relative abundance, and trophic guild, and represented species occupancy in all areas of the water column. Target resident fish species for the study included White Sucker, Bluegill, Largemouth Bass, Smallmouth Bass, Fallfish, Golden Shiner, Spottail Shiner, Tessellated Darter, and Yellow Perch, Northern Pike, Brown Bullhead, and Walleye. Three diadromous species, American Eel, American Shad, and Sea Lamprey were also included in the impingement and entrainment analysis.

181. One measure of the ability of a fish to swim quickly for short distances or time intervals less than 15 seconds is referred to as burst speed. Burst speed depends on the species and size of the individual. The burst speed of a fish is related to the ability to capture prey, avoid predators, or in the case of hydroelectric facilities, avoid water velocities at the trashracks and turbines. Burst speeds have been estimated in the scientific literature and are often presented as a range.

182. Additional measures of the swimming ability of a fish include sustained swimming, which is the ability to swim potentially indefinitely, and prolonged swimming, which is the ability to swim for shorter durations but longer than short duration bursts of speed. The Applicant reviewed the scientific literature and the EPRI database to develop a range of fish swim speeds for the species of interest. (Table 11).

Table 11. Various swimming speeds of target species and life stages for estimation of entrainment potential. Burst speed is the speed a fish can swim for less than 15 seconds. Prolonged speed can be sustained by a fish for between 15 and 200 seconds. Sustained speed is the speed a fish can swim indefinitely. Speeds are presented in either feet per second (f/s) or centimeters per second (cm/s). Additional data includes speed per fishes body length was omitted for clarity, although it appears the range of values is representative.

Species	Life Stage	Body Length (inches)	Sustained (f/s)	Prolonged	Burst Speed
American Eel	Juvenile (elver)	2.8-3.9			2-3 (f/s)
	Juvenile (yellow)	14.0-21.0		1.4 (f/s)	
	Adult (silver)	12.5-27.6		2.2 (f/s)	
White Sucker	Juvenile/Adult	6.7		48-73 (cm/s)	
	Adult	15.4-15.7			11.5-14.8 (f/s)
Largemouth Bass	Fry	0.8-0.9		408-31.2 (cm/s)	
	Juvenile	2-10.6	0.79-1.34	30.6-60 (cm/s)	
Smallmouth Bass	Fry	0.6-1		0.6-0.89 (f/s)	
	Juvenile	3.6-3.7		1.3-1.8 (f/s)	
	Adult	10.5-14.9		1.6-3.9 (f/s)	
Bluegill	Juvenile	0.8-2.2		0.33-28.1 (f/s)	
	Adult	3.9-6		37 (cm/s)	4.3 (f/s)
Pumpkinseed		5		37.2 (cm/s)	
American Shad	Juvenile	1.0-3.0		1.5 – 1.75 fps	2.5 (f/s)
	Adult	15.4-15.7	2.36-2.47	7 (f/s)	11.0 (f/s)

Species	Life Stage	Body Length (inches)	Sustained (f/s)	Prolonged	Burst Speed
Fallfish	Juvenile/Adult	7.1-11.8		0.2-1.1 m/s	
Golden Shiner		1.8-2.7		31.7-43.4 (cm/s)	
Spottail Shiner	Juvenile	2		21.05-22.5 (cm/s)	
Northern Pike		4.7-24.4		21.05-148(cm/s)	NA
Brown Bullhead	Juvenile	2		32 (cm/s)	60-450 (cm/s)
Channel Catfish	Juvenile	6.3-8.3	1.3	2.9 (f/s)	3.9 (f/s)
Yellow Perch	Larval	0.6-1.4		0.6-4.6 (cm/s)	
	Juvenile	3.7-4.1		15.5-33.5 (cm/s)	
Walleye	Fry	0.5-0.8	0.16-0.25 (cm/s)		
	Juvenile	3.2-6.3		38 -138 (cm/s)	
	Adult	15.4-22.4	84 (cm/s)	261 (cm/s)	
Tessellated Darter		1.6-3.1		37.76 (cm/s)	
Sea Lamprey		5.7 -15.4	– 41.3 cm/s		

183. In addition to understanding the burst speed of the target species, calculating the velocity through the trashracks is also required. The through rack velocity was calculated assuming maximum turbine discharge. At the Project, Units 1 through 4 have a calculated intake velocity of 1.4 feet per second (fps), Units 5 through 8 have a calculated intake velocity of 2.5 fps, and Unit 9 and 10 have a calculated intake velocity of 2.1 fps.

184. Fish impingement describes the action of a fish being held in contact with a trashrack or screen. The ability of a fish to get impinged depends on the width of the fish and the spacing between trashrack bars, or clear bar spacing. The clear bar spacing for Units 1 through 8 is 1.75 inches and for Units 9 and 10 is 3.625 inches.

185. For the target species examined at their representative lengths, most of the target species that reach 15 inches or more in total length would have associated body widths that may result in being vulnerable to impingement at Units 1 through 8. For Units 9 and 10, only Northern Pike and Walleye may have body widths that may make them vulnerable to impingement. Ultimately, the rate of impingement will be a function of the size of the fish and the ability of a fish to escape the flow field of the intake.

186. If an individual fish is unable to escape the velocity through the trashracks and is small enough to avoid impingement, it may become entrained, meaning it could be pulled into the turbines. The survival of the fish through the turbines depends on the length of the fish and the type and speed of the turbine.

187. There are both Kaplan and Francis turbines at the Project. Units 5 through 8 are vertical Kaplan turbines and Units 1 through 4 and Units 9 and 10 are vertical Francis turbines. Table 12 provides survival estimates for fish of differing lengths that enter the turbines. The blade strike potential and

estimated survival rates were calculated using the methodology employed by Franke et al. 1997.[9]

Table 12. Estimated survival potential of fish of varying lengths that become entrained in turbines at the Vernon Hydroelectric Project.

Fish length	Vertical Kaplan	Vertical Francis
4-8 inches	78-98%	80-95%
15 inches	59-93%	62-83%
30 inches	18-86%	24-65%

188. The likelihood of a fish becoming entrained depends not only on the size of a fish and its swimming ability, but also on its expected life history, habitat preferences, and on where it typically resides in the river channel and water column, both in terms of location and mesohabitat. A multi-step qualitative assessment was performed using the EPRI database to determine the entrainment potential for each species and lifestage from low to high.

189. For example, at the Project, the intake location relatively deep within the water column, the lack of a seasonal drawdown, and estimated approach velocities may mitigate the potential for entrainment. Conversely, the location of the intakes in close proximity to the shoreline and the large number of migratory species, in particular American Shad, which move in schools near the center of the channel and in the upper portion of the water column, may be factors that increase the potential for entrainment.

190. Table 13 summarizes the entrainment potential for target fish species and life stages based on the characteristics of each species and lifestage.

Table 13. Entrainment potential for target fish species and life stages at the Vernon Hydroelectric Project.

Species and Life stage		Habitat and Life History Relative to Project Characteristics	Swim Speed Relative to Approach Velocity	Other Projects (EPRI 1997)	Overall Entrainment Potential
American Shad					
	Juvenile	H	H-M	H	H
	Adult	H-M	L	H-M	H-M
American Eel					
	Juvenile	L	H-M	L	L
	Adult	H	L	H-M	H
Bluegill					
	Juvenile	H-M	H-	H-M	H-M
	Adult	L	H-M	M-L	M-L

[9] Franke, G., D. Webb, R. Fisher, D. Mathur, P. Hopping, P. March, M. Headrick, I. Laczo, Y. Ventikos, F. Sotiropoulis. 1997. Development of environmentally advanced hydropower turbine system concepts. Idaho Falls, ID: US Department of Energy. Report No. 2677-0141. Prepared for Voith Hydro.

Species and Life stage		Habitat and Life History Relative to Project Characteristics	Swim Speed Relative to Approach Velocity	Other Projects (EPRI 1997)	Overall Entrainment Potential
Brown Bullhead					
	Juvenile	L	H	H-M	M-L
	Adult	L	L	M-L	L
Fallfish					
	Juvenile	L	L	L	L
	Adult	L	L	L	L
Goolden Shiner					
	Juvenile	H	H-M	H-M	H-M
	Adult	M	ND	L	M-L
Largemouth Bass					
	Juvenile	M	H-M	H-M	H-M
	Adult	L	H-M	M-L	M
Northern Pike					
	Juvenile	L	M-L	M-L	M-L
	Adult	L	L	M-L	L
Sea Lamprey					
	Juvenile	M	H	L	M
	Adult	L	ND	L	L
Smallmouth Bass					
	Juvenile	M	H-M	M	H-M
	Adult	L	M-L	M-L	M-L
Spottail Shiner					
	Juvenile	H	H	H-M	H-M
	Adult	M	H	H-M	H-M
Tessellated Darter					
	Juvenile	L	L	M-L	L
	Adult	L	L	M-L	L
Walleye					
	Juvenile	M	H-M	H-M	H-M
	Adult	M	L	M-L	M-L
White Sucker					
	Juvenile	M	M-L	H-M	M
	Adult	L	L	M	M-L
Yellow Perch					
	Juvenile	M	H-M	H	H-M
	Adult	L	M	M-L	M-L

I. Fish Passage

191. There are both upstream and downstream fish passage facilities at the Project, which are intended for Atlantic Salmon and American Shad. In 1978, FERC approved a settlement agreement on upstream fish passage for the lower Connecticut River projects. Construction of facilities took place first at Vernon with operation beginning in 1981. Permanent downstream passage was provided when the Applicant entered an MOU with CRASC in 1990 with construction occurring in 1995.

192. In the original agreements, operation of the passage facilities was based upon the presence of Atlantic Salmon and American Shad below the Project. The operating schedules of both the upstream and downstream passage have been provided by CRASC, and now by CRMFC, each year.

Upstream

193. The upstream fish passage facility is described in Findings 42 through 47. The current passage infrastructure was designed to pass Atlantic Salmon and American Shad, which was the primary focus when fish passage measures were initiated. Subsequently, there have been investigations and modifications to increase effectiveness, in particular for American Shad. There are additional fish species that migrate up the Connecticut River as part of their life history, including American Eel and Sea Lamprey. In addition to the migratory species of interest, resident species also seek to move upstream of the Project.

194. The Applicant conducted several studies to evaluate upstream fish passage for resident and migratory species.

195. Study 17 involved continuous monitoring of the upstream fish ladder at the Project throughout the 2015 season from ice out to ice-in using a camera and motion activated software. The upstream fish passage facility was operated from May 5 through January 6. The purpose was to capture all movements during the open water period and assess fish ladder usage for periods of higher use for either diadromous or resident species.

196. At the Project, the target diadromous species for the study were Atlantic Salmon, American Shad, Sea Lamprey, and American Eel, and all were observed in the ladder. The resident species targeted were Smallmouth Bass, Largemouth Bass, White Sucker, Walleye, Brook Trout, Rainbow Trout, Brown Trout, Bluegill, Pumpkinseed, Brown Bullhead, Yellow Bullhead, Black Crappie, White Crappie, Northern Pike, Chain Pickerel, Yellow Perch, Common Carp, and ‘other’. The other category was used for any unidentifiable species that were recorded on the camera. At the Vernon ladder, all of the target species, with the exception of Yellow Perch, were observed in the ladder.

197. The camera footage was reviewed which allowed a count of the number of fish moving upstream or downstream through the ladder, in addition to the timing of when fish moved throughout the monitoring season. An additional camera was

used as a backup and for quality control of the recordings. Despite the weekly checks of the secondary camera, there was a single, short duration outage, which occurred on September 2 when the software froze, though no data was lost during this period of time, as the record was reconstructed from video.

198. Fish were observed using the fish ladder from May 5, 2015, the first day of operation, through December 22, 2015. Table 14 notes the target species, the date of first fish passage, the date of last passage, the date of the peak passage, in addition to when 80 percent of the fish had passed through the ladder.

Table 14. Counts of fish moving upstream in the Vernon fish ladder during the 2015 study season. Net fish is the number of fish observed going up minus the number observed going down. First date indicates the date when a fish species or genera was initially observed, peak date is when the maximum number of observations were made, 80% date is the date when 80 percent of the fish had passed, and last date is the last date of observations for the species or genera.

Species/ Genera	Net Passage	First Date	Peak Date	80% Date	Last Date
Atlantic Salmon	7	5/20	NA	6/17	7/12
American Shad	39,196	5/10	5/18	5/30	8/22
Sea Lamprey	2,440	5/13	5/28-6/1	5/31	7/18
American Eel	1545	5/21	5/30-6/1, 7/13	7/21	12/16
Bass	761	5/5	5/16	8/20	11/06
White Sucker	322	5/5	5/5, 5/7	5/7	10/31
Walleye	58	5/5	5/5,5/9, 5/10	6/10	11/6
Trout	30	5/12	5/13, 5/18, 5/22, 5/30	7/12	12/2
Sunfish	1,188	5/7	NA	9/6	10/22
Bullhead	2	5/10	NA	6/21	8/13
Crappie	14	5/16	NA	5/30	6/11
Pike/Pickerel	-1	5/06	NA	NA	7/11
Yellow Perch	0	NA	NA	NA	NA
Carp	8	5/25	NA	7/20	7/23
Other	13	5/10	NA	7/20	12/10

199. The number of fish observed moving upstream in the ladder made it difficult to determine whether movement varied with operational changes. For example, how river discharge was partitioned through the facility (i.e., fish ladder, attraction water, operational discharge, spillage) are elements that introduced uncertainty to assessing the effect of operations on ladder performance. However, certain trends can be drawn from the data.

200. In 2015, American Shad and Sea Lamprey passage was most concentrated during a period of low river flows following the spring freshet, although Sea Lamprey passage continued at a reduced rate over a variety of flow conditions. American Eel passage was observed primarily during low flow periods during

the summer with no apparent relationship to high flow events. Bass passage was distributed across a range of flows through spring and summer. White Sucker passage was observed only during the spring while the freshet was receding. Walleye, trout, and sunfish passage was sporadic and distributed over a range of flow conditions from spring until early fall. Upstream passage of resident species occurred throughout the season until December 22. Cumulative net passage reached 80 percent by August 31.

American Eel

201. Another upstream passage study was conducted specific to American Eel (study 18) with the goal of collecting baseline data on American Eel attempting to move upstream past the Project. The methods included visual nighttime surveys within the tailrace and the spillway, in addition to setting baited eel pots in specific locations.

202. During the 2015 study season, visual surveys were conducted once a week from May to October at the Project. Eighty eels were documented with all observations occurring between mid-June and late September. Most eel were either documented at the fish ladder, 49 percent, or the submerged flood gates, 45 percent. Most eel, 66 percent, were estimated to be in the 12-18-inch size class, while another 30 percent were estimated to be in the 6-12-inch size class. Eel pots were deployed starting in May and continued through August with no eels collected in the baited pots.

203. Over the course of the 2015 season, extended fish ladder operations occurred in relation to study 17. Results from that study showed eel using the fish ladder from May 21 through December 16. The net upstream count was 1,545 eels with approximately 80 percent having passed by July 21.

204. Supplemental eel surveys using the same methodology were conducted in 2016 to understand eel presence below the dam in the absence of extended fish ladder operations, in particular after the ladder ceases operation in mid-July under current operations. Seventy eels were observed across weekly surveys from late July until October. The majority of the eel observations occurred across two weekly surveys in late August. Eel observations were generally more dispersed across observation locations than in 2015 when the ladder was open. Most eels, 66 percent, were estimated to be over 8 inches in length, with 33 percent estimated to be between 4-8 inches in length. The 2016 study included installation of a temporary eel ramp and trap near the entrance to the fish ladder that began operating on September 6. One eel, 10.9 inches in length, was collected on September 23.

205. Eel surveys continued in 2017 using the same methodology with the goal of further evaluating eel presence both with and without the fish ladder operating. During the 2017 season, the fish ladder operated from May 1 through August 7 and surveys were conducted from June 1 to November 6. Over this period, 148 eels were observed with the peak occurring from mid-June to mid-July. Eels were dispersed across observation points, but most were observed by the fish

ladder. The majority of eels observed were in the 6-12 inch size class, though most observed in the ladder were in the 12-18 inch size class.

206. In 2017, an eel trap was operated continuously from June 1 to November 8. One hundred twenty three eels were collected between July 5 and September 19. Peak collection occurred in late August when 60 percent of the collections occurred over a three day period. Eels collected from the trap ranged from 6.6 to 14.2 inches. Additionally, 581 eels were counted during the upstream fish ladder operating period and 120 eels were collected when dewatering the fish ladder.

207. During the 2018 study season, surveys following the same methodology as prior seasons were conducted from June 7 to November 1. However, the fish ladder operated on an extended schedule through October 15, the eel trap was not utilized, and additional observation locations were added in the tailrace and upstream of the trash sluice gate. Observations continued to be concentrated at the fish ladder where 61 percent of all observations occurred. From the observations in the counting room, eels generally travelled upstream at the bottom of the water column, and downstream, including fallback, through the middle of the water column. This provided context for a negative net count of eel and suggests that the automated software may not be picking up the totality of eels travelling upstream.

208. During the 2019 study season, upstream passage of juvenile eel was evaluated using PIT tags under shad passage flows of 64 cfs to identify the rate of travel through the fishway, assess the number of attempts individual eels undertook, and identify any problematic areas of the fishway. Seven PIT tag detection locations were distributed from the lower fishway to the exit weir. One hundred and sixty two eels were injected with PIT tags and released in four events between July 29 and September 5.

209. Of the study group, 126 eels attempted to move upstream in the fish ladder, making 188 unique attempts to ascend. Only seven eels reached the uppermost detection location. The time of travel for those individuals ranged from 33 to 1,176 hours with a median of 605 hours. The range of attempts to ascend per individual was 1 to 12 attempts.

210. Most attempts to ascend ended with a final detection just downstream of the counting window. It had been assumed that unsuccessful attempts would be evident by detections at lower receiver locations as a fish exited the fishway, but that did not occur. It is expected that many of these attempts ended with a fish exiting the ladder via the regulating pool overflow weir. This demonstrated outflow from the overflow weir may be an impediment to effective eel passage under normal shad operating conditions. This conclusion was also evidenced by one eel making 12 attempts to pass via the ladder.

Sea Lamprey

211. Sea Lamprey were observed using the fish ladder (study 17) and the results

from the 2015 study season are described in Findings 198 through 200. In 2016, fish ladder usage increased to 5,539 Sea Lamprey.

212. In addition, study 16 evaluated Sea Lamprey spawning. (Findings 338 to 345). This study demonstrated that Sea Lamprey use the fish ladders to move upstream of the dams and access suitable habitat to spawn.

American Shad

213. American Shad were the migratory fish most frequently observed in study 17. In addition to the timing inferences previously described, it is worth noting that most shad passage occurred during the day. While the lack of attraction did not preclude passage, the lack of attraction flow may be a factor in fish passage performance at night.

214. Upstream passage of American Shad was evaluated in study 21, which sought to assess the approach of shad attempting to move upstream, tailrace residency, movement within the fish ladder, and passage upstream. The study utilized individuals that were both radio tagged (dual tagged) and solely PIT-tagged.

215. One hundred shad were tagged with PIT tags and 52 of those were also tagged with radio tags. Study fish were released 9.5 river miles downstream in Northfield, Massachusetts. In a similar study at the next hydroelectric project downstream, 793 PIT or dual tagged individuals were released further downstream. The study area for PIT-tagged shad was limited to the fishway, while the study area for the dual-tagged shad included the reach from Stebbins Island to the tailrace, the tailrace, the fishway, and the forebay.

216. Fifty eight dual-tagged and 71 PIT-tagged shad were detected in the study area meaning the sample size for the study was 129 individuals. Median downstream residence time for dual-tagged shad was just under two days with no difference in average tailrace residence time between those that passed successfully versus those that fell back.

217. Effectiveness of the fish ladder for the upstream passage of American Shad was assessed by calculating three metrics: nearfield attraction, entrance efficiency, and internal efficiency. Attraction effectiveness was calculated from the proportion of dual-tagged shad detected within the immediate vicinity of the ladder. Thirty-four of the 58 available dual-tagged shad, or 58.6 percent, were attracted to the entrance of the fish ladder. Entrance efficiency was calculated from the proportion of dual-tagged shad detected within the vicinity of the ladder that then entered the ladder. Twenty-five dual-tagged shad and 71 PIT tagged shad were detected as moving through the fish ladder entrance resulting in an entrance efficiency of 73.5 percent. Internal efficiency was calculated from the number of dual-tagged and PIT-tagged shad that entered the ladder, exited the upstream end, and remained upstream for more than 48 hours. Internal efficiency was calculated to be 55.2 percent.

Downstream

218. The downstream fish passage facilities are described in Findings 49 through 51.

219. Migratory species that utilize areas upstream of the Project to complete their life cycle must also pass downstream in a safe, timely, and effective manner. For the Vernon Project, these include American Eel, Sea Lamprey, and American Shad.

American Eel

220. American Eel undergo metamorphosis before out-migrating to reproduce in the Sargasso Sea to spawn to complete their life cycle. For the life stages in the Connecticut River, this includes the 'silvering' phase during which an individual begins to change color pigmentation and eye diameter increases. The timing of metamorphosis and out-migration can vary.

221. The Applicant undertook two studies to inform the downstream passage of American Eel. Study 19 focused on safe, timely, and effective passage of adult (silver phase) American Eel, while study 20 was a desktop exercise to gather information on potential migratory cues for downstream migrating American Eel.

222. Study 20 relied upon a literature review that examined various potential cues that may trigger American Eel to migrate. While the focus was on triggers specific to the Connecticut River basin, other basins were also reviewed to identify commonality among cues.

223. Although several studies related to the out-migration timing of American Eel were reviewed, the anticipated cues continue to only be generally defined. However, the literature suggests that decreasing water temperatures and increasing river flow may act as cues. The extent of their influence, or whether there may be specific discharge or temperature thresholds, remains unknown and could be location specific. Studies have also found that migration of silver eels tends to occur at night.

224. The Project specific eel passage study (study 19) had two major components: quantifying turbine survival of American Eel passing through the turbines, as well as quantifying movement rates, timing, and route selection at the Project.

225. There are three groups of turbines at the Project based on type and size. (Finding 35). Units 1 through 4 are smaller Francis units, Units 5 through 8 are Kaplan turbines, and Units 9 and 10 are larger Francis units. As a result, Units 4, 8, and 9 were tested. Additionally, because tests at Wilder Unit 3 were suspended, additional eels were used to test a second discharge at Vernon Unit 8. This occurred because Vernon is likely to pass more eels and Units 5 through 8 are generally first on and last off.

226. The Applicant utilized a power analysis to determine the number of eel needed at each turbine for a statistically valid result. For Unit 4, 48 eels were released, for Unit 8, 48 were released at 1,000 cfs and 50 were released at 1,700 cfs, and for Unit 9, 48 eels were released. Fish were inserted directly below the ceiling of the turbine intakes.

227. Eels were tagged with several tags before release into the turbines. One type of tag was three to six HI-Z balloon tags. These tags are designed to deploy after passing through a turbine to rapidly bring large adult eels to the water surface for efficient recapture. The number of HI-Z balloon tags used was dependent on the size of the fish. A radio telemetry tag was also attached to one of the ballon tags. This was used to locate any fish that may not return immediately to the surface. The last tag was a small, numbered Floy tag to identify individuals.

228. In addition to those fish released into the turbines, a control group of 19 fish were released into the tailrace of the Project to assess any effect from the tagging process.

229. After release of the fish into the turbines or the tailrace, the eels were tracked using radio telemetry and then recaptured when the individual buoyed to the surface. The fish were brought into a boat, had all but the Floy tags removed, and were immediately examined for visible injuries, or loss of equilibrium. Fish were then held for 48 hours to assess delayed mortality or related injuries and to assess shear effects via a necropsy.

230. After the recapture process, fish were either classified as: alive recaptured, alive (assumed alive based on telemetry evidence but did not buoy to the surface), dead recaptured, dead (assumed dead based on telemetry evidence or assumed will not survive given injuries), or unknown.

231. If an individual fish was found to have no injuries or loss of equilibrium, the fish was provided the term “malady – free” which is a classification that has been standardized. Additionally, for the purposes of estimating survival of the control group, all control fish were combined for the three Connecticut River projects (Wilder, Bellows Falls, and Vernon).

232. Of the 48 released into Unit 4, 94 percent were recaptured alive. Of the 48 eel released into Unit 8 at a discharge of 1,000 cfs, 90 percent were recaptured alive. Of the 50 released into Unit 8 at a discharge of 1,700 cfs, 78 percent were recaptured alive. Of the 48 released into Unit 9, 96 percent were recaptured alive. Of the combined control group, 97 percent were recaptured alive. Table 15 provides the outcome of the released fish and estimates of 1-hour and 48-hour survival for the test turbines and discharges.

Table 15. American Eel turbine survival estimates for the turbines at the Vernon Hydroelectric Project.

Metric	Vernon Unit 4		Vernon Unit 8 @ 1,000 cfs		Vernon Unit 8 @ 1,700 cfs		Vernon Unit 9		Combined Controls	
	Number	%	Number	%	Number	%	Number	%	Number	%
No. Released	48		48		50		48		39	
No Alive	45	94	43	90	39	78	46	96	38	97
No. Recaptured			3	6			0			
dead	0				5	10			0	3
No. Assigned			0				0			
Alive	0				0				1	
No. Assigned			2	4			1	2		
Dead	1	2			6	12			0	
Tags only	1		2		4		0		0	
Stationary Signal	0		0		2		1		0	
No. Unknown	2	4	0		0		1	2	0	
Survival at 1 hour	97.80%		89.6%		78%		97.9%			
Std Error	2.20%		4.4%		5.90%		2.1%			
No. Held	45		43		39		46		38	
Died in Holding	2		1		2		0		0	
Alive at 48 hours	43		42		37		46		38	
Survival at 48			87.5%				97.9%			
hours	93.50%				74.0%		2.1%			
Std Error	3.60%		4.8%		6.20%		3.5%			
90% CI*	6%		7.8%		10.2%					

233. Survival estimates after 48 hours for American Eel passing through Unit 4 was 93.5 percent, for Unit 8 at 1,000 cfs, 87.5 percent, for Unit 8 at 1,700 cfs, 74 percent, and for Unit 9, 97.9 percent. This study does indicate that generally, American Eel fare better passing through Francis type turbines than through Kaplan type turbines.

234. For Unit 4, Unit 8 at a discharge of 1,000 cfs, Unit 8 at a discharge of 1,700 cfs, and Unit 9, 35.6 percent, 28.3 percent, 27.3 percent, and 8.7 percent of the recaptured eel had passage related injuries, respectively. The dominant injuries were generally scrapes and bruises with the exception of unit 8 at 1,700 cfs, in which decapitation or severed body was the dominant form of injury observed.

235. The study also investigated passage duration and route selection of American Eel passing through the Project through radio telemetry monitoring. This was accomplished by releasing 50 individuals with surgically implanted radio tags into the Project impoundment at a release point roughly three miles upstream of the dam. Fish were released in five different groups in the fall on October 27, 29, 31, and November 3, and 5, 2015. Additionally, eels released upstream at Wilder and Bellows Falls could also be tracked at the Project. Of the 70 eels released at Bellows Falls, 45 were detected in the Vernon study area. Twenty-five of the 50 eels released at Wilder were detected at Vernon.

236. The fish were tracked using a series of receivers that could detect radio tags and identify individuals. The receivers were set up in such a way to determine the specific path, or route, through the facility. The receivers focused on the

Project forebay, log and diversion boom, fish pipe, fish tube, fish ladder exit, turbines, tailrace, and spillway.

237. Table 16 depicts the route selection of American Eel passed at the Project. Only 66 percent of eels that were detected passed the Project. Of those fish, most went through the units with 47 percent passing via Units 5 through 8, 23 percent passing via Units 9 and 10, and another 13 percent passing via Units 1 through 4.

Table 16. Route selection of American Eel at the Vernon Hydroelectric Project from the downstream eel passage study conducted in 2015.

Passage Route	Number of Fish	Percent of All Individuals Passed	Percent of All Individuals Released
Unit 5-8 intake	53	47.3%	31.2%
Unit 9-10 intake	26	23.2%	15.3%
Unit 1-4 intake	14	12.5%	8.2%
Fish pipe	4	3.6%	2.4%
Trash/ ice sluice	2	1.8%	1.2%
Fish tube	1	0.9%	0.6%
Fish ladder	1	0.9%	0.6%
Unknown	11	9.8%	6.5%
Total Passed	112	100%	65.9%
Did not pass	2		1.2%
Did not approach	56		32.9%
Total released	170		100%

238. In addition to route selection, the study examined the time required for an individual to move past the facility. The radio telemetry data allowed for estimates of the total Project duration it took for individuals to move through the facility and how long an individual spent in any one location. Table 17 summarizes American Eel passage durations with all groups combined.

Table 17. Duration in hours of American Eel passing through portions of the Vernon Hydroelectric Project in 2015.

Location of Interest	Min	Max	Mean	Median	Number
Approach Duration	4.3	531.5	74.4	49.5	44
Forebay Residency Duration*	<0.1	835	11.1	0.2	114
Tailrace Duration*	<0.1	1961.9	148.8	0.8	112
Total Project Duration*	0.1	1962.1	160.1	1.2	112

*Includes available eel released at upstream Wilder and Bellows Falls projects

239. Approach duration was able to be calculated for all 44 individuals released into the impoundment and detected in the forebay. For the study group, approach

duration ranged from approximately 4.3 hours to 531.5 hours with a median duration of 49.5 hours. Thirty-six percent of the radio tagged eels were detected at the Project within 24 hours following the release. Approach from the Vernon impoundment release site to the forebay was slower than observed at the upstream projects.

240. Forebay residency duration could be calculated for 114 eels, including the individuals available from releases at the upstream Wilder and Bellows Falls projects. For the study group, time spent in the forebay ranged from less than 0.1 hours to 835 hours with a median duration of 0.2 hours. For the fish that passed the Project, forebay residency duration was less than four hours for 89 percent of the study fish. Statistically significant differences in forebay residency duration were not detected across known passage routes.

241. Tailrace residency duration could be calculated for the 112 eels that passed the Project including the individuals available from releases at the upstream Wilder and Bellows Falls projects. For the study group, tailrace residency time ranged from less than 0.1 hour to 1,961.9 hours with a median duration of 0.8 hours. Approximately 69 percent of the individuals were detected within the tailrace for four or fewer hours following passage. Six individuals that were detected for at least 70 days after passage and were not detected downstream at Stebbins Island were likely mortalities. An additional ten eels that passed via the turbines had tailrace residency durations between 2 and 49 days, and are also likely mortalities. While these fish were detected at Stebbins Island their condition is not known. Statistically significant differences in forebay residency duration were not detected across known passage routes.

242. Total project residency duration was calculated for the 112 eels that passed the Project including the individuals available from releases at the upstream Wilder and Bellows Falls projects. The total project residency duration was defined as time from when an individual was detected approaching the Project until its final detection downstream. Total project residency duration ranged from 0.1 hours to 1,962.1 hours with a median duration of 1.2 hours. The total project residency duration of approximately 76 percent of the study group, or 85 of 122 fish, was less than 24 hours.

243. The timing of passage was also analyzed. Most of the fish passed the Project during the evening and early nighttime hours. Seventy percent of eels released into the impoundment passed the Project within one day of the final release on November 15, 2015, with the last American eel passage event occurring on November 20, 2015. Eels approaching from the Bellows Falls impoundment passed Vernon between October 29 and December 28, 2015, and eels approaching from the Wilder impoundment passed Vernon between November 1 and November 21, 2015.

244. When fish were passing through the Project, the units were running, and total project flow was concentrated there. Passage at the trash/ice sluice did not occur when there was significant discharge.

245. When considering potential project effects, one metric to consider is forebay duration. The assumption is that fish exhibiting back and forth behavior could indicate a potential Project effect, because the individual has shown interest in migration by moving into the forebay but is unable to locate downstream passage. Time spent wandering or searching for greater than 8 or 24 hours was identified. Five fish, or 4.5 percent of the eels that passed the Project were observed for 24 or more hours and another seven eels, or 6.3 percent, exhibited this behavior for 8 to 24 hours. The remining 100 eel (89.3 percent) exhibited this behavior for less than 8 hours, with 67 eel, or 74.4 percent, passing in less than one hour.

246. As discussed above, the American Eel downstream passage study took place at the upstream Wilder and Bellows Falls projects owned by the Applicant and undergoing relicensing. As a result, travel time from each facility to the next facility for individuals detected at multiple facilities can be determined.

247. Fifty-eight percent of the eels released upstream of the Wilder project passed downstream of Bellows Falls. Detection information was available for 27 individuals to estimate transit time. Transit time from the Wilder tailrace to the monitoring station immediately upstream of Bellows Falls, approximately 44 river miles, ranged from 26 hours to 169.9 hours, with a median of 53.5 hours.

248. Seventy two percent of the eels released upstream of either the Wilder or Bellows Falls projects that passed downstream of Bellows Falls reached Vernon. Detection data was available for 62 individuals to estimate transit time. Transit time from the Bellows Falls tailrace and the monitoring station immediately upstream of Vernon, a distance of approximately 31 river miles, ranged from 16.2 hours to 437.5 hours with a median of 62.4 hours.

249. Of the 112 eels that passed downstream of Vernon, detection data was available for 102 individuals to evaluate transit time between the Vernon tailrace and the Stebbins Island monitoring station, approximately 0.75 river miles, ranged from less than 0.1 hour to 657.3 hours with a median of 0.1 hour.

250. Total project survival based on radio telemetry data was estimated at 89.3 percent due to the passage route proportional distribution and estimated route survival rates. Two other estimates of project survival can be derived from the Hi-Z tag direct turbine survival and Franke turbine survival estimates, and are 89.3 and a range of 39.8-81.1 percent respectively.

American Shad

251. The Applicant undertook a study to evaluate the downstream passage of American Shad through the Project. Sixty-five individuals were available for monitoring. Fifty-four were collected at the Vernon fish ladder, radio-tagged, and released upstream on May 17 and 30, 2015. The other 11 shad passed upstream, retained their tags, and could be tracked during downstream migration.

252. Of the individuals available for the study, 59 shad, or 91 percent, returned to the Vernon forebay. The time from when a fish was released upstream to the return detection in the forebay ranged from 20.9 hours to 39.5 days with a median time of 12.3 days. Nine shad mortalities occurred at the trashracks and another individual was removed from the analysis. Of the remaining 49 shad active in the forebay, residency could be determined for 39 individuals. Forebay residency ranged from several minutes to greater than 21 days, with the shortest residency time associated with times when discharge exceeded maximum station generating capacity. Forebay residence time tended to be shorter for shad using the fish pipe versus those using the units. Median residence time in the Vernon forebay was less than 12 hours, however, the number of fish available to evaluate route selection was low.

253. Most downstream passage events occurred when all ten units were operating, which occurred during about 48 percent of the study period. Passage events generally increased with peaks in discharge.

254. Station telemetry data was compiled from Stebbins Island located 0.75 miles downstream of Vernon dam, Northfield Mountain about 15 miles downstream, and Turners Falls dam located about 22 miles downstream. Of the 42 shad that passed Vernon, 78.6 percent were detected at Stebbins Island, 59.5 percent were detected at Northfield Mountain, and 54.8 percent were detected at Turners Falls Dam. Shad that passed through Units 9 and 10 and through the fish pipe tended to show a higher degree of downstream movement, than shad that passed via spill or through Units 5 through 8.

255. An additional downstream passage assessment of radio-tagged adult shad was conducted in 2017. The 2017 study followed the same general methodology as in 2015, however a larger study group of 99 fish released above Vernon dam was paired with a more extensive detection array to reduce the number of unknown routes of passage. Study fish were released at the Old Ferry Boat Launch in Brattleboro, Vermont roughly 11 miles upstream of the dam. Releases occurred during the early, mid, and late portions of the spawning run.

256. Sixty-one of the 99 study fish, or 62 percent, approached the Project and downstream passage could be documented for 48 individuals of that group. The time from release to first detection in the study area ranged from 0.96 days to 37.22 days with a median of 7.8 days. Study fish approached the Project from June 3 through July 18, 2017, with 86 percent approaching during June. For the 48 individuals that passed, forebay residency duration ranged from 0.01 to 426.3 hours with a median of 11.69 hours. Adjusting for time in between approaches when an individual left the study area, adjusted residency duration ranged from 0.01 to 247.27 hours with a median of 4.72 hours. Adjusted residency time was shortest for shad passing by spill, Units 9 and 10, and the east fish pipe and longer for passage via the sluice, Units 5 through8 and Units 1 through 4.

257. Route selection was informed by the 48 fish that passed downstream. The largest proportion of fish, or 33 percent, passed via the fish pipe, 27.1 percent

passed over the spillway, 10.4 percent passed via Units 9 and 10, 10.4 percent passed via Units 5 through 8, 6.3 percent passed via the sluice gate, 6.3 percent passed via the fish ladder, and a definitive route could not be determined for one individual. Twenty-three fish passed downstream when all 10 units were in operation and 21 fish passed when the Project was spilling. As in 2015, elevated discharge seemed to facilitate downstream shad movement.

258. Downstream passage of juvenile shad was evaluated by Study 22 with the objectives of quantifying forebay residence time, identifying proportional route selection, and evaluating turbine survival. A total of 310 juvenile shad were radio-tagged and released upstream of the Project in 15 groups of 13 to 20 fish between September 25 and October 30, 2015. Telemetry monitoring locations included the forebay, log boom and diversion boom, fish pipe, fish tube, turbines, tailrace, and spillway.

259. Two hundred seventy shad, or 87.1 percent approached the Project. The percentage of juvenile shad failing to approach was largest during the earliest release groups. For the 270 shad that entered the forebay, approach duration ranged from 0.1 hours to 70.8 hours, with a median of 1.9 hours. Sixty-eight percent of released juvenile shad were present in the forebay within four hours of release.

260. For the 265 fish that approached the Project, valid detection information was available to determine forebay residence duration, which ranged from approximately six minutes to 237.7 hours with a median of 44 minutes. Fish that failed to approach and fish with the longest median forebay residency time were associated with the earliest release. Of the individuals in the first release, 38 percent did not pass through the Project. Approximately 87 percent of the shad that passed the Project did so in 12 hours or less after detection.

261. Of the 270 study individuals detected in the forebay, 83.7 percent were confirmed to have passed the dam, however a definitive passage route was available for 75.2 percent of that group, or 170 fish. Eighty seven percent of shad with a definitive passage route passed via the turbines. Fifty three percent passed via Units 5 through 8, 20.6 percent passed via Units 9 and 10, and 12.9 percent passed via Units 1 through 4. Eighty five percent of shad passage occurred from 5 PM to 10 PM and 80 percent passed at flows between 8,000 and 11,000 cfs. Passage did not necessarily occur via the route with the greatest proportion of total project discharge, but this did occur about 53 percent of the time.

262. While the route selection component of the study was not intended to quantify downstream survival, as there are no available estimates of background mortality, of the 226 that were confirmed to pass the Project, 70.4 percent were detected at Stebbins Island.

263. Survival estimates could be derived from radio telemetry, Hi-Z tag, and Franke turbine methodologies to the proportion of shad passing via the turbines. Total project survival ranged from 70.4 percent to 87.5 percent. The radio telemetry

estimate of 70.4 percent was lower than the Hi-Z estimate of 85.8 percent and the Franke-based range of 83.1-87.5 percent.

264. The juvenile shad study also included an evaluation of the timing of the 2015 juvenile shad emigration period by deploying hydroacoustics in the vicinity of the entrance to the downstream fish pipe. The time series of acoustic detections was used to determine the onset, departure, timing, duration of peak abundance, diel periodicity, and depth distribution of juvenile shad. Hydroacoustic data was verified by three additional independent sampling methods: cast netting, visual observations, and electrofishing.

265. Results showed that schooling fish first appeared in the Vernon forebay on August 17 and last appeared on October 30, a period of 74 days, although they were not consistently present until the beginning of September. Fish density increased through September, reaching the highest density on October 3 with two subsequent peaks in late October.

266. Fish school density was most abundant following a sharp decrease in water temperatures, but was absent once temperatures remained below 50°F. Fish density was also highest during the afternoon and dusk. Schools tended to concentrate toward the middle of the water column at depths of 20 to33 feet, and then moved toward the surface around dusk. Schools were identified at the depth in the water column where the fish pipe is located during October. Fish density of juvenile shad generally decreased within two days indicating likely passage.

267. Turbine survival and injury was also assessed. The estimated one hour survival for unit 4 was 91.7 percent and for unit 8 was 95.2 percent. Survival at 48 hours could not be estimated due to high mortality amongst the control group. Of the recaptured fish, 95.5 percent of the fish that passed through unit 4 did not have injuries and 95.7 percent of the fish that passed through unit 8 did not have injuries. The primary injury type on fish that passed through unit 4 was hemorrhaging on the body and for fish that passed through unit 8 was operculum/gill damage. Mechanical force alone or in combination with shear force were attributed to most of the observed injuries.

J. Aquatic Habitat

268. The Connecticut River is classified by the State of Vermont as Class B(2) for the aquatic habitat designated use.

269. Waters classified as Class B(2) for aquatic habitat use shall be managed to achieve and maintain high quality aquatic habitat, characterized by the physical habitat structure, stream processes, and flow characteristics of rivers and streams and the physical character and water level of lakes and ponds necessary to protect and support all life-cycle functions of aquatic biota and wildlife, including overwintering and reproductive requirements. (Standards, Section 29A-306(b)(3)(A)).

270. There are two distinct areas where the Project may affect aquatic habitat, the impounded reach above the dam, and the Connecticut River downstream of the dam.

271. The Vernon impoundment is typically described as extending roughly 26 miles upstream to the Walpole Bridge at Westminster Station, VT, however study 9 described the upstream extent as Dunshee Island. At the normal full pond elevation of 220.13 feet, the impoundment is estimated to have a surface area of 2,550 acres, about 69 miles of shoreline, and a volume of approximately 40,000 acre-feet.

272. Study 7 delineated 3,137 acres of aquatic habitat in the Vernon impoundment during field efforts. The dominant substrate type was sand/silt/clay, making up 76.2 percent. Gravel/cobble, boulder, woody debris, rip rap, and ledge followed in descending abundance at 14.9 percent, 3.3 percent, 3.0 percent, 1.7 percent, and 0.9 percent, respectively.

273. Below the Vernon Dam, there is a stretch of riverine habitat to the backwater from the Turners Falls impoundment. The reach extends 1.3 miles from a pool below Vernon Dam to the downstream extent of Stebbins Island. Stebbins Island is subject to wide variations in wetted habitat area under current Project operations and is also heavily used for spawning by several species of fish.

Flow Needs for the Protection of Aquatic Habitat

274. The Applicant has proposed to operate the Project in an IEO mode as the predominant mode of operation, along with flexible operations that vary seasonally by month with transition operations to bridge departures from and returns to IEO mode. As part of the relicensing, the Applicant conducted a flow habitat study (Study 9), also referred to as a physical habitat simulation (PHABSIM) or hydraulic habitat study.

275. Three mesohabitat types were mapped in the Vernon riverine reach. These mesohabitat types were pool (deep pool, shallow pool), glide, and run. Pool was the dominant mesohabitat type at 39.5 percent, followed by run, and glide at 34.9 percent and 25.6 percent, respectively. The dominant sediment type in the reach was gravel, followed by silt, sand, cobble, mud/clay, bedrock, and boulder at 18 percent, 13 percent, 5 percent, 2 percent, 2 percent, and 1 percent, respectively.

276. A total of 16 transects were selected in the Vernon riverine reach in consultation with the Applicant, consultants, applicable agencies, and non-governmental stakeholders. A total of seven transects were located in runs, five in either deep or shallow pools, three in glides, and one in a riffle located in a side channel.

277. Each transect was then segmented into sections perpendicular to river flow. In each section, substrate data was collected under low flows. If waters were too deep to identify substrate, then an underwater camera was used. Substrate

was coded as detritus/organic, mud/clay, silt, sand, gravel, cobble, boulder, or bedrock.

278. Within each section, depth and velocity were collected at three flows for model calibration. The target flows for calibration were 1,600-2,500 cfs, 5,000-7,500 cfs, and 10,000- 12,000 cfs. Depth and velocity measurements were primarily obtained with an acoustic doppler current profiler that was moved across the river channel multiple times.

279. The three target flows were used to develop stage-discharge relationships at each individual transect. The general rule of thumb for model calibration is that models can estimate flows and depth at roughly 0.4 times the lowest calibration flow and 2.5 times the highest calibration flow. This allowed for modeling to the minimum (1,250 cfs) and maximum (17,100 cfs) hydraulic capacity of the Project.

280. Each section across a transect was then evaluated for suitability for a series of target species and life stages. Target species and life stages included American Shad (juvenile, adult, and spawning), Walleye (fry, juvenile, adult, spawning), Fallfish (fry, juvenile, adult, and spawning), White Sucker (fry, juvenile/adult, spawning), Longnose Dace (juvenile, adult, and young of year), Tessellated Darter adult, Sea Lamprey spawning, Smallmouth Bass (young of year, juvenile, adult, and spawning), benthic macroinvertebrates, and co-occurring mussels.

281. In addition to the specific species and life stages, the Applicant included suitability for various mesohabitat types including shallow-fast, shallow-slow, deep-fast, and deep-slow. This offers an opportunity to review available habitat in a broader context, in addition to species specific information.

282. Habitat suitability curves typically include information on the suitability of substrate type, velocity, and depth. The suitability of each variable falls within a range of 0 to 1, 0 being not suitable at all, and 1 being the most suitable. Each variable is multiplied at each cell across the transect to obtain an overall suitability score. These values are then summed at each transect and each modeled discharge.

283. Habitat suitability curves for each species were chosen in consultation with the Applicant, their consultants, and relevant agencies. Two habitat suitability curves, co-occurring mussel and dwarf wedgemussel, were developed as part of a delphi process and included additional variables of shear stress, bed shear stress, and benthic water velocity.[10]

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[10] The delphi process is a discussion between a group of experts to reach consensus on a topic. For the delphi based HSC curve development was as follows: (1) a group of experts was identified; (2) the objectives and procedures of the Delphi exercise were explained to each expert; (3) the experts agree to participate as panelists; (4) each panelist gave their opinion or estimate on the inquiry; (5) the results, including rationale given by each panelist, were summarized and fed back to each panelist, ending the first round; (6) panelists answered the inquiry again, in light of the information generated by the

284. In addition to determining the available habitat at any single discharge, available habitat can also be determined using either a dual flow, for immobile species, or two-flow, for mobile species, analysis. In a dual flow analysis, the amount of habitat at two different flows are estimated on a cell-by-cell basis across each transect. Any cell that contains adequate available habitat at both flows is counted. This analysis is intended for a species and life stage of interest that is considered immobile and therefore cannot readily move to a location with suitable habitat when habitat suitability changes.

285. A two-flow analysis considers the amount of available habitat across a transect at two different flows. The flow that contains the least amount of habitat is considered the limiting flow and determines the habitat available under the scenario. This methodology accounts for changes in suitability with flow, but in the context of mobile species that can move from one location to another to seek suitable habitat.

286. The results of the study indicate that there is a wide range of flows over which habitat for each species and life stages of interest are optimized in the Vernon riverine reach, rather than a flow that accommodates all species. This is understandable given the wide variety of species of interest evaluated and their varied habitat preferences. However, some general conclusions can be drawn.

287. The amount of suitable habitat that remains under either a dual flow or two flow analysis is greatest when the magnitude of changes in flow are reduced. For example, white sucker fry are considered an immobile species and were evaluated under a dual flow analysis. When flows change from the typical minimum generation flow at the project of 1,600 cfs, to the maximum capacity of the Project, 17,100 cfs, the amount of habitat lost is 89 percent. However, if the base flow is increased and the magnitude of change between the two flows is reduced, the percentage of habitat lost is reduced. For example, when the range of flow change is reduced from 5,000 cfs to 17,100 cfs, the percentage of habitat lost is reduced to 54 percent. This trend is common for most immobile species, although to differing degrees.

288. The amount of habitat that persists under a two flow analysis shows a similar trend as habitat under a dual flow analysis. Fallfish adults are considered a mobile species and can move to suitable habitat as needed, although it is important to note this comes at an energetic cost for any mobile species. With a base flow of 1,600 cfs to a maximum flow of 17,100 cfs, 47 percent of the habitat is lost. If the base flow is increased to 2,250 cfs and the peak flow is reduced to 10,595 cfs, 28 percent of the habitat is lost. This trend is similar for other mobile species.

289. In addition to the energetic cost of changing locations to seek suitable habitat, there is a concern that if these fluctuations occur too rapidly, some fish could

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collective responses from round 1; (7) the process was repeated until a consensus or acceptable level of agreement was reached; (8) the exercise is terminated and the procedures and results are documented, including all rationale for agreement or disagreement.

become stranded or the likelihood of predation may increase. The likelihood of this depends on the species, lifestage, its swimming ability, and preferred habitat. For example, a fish species that prefers shallower depths or has weak swimming capabilities are more likely to become stranded than a fish that prefers pool type habitats.

290. Lifestages such as spawning, incubation, and fry are not present year-round and the specific timing of these reproductive processes can vary from year to year. These lifestages are often, depending on the species, more sensitive to changes in flow due to their immobility, and on occasion more limited in suitable ranges of depths, velocities, or substrate types.

291. The instream flow habitat study results indicate that when evaluating a single optimized flow at a seasonal level there may be a wide range of flows over which habitat is optimized for a given species and lifestage. However, when considering the magnitude of change between two flows, the general trend is that the smaller the change in flow, the greater amount of suitable habitat remaining.

Water Level Fluctuation in the Impoundment

292. While operating in IEO mode, the Project will not operate out of storage. This will result in minimal artificial water level fluctuation within the impoundment during this mode of operation.

293. The Applicant also proposes to operate in a flexible operations mode with the allowable frequency of these operations varying seasonally. During flexible operations, the impoundment will fluctuate which may affect immobile species, the spawning activity of fishes during specific seasons (see protection and support of life cycle functions), and potentially erosion (see stream processes and physical habitat structure).

294. The Project will employ transition operations between IEO and flexible operations, which will limit the rate of drawdown during flexible operations and the time that the impoundment may be lowered. This is accomplished by the up-ramping rate and the requirement to refill within 48 hours after a flexible operations has ended.

295. In addition to flexible operations, maintenance activities are not seasonally planned as they are dependent on when repairs are needed. The timing and duration of a drawdown can have different effects on the habitat within the impoundment.

Stream Processes and Physical Habitat Structure

296. Stream processes are defined as the hydrologic, bed-load sediment, and large woody debris regimes of a particular stream reach and is a term used to describe stream channel hydraulics, or the erosion, deposition, sorting, and distribution of instream materials by the power of flowing water. Stream

processes work toward an equilibrium condition, are governed by flow characteristics, stream morphology, channel roughness, and floodplain connectivity and, in part, determine physical habitat structure and aquatic habitat quality. (Standards, Section 29A-102 (43)).

297. Physical habitat structure is defined as the diverse combination and complexity of instream forms created within substrate and woody debris on and within the bed and banks of the channel by stream processes and flow characteristics. Physical habitat structure, in part, determines aquatic habitat quality at the stream reach and stream network scales by providing for all life cycle functions, which includes the full set of forms necessary for the provision of and access to cover, overwintering, and temperature refuge and the substrates necessary for feeding and reproduction of aquatic biota and wildlife. (Standards, Section 29A-102 (34)).

298. Erosion is a natural process that occurs in waterbodies. There are many forces that act on the substrates, channels, and corridors of rivers and there are many processes that can contribute to erosion within rivers, some include the hydraulics of river flows, freeze thaw cycles, and abrasion which reforms stream channels. Erosion can also be exacerbated by anthropogenic causes. Bank erosion occurs when the various forces of erosion exceed the resisting force of the bank material.

299. The Connecticut River has historically been straightened and armored to facilitate development, for example log drives and the armoring of railroads. Channels adjustment and the sorting of instream material is a natural process in which river channels seek equilibrium condition where the sediment and hydrologic regimes are in balance. However, this process can be hindered by manmade activities and structures, including hydroelectric facilities. These effects can be exacerbated when high flows, or flood flows, reach a constriction point, or pinch point, in the river.

300. The Applicant conducted erosion studies (studies 1 through 3) along roughly 250 miles of streambank over the course of two years. In addition to the physical measurements that took place over the two-year study, the Applicant also acquired historical photos to examine historical erosion rates through time.

301. For the historical analysis, the Applicant located as many historical photos of the river reaches as possible for comparison. Every 0.5 miles of river were analyzed as frequently as possible. The study area included the Vernon impoundment, but omitted the 1.5-mile riverine section below Vernon dam. The available data sets varied, but photos were available from as early as 1939 to 2010, at various time steps. From these photos, the Applicant was able to estimate the rate of movement per year.

302. It is important to note that this analysis has important limitations because of the lack of data and precision associated with each photo. The Applicant attempted to ensure that the locations within the photos aligned, and measurements were taken in the same locations. However, the analysis relied on best professional

judgement.

303. The analysis of historical photographs showed a decline in erosion rates since the 1950/55 photographs, particularly in the Vernon impoundment where areas of substantial erosion declined significantly. Additionally, comparisons of erosion mapping completed in 1958, 1978, and 2014 also note declines in the amount of erosion in the Vernon impoundment.

304. The two-year field study was conducted between 2013 and 2015 in which five sites within the Vernon Project area were assessed on eight different occasions. Three study sites were located within the impoundment and two in the riverine reach. At the time of the study, the Applicant was operating under current operations under the existing license. The Applicant performed surveys along a single transect, took repeated photos of the bank, and monitored water levels at 15-minute intervals. Additionally, the Applicant described the bank sediments and did a one-time survey across the full river channel at the site.

305. Over the course of the study, erosion was observed at each of the three sites within the impoundment and one of the two sites in the riverine reach.

306. The Applicant examined water surface elevation data for changes during normal operations relative to the height of erosion along the banks, so a base elevation could be established around which water levels fluctuate due to current project operations. This may identify potential notching, where material is removed from the bank closer to the water surface and may, over time, cause large amounts of material to be removed from the bank.

307. The most upstream Vernon impoundment site, V02 upstream, is located in Putney, Vermont near the upstream end of the Vernon impoundment. Over the course of the monitoring period, a large planar slip was noted mid bank, along with smaller slips higher up on the bank, as well as notching at the bank toe. The large planar slip and features higher on the bank are outside of the range of Project operations. Additionally, the planar slip was noted on a visit after the spring freshet receded. While notching can occur due to Project operations, the elevation of the notching at this site appears to be above the median WSE range. This site was characterized as eroding.

308. The second most upstream Vernon impoundment site, V03 downstream, is also located in Putney, Vermont near the upstream end of the Vernon impoundment and in proximity to V02. Over the course of the monitoring period, a planar slip was noted mid-bank, along with notching at the toe, and topples detaching and being mobilized, likely by the notching process. The notching at this site appears closer to the median WSE range, but still above that range. This site was also characterized as eroding.

309. The third and most downstream Vernon impoundment site, V06, is located in the lower Vernon impoundment in Chesterfield, New Hampshire. The change observed at this site was notching at the bank toe. It is estimated that one foot of material was removed over the course of the study period. Notching was first

noted in the fall of 2014, along with a bank retreat of 0.3 feet. Between the retreat of the spring freshet, additional notching was noted and noted again between the spring to summer monitoring period. The notching at this site appears to be well above the median WSE range and closer to a modeled flow of 35,000 cfs. This site was characterized as vegetated eroding.

310. The first Vernon riverine site, VR01, is the most upstream and is located just downstream of Vernon Dam in Hinsdale, New Hampshire. The site features a high, steep, sandy bank. Changes at this site included some rotation noted at the top of an overhanging bank at an elevation greater than 255 feet (NAVD88), deposition, and notching at the middle and upper beach. The notching was documented above the median WSE range at flows above those associated with normal project operations. This site was characterized as eroding and has been monitored by the Applicant for years due to its proximity to the dam.

311. The second Vernon riverine site, VR02, is the most downstream and is located at Stebbins Island in Hinsdale, New Hampshire within the influence of Turners Falls Dam. Changes at this site included a planar slip documented at the first visit after the 2015 spring freshet receded, along with some removal of material, and notching at the bank toe. Notching at this site appeared to be within the median WSE range, although also within the zone of influence of the downstream hydroelectric projects not operated by the Applicant but also going through relicensing. This site was characterized as stable.

312. In addition to the transect monitoring that took place, the Applicant also conducted HEC-RAS modeling to assess the velocity needed to move bank particles at the erosion study sites within the Project area. This study used ADCP data, a constant water surface elevation, and known particle sizes to calculate shear stress and determine under what conditions substrates would be moved into the water column.

313. The Applicant used the D_{50} particles collected at the site to determine which size to consider when determining shear stress. This is a standard practice when considering the shear stress on substrates. Although it does not encompass all available substrate sizes at each sample site, substrate size results indicate that the next dominant size class was only slightly larger or smaller than the substrate size used in the analysis.

314. The HEC- RAS model simulated a consistent surface water elevation and then modeled low (2,000 cfs), medium (6,000 cfs), and high (15,000 cfs) flows. The near bank velocity was estimated and compared to the results of the shear stress estimates. When the near bank velocity is greater than the estimated shear stress then there is the possibility of erosion occurring near the bank and under the water surface.

315. Five sites were evaluated within the Vernon project area for project effects. Four did not show potential for project effects. One riverine site, VR02, showed that under some conditions near bank velocity was greater than the critical

shear stress. While sediment from the depositional beach areas could be mobilized at operational flows, the potential for entrainment of bank sediment required a velocity associated with a flow of 15,000 cfs, or above the maximum hydraulic capacity of the Project.

316. The preceding findings (Findings 304 through 315) describe observations at specific monitoring locations, but there is recognition that the magnitude of impoundment water surface elevation change depends on the location within the impoundment, particularly distance from the dam and site specific characteristics. This is in part due to the hydraulic controls located within the impoundment shorelines and inflow from upstream and tributaries to the impoundment. As part of relicensing, the Applicant developed nodal water surface elevation data from Bellows Falls Dam to Vernon Dam. This allows modeled estimates of the minimum and maximum daily average impoundment elevation levels throughout the impoundment to be calculated for representative years and months.

317. There are a total of 465 different nodes or locations where WSE is modeled between the Vernon dam and the Bellows Falls Dam. These nodes are located at relatively equal segments. This nodal data set also covers the free flowing Bellows Falls riverine reach where water surface elevations are dictated by the elevation and slope of the channel and the magnitude of flow, rather than operations at Vernon Dam. Using the model provided by the Applicant, nodes were identified from the dam to upstream extent of the impoundment to assess the effects of Project operations on WSEs throughout the impoundment. The location of nodes at known features provided context for determining the upper extent of the Project impoundment and brackets the break point. For example, Walpole Island, which is near the lower extent of the Bellows Falls riverine reach is located at node 448 and the most upstream erosion monitoring site in the Vernon impoundment is located at node 377. While the upper end of the impoundment is proverbially described as the Walpole Bridge, the instream flow identified Dunshee Island as the approximate divide between the Bellows Falls riverine reach and the upper extent of Vernon impoundment, which is downstream of the Walpole Bridge. Based on the nodes across the Project impoundment, this feature is likely located around node 425. For the purpose of this analysis, a point slightly downstream at node 415 was identified as the upper extent of the Vernon impoundment.

318. In the tables below, seven nodes are roughly evenly spaced between Vernon Dam and the upper impoundment. The exception is the final two nodes due to the impoundment break point. This nodal data is representative of what is occurring across the Project impoundment. Due to the intensity of the model, the years and months are intended to represent both a range of hydrologic conditions that would be anticipated and seasonal considerations.

319. Table 18 presents the modeled results of the difference between the average daily minimum water surface elevation and the average daily maximum water surface elevation by modeled year and month for proposed operations. Table 19 presents the modeled results of the difference between the daily average

minimum water surface elevation and the daily average maximum water surface elevation by modeled year and month for IEO mode, or as if the Project were strictly passing inflow downstream.

Table 18. Modeled results of the difference between average daily minimum water surface elevation and the average daily maximum water surface elevation by year and month for proposed operations. Years represent different types of hydrological conditions from wet to dry. The months (February (Feb), June, August (Aug), and November (Nov)) are representative of different seasons and flexible hour limitations.

Year	Month	Node 55	Node 120	Node 185	Node 250	Node 315	Node 380	Node 415
2009	Feb	0.4	0.4	0.4	0.4	0.4	0.5	0.8
	June	0.0	0.1	0.1	0.1	0.2	0.4	0.7
	Aug	0.3	0.3	0.3	0.4	0.5	0.6	0.8
	Nov	0.1	0.1	0.2	0.3	0.4	0.5	0.8
2015	Feb	0.6	0.6	0.5	0.5	0.5	0.5	0.8
	June	0.1	0.2	0.3	0.5	0.7	1.0	1.4
	Aug	0.2	0.2	0.2	0.2	0.2	0.2	0.4
	Nov	0.4	0.3	0.3	0.4	0.4	0.4	0.7
2016	Feb	0.3	0.5	0.6	0.7	0.9	1.2	1.6
	June	0.2	0.2	0.2	0.2	0.3	0.3	0.4
	Aug	0.2	0.2	0.2	0.2	0.2	0.3	0.3
	Nov	0.5	0.5	0.5	0.5	0.5	0.5	0.8
2017	Feb	0.6	0.7	0.7	0.8	0.8	1.0	1.3
	June	0.1	0.1	0.2	0.3	0.4	0.6	0.9
	Aug	0.2	0.2	0.2	0.2	0.2	0.3	0.4
	Nov	0.3	0.3	0.3	0.4	0.4	0.5	0.7

Table 19. Modeled results of the difference between the average daily minimum water surface elevation and the average daily maximum water surface elevation per month for inflow equals outflow mode. Years represent different types of hydrological conditions from wet to dry. The months (February (Feb), June, August (Aug), and November (Nov)) are representative of different seasons and flexible hour limitations.

Year	Month	Node 55	Node 120	Node 185	Node 250	Node 315	Node 380	Node 415
2009	Feb	0.0	0.0	0.0	0.0	0.1	0.1	0.2
	June	0.0	0.0	0.1	0.1	0.2	0.3	0.6
	Aug	0.0	0.1	0.1	0.2	0.3	0.4	0.6
	Nov	0.0	0.1	0.1	0.2	0.3	0.4	0.7
2015	Feb	0.0	0.0	0.0	0.0	0.0	0.1	0.1
	June	0.0	0.1	0.2	0.4	0.6	1.0	1.4
	Aug	0.0	0.0	0.0	0.0	0.1	0.1	0.2
	Nov	0.0	0.0	0.0	0.1	0.1	0.1	0.2
2016	Feb	0.1	0.2	0.3	0.5	0.8	1.1	1.5
	June	0.0	0.0	0.0	0.1	0.1	0.2	0.4
	Aug	0.0	0.0	0.0	0.0	0.1	0.2	0.3
	Nov	0.0	0.1	0.2	0.3	0.4	0.5	0.7
2017	Feb	0.0	0.1	0.2	0.3	0.4	0.5	0.7
	June	0.0	0.1	0.1	0.2	0.4	0.6	0.9
	Aug	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	Nov	0.0	0.0	0.1	0.1	0.2	0.3	0.4

320. There are several similarities between the two tables, including greater changes in water surface elevation moving upstream from the dam (higher numbered nodes), and the largest range of water surface elevations occurring in the upper reaches of the impoundment. For the proposed operations, the difference between the average daily minimum and maximum surface water elevation ranged from 0.0 to 1.6 feet. Similarly, under an IEO mode, the difference between the average daily minimum and maximum water surface elevation ranged from 0.0 to 1.5 feet.

Protection and Support of Life Cycle Functions

321. Water level fluctuation at times throughout the year can affect spawning fish, their eggs, and fry, and can therefore interfere with reproduction. This is particularly true for lifestages utilizing nearshore habitat, either in the impoundment or riverine reach, that can become dewatered with fluctuating

flows and water levels.

322. The Applicant conducted three spawning studies as part of the relicensing effort. One focused on resident fish species in the impoundment and riverine areas, another focused on Sea Lamprey, and another focused on American Shad.

323. The resident fish species spawning study involved observing nesting sites for species of interest, both backwater spawners and tributary spawners, in both early and late spring in the impoundment and riverine reach. It also included an analysis of the effects of fluctuating impoundment water levels and downstream flows associated with current operations on the study sites.

324. Within the impoundment, study sites focused on areas where fish were likely to spawn, which excluded steep banks and silty or muddy substrates. Sites were also selected based on where observations were likely to occur, therefore excluding hazardous working conditions, and targeted depths less than five to six feet deep.

325. Four backwater sites were selected within the Vernon impoundment and four sites were selected at the confluence of tributaries and the mainstem. These sites were distributed between the upper, mid, and lower impoundment to the extent feasible. Sites were selected in part based on known spawning locations from angler or Agency reports.

326. Within the riverine reach, site selection also focused on where fish were likely to spawn, which excluded areas where velocities would be too slow for walleye or suckers (non-riffles) and areas where velocities were too fast for smallmouth bass spawning. Additional locations were omitted due to hazardous working conditions and depths greater than 10 feet where observations would be difficult and would likely not be impacted by Project operations.

327. Two sites were selected at riffles and two sites were selected at islands in the Vernon riverine segment. These were distributed among the length of the reach to the extent possible. Sites were again selected, in part, based on known spawning locations from angler or Agency reports.

328. Additional data was collected within the vicinity of each study site. These included water levels, via data loggers set to record data every 15 minutes, as well as water temperature, specific conductivity, pH, dissolved oxygen, and turbidity each time a study site was visited.

329. Various methodologies were deployed for observing nest sites depending on the study site. Egg blocks were deployed to detect spawning of White Suckers and Walleye at applicable sites. Visual surveys were conducted at backwater sites using two biologists either wading or closely observing the study site and identifying egg masses or adults attending nests in the case of Smallmouth Bass. In backwater areas, individual fish were captured using minnow traps, angling, and net sweeps and then assessed for ripeness to verify successful

spawning. Visual surveys like those used at backwater sites were conducted at tributary mouths and island samplings sites and snorkeling was selectively employed. At all observed nest sites, depth information was collected and the species of interest was identified to the extent possible.

330. Two methods were used to determine project effects on observed spawning sites. The first was to compare 2015 spawning observations to water surface elevation changes in 2015. The second was to compare the location of 2015 spawning observations to five different water years using the operations model developed in study 5.

331. Analyzing if a spawning site had been considered dewatered was dependent on the fish species in question. For Yellow Perch, it was assumed that if the water surface elevation fell below the elevation of the egg mass, it was dewatered. For nest guarding species such as Smallmouth Bass and sunfish, a minimum depth over the nest was required to avoid impacts. These thresholds were based on habitat suitability curves for various species. It was assumed that if depths were less than 0.5 feet, sunfish species would abandon a nest, and if depths were less than one foot, Smallmouth Bass would abandon their nests. Similarly, it was assumed that Fallfish mounds were dewatered, if there was less than 0.5 feet of water above the base of the nest.

332. In addition to analyzing if a nest site was dewatered, the Applicant also considered the duration of egg and fry incubation to assess impacts to spawning. It was assumed that when a nest was first observed that date was day one of egg incubation or fry development. Multiple methodologies were used to estimate the incubation period including degree days or days since observation, which varied according to species and life histories.

333. Within the Project impoundment and riverine areas, no evidence of White Sucker eggs, nor Walleye eggs was documented. Spawning activity of Northern Pike and Chain Pickerel was not observed, despite extensive effort expended. Angling encountered the occasional individual that had recently spawned or would be spawning imminently. Therefore, project effects cannot be determined for these species.

334. Within the Project impoundment, 42 Yellow Perch egg masses and 65 sunfish (Bluegill, Pumpkin seed, and unknown species) nests were located, but no Largemouth Bass nests were found. The percentage of Yellow Perch egg masses and sunfish nests that were vulnerable to dewatering was estimated to be 43 and 29 percent, respectively.

335. For the late spring spawning species, a total of eight Smallmouth Bass nests were located within the impoundment, two Fallfish nests were located in the riverine reach, along with an additional eight Smallmouth Bass nests. At the Stebbins Island site, the most spawning activity during the late spring period was documented. At the site, both Fallfish nests (100 percent) and seven of eight (88 percent) Smallmouth Bass nests were determined to be vulnerable to dewatering over the course of the study.

336. The Applicant used the 2015 spawning locations to determine the maximum, minimum, and median heights of each spawning nest for each target species. This information was paired with the dates when spawning and nest incubation were observed. The nest locations were then compared across five different hydrologic years, spanning a range of hydrologic conditions from dry to wet. Table 20 provides an estimate of the average number of days that the water surface elevation would be expected to fall below the height of nests or spawning areas.

Table 20. Estimates of the average proportion of days water surface elevation would be expected to fall below the height of nests or affect spawning sites for various water years representing the driest to wettest conditions. The values represent the average number of days as a Percent of days below min (Precent of days below minimum elevation of nest), Percent of days below median (percent of days below median height of nest), and Percent of days below max (percent of days below the maximum elevation of nests). The locations in the Vernon Project area include BW (backwaters), Islands, and Tribs (tributaries). Each value varies depending on the species of interest.

		Species	Yellow Perch	Sunfish	Fallfish	Smallmouth Bass	
		Reach/habitat types	Vernon BW	Vernon BW	Vernon Islands	Vernon Tribs	Vernon Islands
1992	**Driest year**	Percent of days below min	0%	0%	10%	0%	6%
		Percent of days below median	0%	1%	14%	0%	34%
		Percent of days below max	3%	25%	38%	0%	78%
1989		Percent of days below min	0%	0%	0%	0%	0%
		Percent of days below median	0%	5%	0%	0%	16%
		Percent of days below max	0%	27%	0%	0%	47%
1994	**Average Year**	Percent of days below min	0%	0%	0%	0%	0%
		Percent of days below median	5%	1%	5%	0%	9%
		Percent of days below max	10%	14%	10%	0%	28%
2007		Percent of days below min	0%	0%	0%	0%	0%
		Percent of days below median	0%	4%	5%	0%	22%
		Percent of days below max	8%	19%	5%	0%	59%
1990	**Wettest year**	Percent of days below min	0%	0%	0%	0%	6%
		Percent of days below median	1%	5%	0%	0%	13%
		Percent of days below max	21%	23%	5%	0%	47%

337. Spawning year 2015 was used to estimate the location and number of spawning areas within the Project area. It is anticipated that various fish species will spawn where appropriate conditions occur, which may change as hydrologic conditions differ from year to year. As noted above, while many visual surveys took place, the likelihood of observing spawning areas was limited due to turbidity early in the season. Therefore, there may be additional spawning areas that were not observed.

338. The Applicant also conducted a spawning study (study 16) specific to Sea Lamprey. The goal of this study was to assess the level of spawning activity by Sea Lamprey in the Wilder, Bellows Falls, and Vernon project affected areas and to determine whether project operations are affecting the success, from survival to emergence, of lamprey spawning.

339. The study involved first identifying suitable study sites within the Project affected area, including both the impoundment and riverine reach. Sea Lamprey typically spawn in areas of shallow, rapid water with cobble/gravel substrate for nest building and sandy/muddy substrate and velocity refugia for ammocoete development. This process focused both on locations where spawning was known to occur and also sites that were likely to contain suitable habitat. Within the Project affected area, a total of seven sites were identified, five in the Vernon impoundment and two in the Vernon riverine reach.

340. In addition to identifying areas with suitable habitat for evaluation, migrating Sea Lamprey were tagged with radio transmitters to determine specific spawning habitats and behavior. Study fish were collected from the Vernon fish ladder. Following standard methodologies for tag implantation and after a period of time that allowed Sea Lamprey to recover, 20 adults were released into the Vernon and Bellows Falls impoundments, approximately 1.25 miles above each dam. Manual tracking of tagged lamprey was done from road vehicle, boat, and aircraft.

341. Of the 20 fish that were released into the Vernon impoundment, one was never relocated, six remained in the Vernon impoundment, another two moved into the West River, a tributary in the Vernon impoundment, eight moved into the Bellows Falls riverine reach, one moved into the Bellows Falls impoundment, and two moved into the Wilder riverine reach. Relocated lamprey were used to confirm spawning activity and site locations, or change the pre-selected spawning habitat locations.

342. The results of the lamprey tagging indicated that lamprey migrate long distances to reach suitable spawning habitat with some being observed moving up into a tributary, returning to the Connecticut River mainstem, then migrating into another tributary. Additionally, multiple fish were observed at multiple spawning survey locations.

343. Two survey locations in the Vernon impoundment did not have verified spawning activity, through either radio telemetry or visual observations, during either the spring or later in the year when sites were visited again under low

water conditions. At each of these sites, it was determined there was insufficient spawning habitat. High concentrations of spawning activity was observed at some sites in the Project area, including at the sites below Vernon dam and in Partridge Brook, a tributary in the Vernon impoundment.

344. Spawning locations and the elevation where nests were observed were then compared to five different water years using the operations model developed in study 5. The modeling indicated that the nests most susceptible to dewatering and exposure occurred nearest to the outflow of the facility where the change in flow fluctuations and water surface elevations are generally greatest.

345. Of the seven sites in the Project area, three sites were not assessed for project effects. These include the two sites described in Finding 343 as lacking suitable spawning habitat and another site where no spawning was observed during the study period. Three sites, including both in the Vernon riverine reach, were considered to have a moderate project effect, meaning a nest was dewatered in one or more modeled years or the nests were continuously submerged for all modeled years. One site was deemed not to have a project effect.

346. The third spawning study focused on American Shad, which was part of study 21. Goals included identification of spawning areas, assessment of the effects of Project operations on spawning, and quantification of spawning.

347. Nightime ichthyoplankton sampling for shad eggs and larvae occurred from late May to early July over 60 sampling events. During each event, two nets were deployed making a total of 120 samples across all sample sites. The study included sampling in the Project impoundment and riverine reach. Sample locations were determined based on the presence of radio-tagged adult shad. Following sample collection, the developmental stage of each collected egg was determined. Given that American Shad are broadcast spawners, for all stage 1 eggs, a back calculated spawning location was determined using an estimated time from spawn and river velocity. For each spawning location, mean channel velocity, channel width, and thalweg depth were modeled from minimum flow to flows greater than maximum discharge to assess project effects.

348. Eggs and larvae were collected at 31 of the 60 sampling locations, with a total of 794 eggs and larvae collected. Approximately 78 percent of the eggs were determined to be stage 1 for which a back calculated spawning location could be determined. In the Project area, eggs were predominately collected from the Vernon Riverine reach with 46.3 percent of the total across all sampling locations.

349. Based on the back-calculations, four spawning areas were identified within the Project affected area: The transition area between the Bellows Falls riverine reach and upper Vernon impoundment in the vicinity of the Mad Brook confluence; Vernon impoundment in the vicinity of the Mill Brook confluence; Vernon impoundment upstream of the Route 119 bridge in

Brattleboro/Hinsdale; and the Vernon riverine reach from the tailrace to Stebbins Island. Of these sites and based on average catch per unit of effort, catch was highest for the Vernon riverine reach downstream of the tailrace.

350. Project operations over the course of the study ranged from minimum flow to sustained periods of high flow. Accordingly, discharges from minimum flow to greater than maximum discharge to include flows for which back-calculated spawning occurred were evaluated for project effects. Across spawning areas, mean velocity, mean water depth, and mean channel width increased with increasing river flow. Information from the instream flow study was also used to express a combined habitat index value for the riverine reaches by incorporating American Shad habitat suitability criteria for depth, velocity, and substrate. For the Project, habitat suitability peaked just below maximum station discharge, with a slight decline as flow increased to maximum station discharge, and a larger decline beyond maximum station discharge.

351. Each of the identified spawning areas contained areas with suitable depths and velocities to support shad spawning. In no cases, did the modeled thalweg depth drop below the minimum range identified in the literature to support spawning. Reductions in flow to the minimum flow decreased channel width relative to maximum discharge.

K. Wildlife and Wetlands

352. The VWQS require the Secretary of the Agency of Natural Resources to identify and protect existing uses of state waters, which include those of surficial wetlands. The Standards prohibit activities that degrade the existing uses of wetlands. These uses can include fish and wildlife habitat, fishing, swimming, recreation, water quality maintenance, and others. (Standards, Sections 29A-104 and 29A-105).

353. Additionally, wetlands that are classified as Class II are protected under 10 V.S.A Chapter 37 and the Vermont Wetlands Rules.

354. The Applicant identified wetlands within any land owned by GRH plus a 200-foot buffer around the FERC identified Project boundary. Wetlands were identified with the National Wetland Inventory as the primary source. Additional information was gathered from the USGS Land Cover Maps and the shoreland study conducted as part of the relicensing process. The following table presents a summary of the identified wetlands (Table 21).

Table 21. Wetland types and amount of acreage within the Vernon Hydroelectric Project area.

Cover Type	Vernon
Deciduous Forest	124.1
Coniferous forested	0.0
Mixed forested	3.5
Deciduous forested/shrub	7.6
Deciduous forested/emergent	0.7
Scrub-shrub	33.9
Scrub-Shrub/emergent	7.9
Emergent	108.2
Phragmites	22.8
Perennial stream	10.9
Intermittent stream	2.1
Pond	7.1
Possible vernal pool	1.5
Submergent aquatic vegetation	326.9
Total	**657.3**

355. A total of 657.3 acres of wetland habitats are contained within the Project area. These consist of a variety of types including forested, emergent, scrub-shrub, phragmites, submerged aquatic vegetation, and streams. Some of these wetlands include backwatered areas that would become dewatered during maintenance drawdowns or impoundment lowering.

356. Deciduous forest, emergent, and submergent aquatic vegetation are the three wetland types that are most prevalent within the Project area. Deciduous forested wetlands are generally found in the medium to large backwater areas, along point bars, and some tributaries and were generally found throughout the Vernon impoundment. They are often made up of eastern cottonwood, silver maples, boxelder, and green ash among others. These wetland types are known to have an herbaceous understory with a variety of fern types, in addition to both native and nonnative species.

357. Emergent wetlands are known to contain herbaceous hydrophytes, plants that can grow partially or totally submerged, for most of the growing season. Wetlands of these types include marshes, meadows, and fens. They are often dominated by broad-leaved cattails, rice cutgrass, woolgrass, American burweed, and water-horse tail among others. These types of wetlands are typically saturated or frequently inundated. Emergent wetlands can be found in backwaters, along the shoreline, and adjacent to tributaries. In the Vernon impoundment, this wetland type was located primarily in the delta at the mouth of the West River downstream of Brattleboro.

358. Submerged aquatic vegetation wetlands consist of floating or submerged

vegetation and typically grow in shallow water zones. In the Project area, this wetland type tends to occur at the mouths of tributaries and in the lower portions of the impoundment. The most common vegetation species found in the Connecticut River for these types of wetlands are water lily, Eurasian watermilfoil, water celery, waterweed and water stargrass. While these species are the most common, they vary in density and canopy cover depending on the location.

359. The wetlands were also assessed for values and functions. The Highway Method was used to evaluate the most common wetland types. Emergent wetlands were found to provide the most functions. Table 22 provides the six most common wetland types and the functions and values provided.

Table 22. The six most observed wetland types and the functions and values provided within the Vernon Project area according to the Highway Method.

Wetland functions	**Aquatic Bed**	**Emergent**	**Scrub/ Shrub**	**Scrub/ Shrub Emergent**	**Forested**	**Forested Scrub/ Shrub**
Groundwater		X		X		
Flood flow Alteration		X	X	X	X	X
Fish and Shellfish Habitat	X	X				
Sediment/ Toxicant Retention	X	X	X		X	X
Nutrient Removal	X	X	X		X	
Production Export	X	X				
Sediment/Shoreline Stabilization	X	X	X	X	X	
Wildlife Habitat		X	X		X	X
***Wetland Values**						
Visual Quality /Aesthetics	X	X				
Endangered species habitat	X	X	X		X	

*Additional wetland values were examined including recreation, educational/scientific value, and uniqueness/ heritage, but it was determined that those values were not provided at a principal level by any wetland type.

360. There is a wide variety of wildlife within the Project area. A total of 87 wildlife species were noted as incidental observations while conducting studies as part of the relicensing. These include, but are not limited to, Common Merganser, Wood Duck, Mallard, Spotted Sandpiper, Bank Swallow, Belted Kingfisher, Green Heron, Bald Eagle adults and juveniles, Osprey, American Kestrel,

Muskrat, American Toad, Spring Peeper, Bullfrog, White Tailed Deer, racoon, mink, possum, and mice.

361. Wetland communities are subjected to a range of hydrologic influences. Those at higher elevations, like forested wetlands, may be primarily influenced by rainfall and runoff. Wetlands at lower elevations, like aquatic bed or emergent wetlands, may be more sensitive to drought or dewatering. These may also be more affected by artificial hydrologic alteration like the operations of a peaking facility.

362. The Applicant investigated the impacts on aquatic communities that are likely to be affected by Project operations. This excluded areas that are impacted during high flow events that are outside of the capacity of the Project. The specific communities evaluated include submerged aquatic vegetation and emergent, scrub/shrub wetlands, and forested wetlands. Water levels were recorded in both the Vernon impoundment and the riverine reach downstream of Vernon Dam as part of the aquatic habitat mapping study.

363. There were two locations within the Vernon impoundment where wetland vegetation and a depth logger were within the same vicinity. Those were at the West River confluence near submerged aquatic vegetation and emergent scrub/shrub wetlands and at Ash Swamp Brook near forested wetlands. At the West River confluence and Ash Swamp Brook sites, the range of water level fluctuation at the site was 1.6 feet and 1.3 feet, respectively, while the range of fluctuation at the dam was 1.2 feet.

364. This is, in part, due to the location of the wetlands relative to the dam. It would be expected that higher fluctuations would occur within the upper impoundment, while lower fluctuations would occur in the lower impoundment, or closer to the facility.

365. Both submerged aquatic vegetation and emergent scrub/shrub wetland types occur in locations where some amount of physical protection is provided, for example within backwaters and the mouths of the large tributaries. These areas are protected from extreme scour events and high flows, yet are at an elevation that provides continuous inundation. In contrast, forested wetlands tend to be found adjacent to beaver dams or backwaters at higher elevations to avoid prolonged inundation.

L. Rare, Threatened, and Endangered Species

366. Several rare, threatened, and endangered species are located or potentially located within the Project area. These include, but are not limited to, Puritan Tiger Beetle (*Cicindela puritana*), Dwarf Wedgemussel (*Alasmidonta heterodon*), Shortnose Sturgeon (*Acipenser brevirostrum*), Northern Long-eared Bat (*Myotis septentrionalis*), Fowlers Toad (*Anaxyrus fowleri*), Cobblestone Tiger Beetle (*Cicindela marginpennis*), Northeastern Bulrush (*Scirpus ancitstrochaetus*), Sticky False Asphodel (*Triantha glutinosa*), Pine-drops (*Pterospora andromedea*) Obedient Plant (*Physostegia virginiana*), Hairy

Pinweed (*Lechea mucronata*), Harsh Sunflower (*Helianthus strumosus*), and Rattlebox (*Crotalaria sagittalis*).

367. While all rare, threatened, and endangered species may potentially be affected by Project related activities, not all are subject to the VWQS. Table 23 includes the species considered as part of this certification and the status of those species at either the state or federal level.

Table 23. Rare, Threatened, and Endangered Species potentially located within the Vernon Project Area. Status is listed at both the state and federal level. Federal status may be blank, if listing is not applicable.

Scientific Name	Common Name	VT Status [a]	Federal Status [a]
Invertebrate Animals			
Alasmidonta heterodon	Dwarf Wedgemussel	E	E
Alasmidonta varicosa	Brook Floater	T	
Cicindela marginipennis	Cobblestone Tiger Beetle	T	
Cicindela puritana	Puritan Tiger Beetle	T	T
Vertebrate Animals			
Anaxyrus fowleri	Fowler's Toad	E	
Myotis septentrionalis	Northern Long-eared Bat	E	E
Myotis sodalis	Indiana Bat	E	E
Acipenser brevirostrum	Shortnose Sturgeon	E	E
Plants			
Astragalus robbinsii var. jesupii	Jessup's Milk Vetch	E	E
Scirpus ancistrochaetus	Northeastern Bulrush	E	E

T=Threatened; E=Endangered.

368. In addition to those listed species in the table above, there are several dragonflies and damselflies listed as species of greatest conservation need in the state of Vermont. Additional species of greatest conservation need include fish species which are discussed in the aquatic biota and aquatic habitat sections of this certification.

Northern Long-eared Bat

369. The Northern long-eared Bat (*Mytosis septentrionalis*) is federally listed as threatened and state-listed as endangered. This species winters in caves and cave-like structures, but summers in tree cavities, under bark or in hallows of

live and dead trees. Tree maintenance has the potential to disrupt roosts between April 1 and October 31. There are no known occurrences, habitat, or winter hibernacula of Northern long-eared bat within a one-mile radius of the Project boundary.

Jessup's Milk Vetch

370. Jessup's Milk Vetch (*Astragalus robbinsii var. jesupii*) is listed as endangered by both New Hampshire and Vermont, in additional to being federally listed by the U.S. Fish and Wildlife Service.

371. Jessup's Milk Vetch is globally rare and is only known to occur naturally along the Connecticut River below Wilder Dam. This plant grows in rock crevasses within calcareous ledge in the upper portions of scour zones along the river. There is an effort to establish an introduction site at the Cornish Ledges in Cornish, New Hampshire. The downstream extent of its known range is limited to the furthest upstream portion of the Bellows Falls impoundment.

Dwarf Wedgemussel

372. Dwarf Wedgemussel (*Alasmidonta heterodon*) is state and federally listed as endangered. Dwarf Wedgemussel (DWM) habitat includes slow to moderate velocities, with a substrate preference for gravel, sand, and cobble. They do not prefer silt, but may burrow in sand with a small layer of silt.

373. The U.S. Fish and Wildlife Service has identified actions needed for the protection of DWM. These actions include collecting basic data needed for protection, preserving populations and occupied habitats, developing educational programs, conducting life history studies and identifying ecological requirements of the species, re-establishing populations within the species historical range, implementing a program to monitor population levels and habitat conditions, and periodically reevaluating the recovery program.

374. Overwintering occurs for DWM as water temperatures begin to drop below 15°C. As temperatures fall, DWM begin to settle into the substrates submerged by water. Should that area become exposed to the air or the area is dewatered, DWM are at risk of freezing.

375. Fertilization for DWM occurs in the summer or early fall with their glochidia being released the following spring. During fertilization, sperm are released into the water column, where females draw it in. Eggs are fertilized and develop within the outermost demibranches of the gills, with the earliest well-developed glochidia occurring in the Connecticut River in early August.

376. Glochidia are released in spring, beginning in early March. The glochidia must attach to host fish to complete their development. Additionally, this helps with dispersal of the species.

377. Host species for DWM within the Project area include Tessellated Darter

(*Etheostoma olmstedi*) and Slimy Sculpin (*Cottus cognatus*). Tessellated Darter are thought to be the primary DWM host species in the lower Connecticut River. Their distribution and habitat may be affected by Project operations and therefore may affect DWM.

378. Known occurrences of DWM occur within the Wilder impoundment, at lower densities within the riverine reach downstream of Wilder, and in the Bellows Falls impoundment at low densities. Surveys conducted in 2011, 2005, and 1999 have not documented DWM within the Vernon Project area.

379. Accordingly, the Applicant's studies specific to DWM did not focus on the Vernon Project area. The fieldwork phase of the DWM habitat suitability criteria development (study 24) did not include sites in the Vernon Project area and the instream flow study did not model DWM habitat in the Vernon riverine reach.

Dragonfly and Damselfly

380. Dragonfly and damselfly species belong to the order Odonata and are referred to as odonates. Seven of Vermont's odonate species listed as Species of Greatest Conservation Need (SGCN) occur within the areas affected by the Wilder, Bellows Falls, and Vernon projects.

381. Odonates spend one or more years in a larval stage within the water. The larvae then exit the water to shed its larval exoskeleton in a process referred to as eclosion. The adult lifestage then spends a short time drying the newly exposed exoskeleton, known as the teneral phase, before the adult can take flight. The casing of the exoskeleton that is left behind is called an exuvia.

382. There are two phases where odonates are vulnerable, particularly to flow fluctuations. The first is during the eclosion phase when the newly emerged exoskeleton of the adult is not yet dry. During this phase, the individual cannot move. The second is during the teneral phase, when the exoskeleton has dried, but the individual cannot yet take flight. During this phase, individuals have limited ability to climb the riverbank or vegetation in response to threats.

383. From a review of literature, it is estimated that the total time from departure from the water, completion of eclosion, and shedding the old exoskeleton is 30 to 40 minutes. It is anticipated that the peak flight period for all seven SGCN odonates ranges from May 21 to July 31. Observations of adults has occurred as late as September 20.

384. Three study sites were located in the Vernon Project area, two in the impoundment and one in the riverine reach. Surveys were conducted between 07:00 and 20:00 hours.

385. The most common species observed in the odonate study across all projects was the species *Gomphus vastus*, a focal species, and *Stylurus spiniceps*. A total of 754 observations were made of odonates or their exuviae.

386. Of the seven SGCN odonate species, four were located within the Project affected area. These include *Gomphus abbreviates, Gomphus vastus, Ophiogomphus rupinsulensis,* and *Stylurus Amnicola. Gomphus abbreviates, Gomphus vastus,* and *Stylurus Amnicola* were observed at multiple transects and in both the riverine and impoundment reaches, while *Ophiogomphus rupinsulensis* was only located in the Vernon riverine reach.

387. Within the Project affected area, a total of 286 odonate observations were made. Two individuals that were observed in the teneral or emerging phase were located at a horizontal distance of 98 inches and a vertical distance of 31 inches from the waterline on average. For the exuviae observations, they were observed at a horizontal distance of 66 inches and a vertical distance of 28 inches from the waterline on average.

388. The elevation of the waterline was subject to change during the study as flow and water level fluctuated. Therefore, some vertically measured exuviae could have been further from the waterline or closer to the waterline when eclosion took place.

389. Eclosion was observed before the start of the survey, with the latest occurring at 16:53 hours. This suggests that eclosion occurs for a longer period through the day than previously thought. Eight individuals were observed during the start to end of the eclosion phase. This ranged from 20 to 45 minutes with an average of 31 minutes.

390. Rapid water level rises greater than eight inches in 30 minutes have the potential to injure or kill odonates during the eclosion process. Under current operations, the type of events described above are estimated to occur less than 2 percent of the time.

Cobblestone and Puritan Tiger Beetles

391. Puritan Tiger Beetle (*Cicindela puritana*) is listed as threatened federally and in the State of Vermont. It is listed as endangered in the State of New Hampshire. The Puritan Tiger Beetle has historically existed within the Connecticut River but has not been observed any further north than Hadley, Massachusetts in the last 25 years.

392. Cobblestone Tiger Beetle (*Cicindela marginipennis*) is listed as threatened in both New Hampshire and Vermont. Cobblestone Tiger Beetle (CTB) have been located throughout the GRH project affected areas. CTB are typically found on cobble and gravel beaches on medium and large rivers. Larvae may dig burrows in wet sand found between cobble, however very little is known about CTB burrows or larvae as they have not been taxonomically described.

393. GRH conducted a study with a focus on CTB due to recent confirmations of the species in project affected areas. The focus was on the adult stage of CTB given the challenge of correct identification of larval burrows.

394. CTB adults are most actively foraging and breeding during June, July, and August, which was the period surveyed. It is believed that larval tiger beetles burrow for one to two years, although the exact duration is unknown. Additionally, larvae are thought to withstand some amount of inundation, but the duration and frequency vary among species, and the tolerance of CTB is unknown.

395. Within the Project affected area, one study site was located based on previously recorded observations and where habitat suitable for CTB is known to occur. The site was located in the Vernon impoundment near the West River.

396. CTB were identified at the site during the July 9, 2014 survey. At the study site, it was estimated that there were 0.58 acres of suitable habitat available.

397. The minimum and maximum habitat elevation was measured at each study site. To assess the effect of Project operations, hydraulic modeling was used. Cross sections from the model were identified at, or near, study sites. Rating curves at those locations were analyzed to determine if the range of measured habitat elevations fell within the modeled range of WSEs at each study site. Based on this information, it was determined that the West River site was located upstream in the tributary beyond the extent of modeled cross sections and was therefore not included in the hydraulic modeling.

Fowler's Toad

398. Fowler's Toad (*Anaxyrus fowleri*) is listed as endangered in the State of Vermont and is a species of greatest conservation need in New Hampshire. This species preferred habitat requires a mix of both wetland pools and bare soils. Its optimal habitat may benefit from the occasional shoreline disturbance to keep areas unvegetated and the floodplains may provide small pools for breeding.

399. GRH conducted a survey for Fowler's Toad within the Project affected area. Potential sites were first identified from previous records and aerial imagery that could contain appropriate habitat. Sites were then visited to confirm aerial imagery and access.

400. Fifteen study sites were identified across the Wilder, Bellows Falls, and Vernon project affected areas with two located in the Vernon impoundment and two located in the Vernon riverine reach. Over the course of the study, some sites were determined to be outside of the Project affected area or unsuitable habitat for Fowler's Toad.

401. Study sites were surveyed by both standard call surveys, where surveyors visit the site and listen for a predetermined amount of time when the Fowler's Toad is likely to call, and via acoustic monitoring, where equipment was deployed to record sounds for later analysis. Although standard call surveys are preferred due to the unique call of the Fowler's Toad, both methods were employed

because four of the 15 sites were challenging to access, particularly at night.

402. For the standard call survey, each site was visited three times with approximately two weeks between each visit. At each site visit, surveyors spent three minutes listening and recording calls after sunset. For acoustic monitoring, equipment was set up at the site and set to record nightly from 8:00 p.m. to 11:00 p.m. Data was saved for later retrieval and analysis.

403. Of the 15 sites, four were in the Project affected area with two located in the impoundment and two located in the riverine reach. Three sites used the standard call method and one employed acoustic monitoring. Fowler's Toad were confirmed at one location, an extensive backwater area on Stebbins Island with a direct connection to the river. Fowler's Toad were detected via acoustic monitoring and was detected on 24 of 26 survey nights.

404. During the breeding season, water level fluctuations due to Project operations may affect Fowler's Toad breeding habitat. During the breeding season, which runs from the third week of May through the third week of July, stable water levels help create persistent pools and temperature conditions that support egg and tadpole development.

405. The site at Stebbins Island has suitable habitat and a moderate Project effect was determined where daily water level fluctuations exceeded three feet on 90 percent of days.

Northeastern Bulrush

406. Northeastern Bulrush (*Scirpus ancistrochaetus*) is listed as endangered federally and also in both Vermont and New Hampshire. The Northeastern Bulrush is a perennial species in the sedge family. This species prefers habitat with an open canopy and intermittently variable water tables. The Northeastern Bulrush requires bare substrate for flowering and germination.

407. Four sites were surveyed within the Project affected area. Two were determined to have potentially suitable habitat for the species. Additional analysis of both sites determined that local hydrologic conditions are primarily determined by beaver activity and the disturbance regime created by spring runoff conditions.

Shortnose Sturgeon

408. Shortnose Sturgeon is listed as endangered federally, as well as in Vermont. The Shortnose Sturgeon is the smallest of the sturgeon species growing to a length of four feet and can live up to 30 years or more, and do not reach reproductive maturity until they are 10 to 12 years old.

409. The historic range of the population in the Connecticut River was widely accepted by researchers and managers to be from the mouth of the river at

Long Island Sound to Great Falls, where the Turners Falls Dam was built in 1905, as the falls were believed to be a natural upstream barrier to migration.

410. In recent years, Shortnose Sturgeon have been documented above and below the Vernon Project via video, photos, and positive detections from environmental DNA sampling. In 2024, a study employing environmental DNA techniques documented the presence of shortnose sturgeon DNA in the reaches affected by the Project. However, researchers believe that the population is likely at lower numbers than the population downstream in the Connecticut River due to the strength of the detection compared with the control.[11]

411. The National Marine Fisheries Service (NMFS) is the federal agency responsible for research and prescribing conservation and management needs for the endangered Shortnose Sturgeon. Currently, there is little to no information on the number of Shortnose Sturgeon present in the reach of the Connecticut River above and below the Project. NMFS is working with partners to better understand the population of sturgeon in this reach of the Connecticut River and any potential conservation or management actions needed to protect them.

M. Recreation

412. The Project area encompasses 287 acres of land, with 34 acres available for outdoor public recreation. The Applicant owns and maintains several recreation areas as Project facilities that are further described below. Additional recreational facilities are located along the Connecticut River in the vicinity of the Project, including locations not directly owned by the Applicant.

All Recreational Activities

413. The Applicant undertook a recreation inventory, use, and needs assessment in 2014-2015 as part of its relicensing effort. There were multiple components to the assessment including an initial inventory of recreational facilities, documentation of recreation use and needs through in-person surveys for individuals utilizing recreation areas and a questionnaire mailed to residents in the region, and estimating future use and capacity at recreation locations. Where applicable, the study distinguished between two seasons, May 1 through October 15 representing the peak season and the remainder of the year representing the off-peak season.

414. The Applicant identified several recreation facilities within the Project area. These include Putney boat landing, Dummerston landing, Chesterfield River Road access, Old Ferry Road access, Retreat Meadows boat launch, West River Marina, Norm's Marina, Hinsdale access, Fisherman access area, Broad

[11] Connecticut River Conservancy Press Release. eDNA Confirms Shortnose Sturgeon in the Connecticut River Between Turners Falls MA and Bellows Falls VT. August 29, 2024. https://www.ctriver.org/post/edna-shortnose-sturgeon-connecticut-river.

Brook access, Fort Hill rail trail, Prospect Street launch, Vernon canoe portage, Vernon Glen, Governor Hunt recreation area, Vernon Neck open space, and three Connecticut River Paddlers' Trail campsites, including the Windyhurst campsite, Wantastiquet-Hinsdale canoe rest area, and Stebbins Island canoe rest area.

415. Of those facilities listed above, the Applicant owns, manages, and maintains the following recreation facilities: Vernon canoe portage, Vernon Glen, and the Governor Hunt recreation area and boat launch that includes the Vernon fish ladder. Vernon Neck open space is a passive use recreation area within the Project boundary, but is informal and not actively maintained.

416. The Vernon canoe portage is located within the Project boundary above the dam between Governor Hunt Road and the river. There is parking along the road and a gated gravel road leads down to the river. Four directional portage signs lead boaters around Vernon Dam. The portage trail is roughly 0.2 miles long. The take-out is just upstream of the log boom, the trail then follows Governor Hunt Road, passes by the Vernon Glen picnic area, and leads to the put-in on a sandy beach at the Governor Hunt recreation area.

417. Vernon Glen is located within the Project boundary above the dam on the west side of Governor Hunt Road from the river and canoe portage area. It is primarily a picnic area with five picnic tables, four grills, and a port-a-potty. There is paved parking for four vehicles with additional parking available on grass near the entrance to the site.

418. The Governor Hunt recreation area and boat launch is located within the Project boundary directly below the dam on Governor Hunt Road. A gravel roadway provides access to parking, a picnic area, and a beach. The picnic area consists of five picnic tables, five grills, and three port-a-potties. The site also includes the public viewing area for the fish ladder. The fish ladder has a separate entrance and an asphalt parking area next to the public viewing window.

419. Vernon Neck open space is located on a peninsula below the dam on the opposite side of the river. It is an informal, undeveloped area with a campsite that overlooks the river.

420. The Applicant currently manages the Wantastiquet-Hinsdale canoe rest area and Stebbins Island canoe rest area as non-project facilities, but is proposing to include these sites as formal Project recreation areas. The Wantastiquet-Hinsdale canoe rest area is a primitive campsite with space for five tents and includes a picnic table, a fire pit and a privy house. The Stebbins Island canoe rest area is a boat-access only campsite with space for four tents and also includes a picnic table, a fire pit and a privy house.

421. The recreation facilities owned by the Applicant and other recreation facilities located in the Project area receive relatively equal use, though with an edge to non-Project recreation sites. The summary of estimated visitations between

March 2014 through February 2015 was 30,561 use days at the Project recreation sites and 41,827 use days at other public recreation sites in the study.

422. Of the Project recreation facilities, all of the documented use occurred at the Governor Hunt recreation area and boat launch, which received 27,274 recreation use days during the peak season. The three highest non-Project owned recreation facilities included Dummerston landing, Norm's Marina, and Prospect Street launch, which received 6,960, 4,320, and 4,762 recreation use days during the peak season.

423. The Applicant also estimated the average duration of a trip for visitors. At the Project during peak season, the minimum number of hours spent was one, the maximum number of hours spent was twelve, with the average number of hours spent being three. The activity that had the longest duration was fishing at 4.9 hours, followed by picnicking at four hours, and then by swimming/sunbathing at 3.5 hours. All other activities were reported as having a duration of three hours or less.

424. The onsite interviews allowed the Applicant to estimate the distribution of recreational activities for those who were onsite. The most common activity reported for the Project was fishing from the shore with 38 percent of respondents identifying this activity. This was followed by fishing from a boat/ice fishing and flat water canoeing/kayaking at 23 percent and 22 percent of respondents, respectively.

425. From individuals who were interviewed on site, responses broke down into similar percentages when asked to identify their primary activity when visiting the Connecticut River. These include fishing from the shore (30.4 percent), fishing from boat or ice fishing (21.0 percent), and flat water canoeing/kayaking (19.3 percent).

426. When onsite visitors completed the survey, they were asked how scenic and how safe the recreation area felt. The responses are provided in Table 24.

Table 24. Responses from onsite interviewees at various Vernon Project area recreational areas for scenic quality and safety.

Scenic Quality			Safety Ratings Vernon Study Area			Safety Ratings Vernon Project		
Number	**Rating**	**Reference Values**	**Number**	**Rating**	**Reference Values**	**Number**	**Rating**	**Reference Values**
85	9	Extremely appealing	103	9	Extremely safe	29	9	Extremely safe
30	8		16	8		11	8	
36	7	Appealing	9	7	Safe	7	7	Safe
10	6		2	6		0	6	
15	5	Average	2	5	Neither safe nor unsafe	1	5	Neither safe nor unsafe
2	4		0	4		0	4	
1	3	Unappealing	0	3	Unsafe	0	3	Unsafe
0	2		0	2		0	2	
0	1	Not at all appealing	0	1	Not safe at all	0	1	Not safe at all

427. For scenic quality, one respondent gave the Governor Hunt recreation area a low score due to the dam and power lines, but most of the respondents gave the site high scenic quality responses.

428. Respondents overwhelming (97 percent) felt safe at the Project facilities. However, respondents were also generally vocal about how safety could be improved at the recreation sites. Several respondents noted strong currents as a concern at the Governor Hunt Recreation Area and boat launch. Some respondents recognized that recreational activities have risk, and a certain amount of individual responsibility is required. This was particularly relevant when related to increases in flow released from the dams.

429. The onsite interviews also asked participants about their satisfaction with the condition of the existing recreational facilities and 73 percent reported being satisfied with the current existing facilities. Opportunities for improvements were noted and common suggestions included removing trash, providing toilets, and improving road conditions.

430. Specific to the Applicant owned properties, dissatisfaction by six respondents was noted at the Governor Hunt recreation area and centered around the condition and lack of maintenance of the boat ramp, garbage and trash accumulation, and road grading.

431. More than 70 percent of respondents reported being either moderately satisfied or extremely satisfied (scores of 7, 8, or 9) with the amount of recreation access provided to the Project.

432. Respondents to the regional mail survey were asked if they had visited any of the recreational facilities offered, and if not, to explain why. Thirty one percent of regional mail survey respondents had made a visit to one of the recreation facilities in the last year. Common reasons cited for not visiting included

distance, lack of familiarity, and a lack of interest in recreation activities related to or near water.

433. The regional mail survey respondents also offered recommendations on specific types of facilities needed at the Vernon area sites. Some recommendations for the Project included boat launch improvements and trash cans.

434. The Applicant reviewed the recreation facilities for adequate parking, in addition to reviewing adequacy for future use. The recreation facilities owned and managed by the Applicant were generally found to be adequate except for the areas listed below.

435. Issues with the boat launch at the Governor Hunt recreation area and boat launch were identified and modifications recommended. During the course of the study, the Applicant implemented a number of improvements, including cutting down dead trees, using the trunks to demarcate parking areas, and regrading. Debris build up was also noted at the Vernon canoe portage that will require annual maintenance to serve its purpose. At Stebbins Island, invasive species creating dense brush was noted that will also require ongoing maintenance. Additionally, missing signage and an aging outhouse were noted. Based on accessibility of the site, conversion of the area to a formal Project recreation area was recommended, which is expected to aid in identifying needs and facilitating maintenance. The Applicant is proposing conversion of this site to a formal Project recreation site.

436. There were several comments submitted to the FERC record and in response to public informational meetings held by the Department on the Application related to recreation at the Project. Some of the comments suggested that the Applicant provide additional opportunities for public access to the river, improve existing recreation areas including the Governor Hunt recreation area and fish passage counting window, enhanced signage, accessibility improvements, and funding for various purposes outside of the Project boundary.

Boating

437. The management objectives for waters classified as Class B(2) for boating are "[w]aters shall be managed to achieve and maintain a level of water quality compatible with good quality boating (Standards, Section 29A-306(d)(3)(A)). The Class B(2) criteria for boating use is "waters shall comply with the Hydrology Criteria in Section 29A-304 of these rules." (Standards, Section 29A-306(d)(3)(B)).

438. A state may adopt subcategories of a designated use and set the appropriate criteria to reflect the varying needs of such subcategories of uses.[12] However, the State is not required to adopt subcategories of designated uses and selects the level of specificity it desires for identifying designated uses and

[12] 40 C.F.R. § 131.10 Designation of uses

subcategories of uses, as long as they are at least as specific as the uses listed in sections 101(a) and 303(c) of the federal Clean Water Act.[13] The Department has not adopted any subcategories of the designated use of recreational boating.

439. The Department manages waters to achieve and maintain a level of water quality compatible with good quality boating, in general, and not particular types of boating. Although some waters or reaches may support different boating types depending on their characteristics and hydrology.

440. There are many types of boaters who utilize the Connecticut River for recreation. This includes motorboaters, scullers, canoers, and kayakers. Of these, through boaters travel longer distances on the Connecticut River with boats that contain gear typically used for overnight trips. Additionally, there are groups of users that primarily utilize the river for boating for day outings. Another group are whitewater boaters, who may through travel, but are primarily interested in areas with elevation drops that create boatable features. These features vary in difficulty and type depending on the area and flow.

441. The primary boating activity that individuals identified from the survey of onsite interviews within the Vernon study area were as follows: 22 percent of respondents were there for flatwater boating, five percent were at the river for motorboating, two percent were there for multi-day trips, one percent were there for sculling, and no respondents identified as being there for whitewater canoeing or kayaking activities. For those who responded to the regional mail survey, which included all Connecticut River hydroelectric projects, 74 percent of respondents engage in flatwater boating, 22 percent engage in motorboating, and 10 percent engage in whitewater canoeing and kayaking activities. Several mail survey respondents selected multiple activities, so the total percentage exceeds 100 percent (Table 25).

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[13] U.S. Environmental Protection Agency (EPA). 2012. *Water Quality Standards Handbook: Chapter 2: Designation of Uses.* EPA-823-B-12-002. EPA Office of Water, Office of Science and Technology, Washington, DC. Accessed November 2024. https://www.epa.gov/sites/default/files/2014-10/documents/handbook-chapter2.pdf

Table 25. Primary activity reported by onsite interviewees and regional mail survey respondents as a percentage of all various activities in the Vernon Project area. Mail survey responses are not project specific.

Activity type	Vernon Interviewees	Mail Survey Resident Respondents
Canoeing/Kayaking-flat water	22%	74%
Canoeing/Kayaking-white water	0%	10%
Motorboating	5%	22%
Sculling	1%	4%
Multiday float trip	2%	7%

442. Through-paddling for both day trips and longer trips is a popular activity, in general. The Connecticut River Paddlers' Trail provides over 55 camping destinations with over 150 access locations.

443. The Connecticut River Paddlers' Trail extends from the headwaters in the Great North Woods of New Hampshire to the Long Island Sound. There are over 20 organizations that assist with building and maintaining the network, including campsites, access points, portage trails, and providing information to travelers. The Applicant provides financial resources in support of the Connecticut River Paddlers' Trail.

N. Debris

444. A hydraulic trashrack rake is used at the Project. The rake can be driven on top of the dam following a set of tracks, placed in front of each unit intake, lowered to the bottom of the racks and retracted to remove debris. The rake is manually operated. Once the debris is removed, it is placed into a trailer for removal.

445. A 13-foot by 13-foot ice sluice/skimmer gate is located on the east side of the forebay and it is opened at times to pass river debris.

446. It was unclear from the Application what types of debris can be associated with these maintenance methods or under what circumstances either methodology is employed.

O. Aesthetics

447. The management objectives for waters classified as Class B(2) for aesthetics are "[w]aters shall be managed to achieve and maintain good aesthetic quality" (Standards, Section 29A-306(c)(3)(A)). The Class B(2) criteria for aesthetics in rivers and streams are "[w]ater character, flows, water level, bed and channel characteristics, and flowing and falling water of good aesthetic value."

(Standards, Section 29A-306(c)(3)(B)(i)).

448. The Project impoundment extends roughly 26 miles upstream. The Connecticut River Valley is known for its scenic views of mountains, historic villages, and farmland. The Project area is visible from several locations, including recreation areas owned by the Applicant and other parties.

449. There is little information related to the aesthetics of Project waters. For example, although there were questions related to aesthetics in the recreational needs and assessment study, individuals referenced cleanliness, vegetation, or vandalism rather than the aesthetic qualities of the waters.

450. Additional comments in the record referenced muddy shorelines, which was noted by the Applicant to occur more often at the confluence with tributaries when flood profile operations needed to be conducted. This can also occur during peaking operations. The Project does not contain a bypass reach, meaning all flow being used for generation is then directly discharged to the Connecticut River.

III. Analysis

451. A state's 401 certification shall "evaluate whether the activity will comply with water quality requirements." (40 C.F.R § 121.3). Accordingly, the Department may set forth limitations and other requirements necessary for it to find that there is reasonable assurance that the Project will be operated in a manner which will not violate VWQS. A goal of the Standards and the Clean Water Act is to restore the biological integrity of waters such that aquatic biota and wildlife are sustained by high quality habitat.

452. Continued operation of the Project may lead to violations of Standards. Those specific aspects of operation that have the potential to cause such violations are analyzed below to determine the limitations and requirements necessary to find that there is reasonable assurance that the activity will not violate VWQS.

453. In addition to the specific items pertaining to the Application under review, if any activity was not presented in the Application and inconsistent with the findings of this certification, the Department reserves the right to review such activities to ensure they do not cause a violation of VWQS (e.g., change in operation, maintenance drawdown, construction activity, etc.). In addition to specific operational conditions, other provisions related to operations like reporting, inspections, and flow monitoring will also be necessary to ensure the activity does not violate VWQS.

A. Water Chemistry

454. The Connecticut River in the vicinity of the Project is classified as Class B(2) for all designated uses and is designated as cold water fish habitat. The criteria for the DO standard is not less than 7 mg/L and 75 percent saturation at all times, nor less than 95 percent saturation during late egg maturation and larval

development of salmonids in waters that the Secretary determines are salmonid spawning or nursery areas important to the establishment or maintenance of the fishery resource. In all other waters designated as a cold water fish habitat, the standard is not less than 6 mg/L and 70 percent saturation at all times. (Standards, Section 29A-302(5)(A)).

455. The Applicant conducted a water chemistry study in the years 2012 and 2015. For details on the methodology, see Findings 159-161. The Applicant was operating the Project as currently licensed.

456. No occurrences of DO falling below the VWQS criteria of no less than 6 mg/L and 70 percent saturation were documented at any time during the course of the studies conducted within the Project affected area. (Findings 162 and 165-168 and Table 10).

457. Temperature within the Project area and upstream in the tributaries followed anticipated trends seen within rivers and riverine impoundments. There was typically a cyclical response to water temperatures throughout the day, with warmer temperatures occurring later in the day. This trend continued through the warm temperatures of late summer and early fall when the highest temperatures were observed. There were no violations of the temperature criteria of the VWQS during the study. (Findings 162-164).

458. Although the studies were conducted under current operations, it is anticipated that the proposed operations will reduce hydrologic alteration, which would be expected to have a positive effect on DO and buffer changes in water temperature relative to current operations. Table 26 shows the difference between the proposed operations and current operations for the downstream flow metrics calculated in Table 6 and Table 9. (Findings 89 and 120).

Table 26. Difference in estimated downstream metrics for proposed operations and current operations of the Vernon Hydroelectric Project. For specific seasons and water years from driest (2009) to wettest (2015).

Target Month and Year	Average Minimum Downstream Flow	Mean Daily Amplitude	Flashiness
2009			
February	2055	-2617	-0.05
June	2989	-4688	-0.06
August	2538	-3105	-0.03
November	2823	-3549	-0.04
2016			
February	2402	-1091	-0.02
June	1944	-3213	-0.02
August	1539	-3145	-0.11
November	2573	-1067	-0.14
2017			
February	2351	-1064	-0.02
June	1896	-3118	-0.11
August	1529	-3226	-0.15
November	1275	-755	-0.04
2015			
February	-151	727	0.00
June	2060	-2451	-0.02
August	2042	-4901	-0.18
November	3537	-5164	-0.12

459. Table 26 indicates that, generally, there is an increase in the average minimum downstream flow, which further supports the expectation that proposed operations are likely to improve water chemistry parameters in the vicinity of the Project relative to current operations. Therefore, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

B. Aquatic Biota

460. "Aquatic Biota" means all organisms that, as part of their natural life cycles, live in or on waters. (Standards, Section 29A-102(5)). Aquatic biota includes fish, aquatic invertebrates, amphibians, and some reptiles such as turtles. There are a wide variety of species with different life histories and requirements for protection within the Vernon Project area. These include fully aquatic species, like fish, who spend their entire life cycle in the water, and organisms who may only spend a part of their life cycle in or on the water such as turtles, beaver, and frogs.

461. The Applicant studied the potential for impingement and entrainment of

resident and migratory fish species at the Project. (Findings 179-190).

462. Adult American Eel and juvenile American Shad both had high overall entrainment potential. The following species and life stages had high to medium overall entrainment potential: American Shad adults, Bluegill juveniles, Golden Shiner juveniles, Largemouth Bass juveniles, Smallmouth Bass juveniles, Spottail Shiner juveniles and adults, Walleye juveniles, and Yellow Perch juveniles. Most of these species and life stages are categorized as such due to their size and swimming ability combined with the velocities at the intake at maximum hydraulic capacity.

463. The amount of time that the Applicant is expected to operate the Project at maximum hydraulic capacity, which under current operations generally occurs on a near daily basis and for multiple hours, will be less frequent and a reduced proportion of generation under proposed operations. Due to the maximum discharge limitations, a flexible operation discharge will not necessarily occur at maximum hydraulic capacity, so in aggregate the proportion of time that the Project will generate at maximum hydraulic capacity will be reduced. This will reduce through rack velocities and lower the overall potential for fish to be entrained into the turbines.

464. This is supported by the reduction in the mean daily amplitude estimated for the proposed operations versus current operations. (Table 26). In all estimated years and months, it is estimated that there will be a decrease in the maximum observed downstream flows. This will lessen entrainment potential and comply with the Standards. Therefore, this certification is conditioned to incorporate the Applicant’s proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

C. Fish Passage

Upstream

465. The Applicant conducted multiple studies specific to upstream fish passage as part of Project relicensing. (Findings 194-217). This included collecting information pertaining to fish currently using the upstream fish ladder, as well as efforts specific to understanding the upstream passage needs of American Eel over multiple seasons, American Shad, and Sea Lamprey.

466. The Applicant reviewed video footage of the fish ladder obtained in 2015 when the ladder was operated throughout the open water season. Usage by the target diadromous species was documented in the thousands to tens of thousands of fish, specifically 39,196 American Shad, 2,440 Sea Lamprey, and 1,545 American Eel. (Table 14). The duration in which most of the target diadromous fish moved past the facility, as shown by the 80 percent completion date generally occurred within the current upstream passage dates. However, movement also occurred outside of the currently prescribed passage dates and this was particularly true for American Eel. Resident species were also observed in the fish ladder, demonstrating that when the upstream passage is

available, it allows for resident species to move upstream as needed. (Table 14).

467. Through multiple study seasons, eels were identified congregating at various points below the Project, concentrating around the fish ladder when in operation and using the existing fish ladder when they had access to it. (Findings 202-205). Alternatives were evaluated including an eel pass, an eel trap, and modifications to the existing fish ladder. (Findings 204, 206, and 207). However, the studies indicated potential impediments to effective eel passage under normal shad operating conditions. (Finding 210). Additional improvements and testing are needed to provide safe, timely, and effective upstream passage for American Eel.

468. Sea Lamprey were shown to utilize the upstream fish ladder to pass the Project. Study 17 documented 2,440 lamprey using the ladder to move upstream of the Project in 2015 (Finding 211). Data from 2016, showed Sea Lamprey upstream ladder usage to increase to 5,539 individuals. Additionally, the Sea Lamprey spawning study (study 16) utilized the fish ladder to collect Sea Lamprey to tag, and subsequent tracking showed Sea Lamprey travelled long distances and used the ladders to access suitable spawning habitat. (Finding 212).

469. American Shad were the most frequently observed migratory fish using the ladder to move upstream of the Project. (Finding 199). The Applicant conducted a PIT tag study to assess the effectiveness of the ladder for migrating American Shad. (Finding 214 - 216). Despite American Shad using the ladder, it appears there are opportunities to increase efficiency and assure safe, timely, and effective passage. (Finding 217).

470. The Applicant has committed to a fish passage settlement agreement that includes a hydraulic study to inform modifications and effectiveness studies by PIT tagging individuals to assess performance of the upstream passage infrastructure. (Finding 121). Ultimately, the Applicant proposes to design and construct measures, and monitor performance of those measures to assure safe, timely and effective fish passage for American Eel, Sea Lamprey, and American Shad. (Findings 132-134, 137). This certification is conditioned to incorporate the Applicant’s proposal to implement and adhere to the fish passage settlement agreement. (Condition E).

Downstream

471. The Applicant conducted two studies to understand downstream passage of American Eel at the Project. (Findings 220-250). The first included estimates of turbine mortality and injury, as well as timely and effective passage. The second study investigated American Eel migration cues specific to the Connecticut River.

472. Estimates of turbine survival were relatively high for the Francis turbines at the Project, with a survival estimate of 93.5 percent through Unit 4 and a higher

survival estimate of 97.9 percent for Unit 9. Survival was lower for the Kaplan units, at 87.5 percent for unit 8 at a discharge of 1,000 cfs and decreases as discharge increases with 74 percent survival at 1,700 cfs. This follows similar studies where American Eel survival is higher for Francis type turbines than Kaplan type turbines. (Findings 232-233,Table 15). In considering turbine passage, it should also be noted that for Unit 4, Unit 8 at 1,00 cfs, and at 1,700 cfs more than 25% of eel had visible injuries, with injury rates of 35.6%, 28.3%, and 27.3, respectively (Finding 234).

473. In the second component of the study, most American Eel that passed the Vernon Project, 54.7 percent of study fish, utilized the turbines in lieu of the trash/ice sluice or fish pipe, which are considered the downstream passage routes and was used by only 3.6 percent of study fish. Additionally, a third of the fish did not approach or pass the Project. (Table 16). Results demonstrate that the current downstream fish passage facilities are not effective for American Eel.

474. The study of downstream passage at the Project indicated there was potential for delay. Any fish that spends longer than eight hours wandering or searching for downstream passage can indicate a potential passage issue. Twelve eel, or 10.8 percent, of the study fish were observed exhibiting this behavior for longer than eight hours. (Finding 245).

475. The downstream passage study for adult American Shad conducted in 2015 showed that while generally shad were able to locate a route of downstream passage, there was potential for delay and assessment of route selection was limited by sample size. (Finding 252). However, survival through Units 5 through 8 was estimated to be 33.3 percent and total project survival was estimated to be 78.6 percent via all passage routes based on detections at Stebbins Island. (Finding 254). When repeated with a larger sample size in 2017, most fish, 60.1 percent, passed either through the fish pipe or via spill. (Finding 257).

476. Downstream passage of juvenile American Shad was also assessed. Eighty-seven percent of shad passed in less than 12 hours after detection indicating that generally shad that entered the forebay were able to find a downstream passage route. (Finding 260). Most juvenile shad, 87 percent, utilized the turbines to pass the Project. (Finding 261). When passing via the turbines, mortality and injury did occur. (Finding 267). Estimates of total project survival of American Shad ranged from 70.4 to 87.5 percent. (Finding 263).

477. The studies at the Project indicate that there are issues with safe, timely, and effective downstream passage of American Eel and American Shad. The Applicant proposed to implement and adhere to the fish passage settlement agreement which includes investigating and modifying downstream passage facilities to provide safe, timely and effective downstream fish passage and monitoring performance of these modifications. This process will take place in consultation with applicable resource agencies. This certification is conditioned to incorporate the Applicant’s proposal to implement and adhere to the terms of

the fish passage settlement agreement. (Condition E).

D. Aquatic Habitat

478. Waters designated as Class B(2) for aquatic habitat use shall be managed to achieve and maintain high quality aquatic habitat, characterized by the physical habitat structure, stream processes, and flow characteristics of rivers and streams and the physical character and water level of lakes and ponds necessary to protect and support all life-cycle functions of aquatic biota and wildlife, including overwintering and reproductive requirements. (Standards, Section 29A-306(b)(3)(A)).

Flow Needs for the Protection of Aquatic Habitat

479. Flow in combination with substrate play a role in determining the quality of aquatic habitat available to aquatic biota. The results of the habitat-flow study indicate that there is no single flow that optimizes available habitat for all target species and lifestages within the riverine reach of the Project. (Findings 286). Additionally, there is no minimum and maximum flow combination that optimizes remaining available habitat for immobile and mobile species. (Findings 287-288). This is not surprising given the number of fish species of interest with varying life histories and habitat preferences for depth, velocity, and substrate type.

480. Changes in flow impact aquatic habitat by reducing habitat for immobile species like spawning life stages or shifting available habitat for mobile species, which has other impacts like increasing the potential for stranding or predation. (Finding 289-290). While there is no single flow or set of flows that will optimize habitat for all species, there are observable trends across species and life stages. (Findings 287-288). In general, the smaller the magnitude of change between the minimum and maximum flow, the greater the amount of suitable habitat that will remain available. (Finding 291).

481. The Applicant's operations proposal seeks to reduce the magnitude and frequency of sub-daily changes in discharge from the stations, increase the amount of time that the Project is operated as IEO, and reduce the magnitude and rate of change in flows downstream of the dams. The proposal includes several measures to achieve these goals, including a maximum downstream flow during flexible operations based on inflow, a limitation on the number of hours in which flexible operations may take place, and up-ramping and down-ramping to make the transitions from, and back to, IEO more gradual. These measures are consistent with the findings of the habitat-flow study described above.

482. By establishing IEO as the base operating mode, minimum downstream flows are expected to increase relative to current operations where minimum downstream flows are generally maintained around 1,600 cfs. In addition, maximum discharge during flexible operations are restricted based on inflow. When inflow is less than 1,800 cfs, maximum discharge is limited to 4,500 cfs.

Above 1,800 cfs, maximum discharge is limited to 2.5 times inflow. Together, the higher baseflow associated with IEO operations and the maximum generation flow restrictions associated with flexible operations will achieve what the habitat-flow study showed is needed to protect aquatic habitat for the diverse community of species present in the Connecticut River by reducing the magnitude of change between the baseflow and generating flow.

483. As described above, specific elements of proposed operations are intended to reduce hydrologic alteration in a manner that protects aquatic habitat. This can be verified by using the HEC-RAS model to estimate the magnitude of fluctuations downstream of the Project under the Applicant's proposal.

484. Table 27 shows the reduction in the daily range of flow fluctuation downstream of the Project between the proposed operations and current operations as represented by change in mean daily amplitude calculated in Table 6 and Table 9. (Findings 86-89 and 119-120).

Table 27. Difference in estimated downstream mean daily amplitude, expressed in cubic feet per second, metrics for proposed operations and current operations. For specific seasons and water years from driest (2009) to wettest (2015).

Target Month and Year	Change in Mean Daily Amplitude
2009	
February	-2617
June	-4688
August	-3105
November	-3549
2016	
February	-1091
June	-3213
August	-3145
November	-1067
2017	
February	-1064
June	-3118
August	-3226
November	-755
2015	
February	727
June	-2451
August	-4901
November	-5164

485. Another way to consider the effects from proposed operations is to calculate the difference in downstream mean daily amplitude compared to the Project operating in strict IEO mode. This would remove any Project related effects in downstream flow as the Applicant would only be passing what was available

from inflow.

486. Table 28 shows the difference between the estimated IEO and proposed operations for the downstream changes in mean daily amplitude as calculated in Table 3 and in Table 9. (Findings 74 and 120).

Table 28. Difference in estimated downstream mean daily amplitude, expressed in cubic feet per second, metrics for estimated inflow equals outflow and proposed operations. For specific seasons and water years from driest (2009) to wettest (2015).

Target Month and Year	Change in Mean Daily Amplitude
2009	
February	3814
June	0
August	787
November	1190
2016	
February	1129
June	524
August	839
November	3039
2017	
February	1169
June	524
August	839
November	3039
2015	
February	0
June	0
August	0
November	0

487. Daily average magnitude of downstream flow below the Project relative to IEO conditions increases under proposed operations as expected. However, this change is small relative to conditions absent Project operations. In all years and seasons, the proposed operations will decrease the daily average magnitude of change in downstream flows relative to current operations. This certification is conditioned to incorporate the Applicant’s proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

488. For mobile species, or those species that move to find suitable habitat, the frequency of those movements can come at an energetic cost and increase predation and stranding risk. (Finding 288). For immobile species, these flow changes can involve a loss of suitable habitat and potential mortality if they become dewatered. Decreasing the frequency of flow fluctuations reduces this energetic cost and is more protective of aquatic habitat.

489. The Applicant's operating proposal reduces the frequency of sub-daily changes in discharge from the dam. Under current operations, flow can fluctuate from the minimum flow to maximum generation on a daily or multiple times a day frequency. The principal measure for achieving this goal in the proposed operations is a limitation on the number of hours during which the Applicant can deviate from IEO and implement flexible operations. In general, during times of year when there are more sensitive species such as spawning and incubation or fry stages, the Applicant is proposing to operate in flexible operations mode less frequently. The specific hours for a month are driven by the habitat needs of specific species. This is discussed in more detail in the 'protection of life cycle requirements' section below. This measure will protect sensitive immobile species and lifestages that are particularly sensitive to flow fluctuations. (Finding 290). As a result of this measure, it is expected that the proposed operating regime will result in a decrease in the frequency of flow fluctuations downstream of the Project.

490. Analysis supports the stated goal that proposed operations will decrease the frequency of fluctuations downstream of the Project. Table 29 shows the difference between proposed operations and current operations for the downstream changes in flashiness as calculated in Table 6 and in Table 9. (Findings 86-89 and 119-120). The measure of flashiness does not have units and instead is an index used as a comparative measure.

Table 29. Difference in estimated flashiness for proposed and current operations of the Vernon Hydroelectric Project. For specific seasons and water years from driest (2009) to wettest (2015).

Target Month and Year	Flashiness
2009	
February	-0.05
June	-0.06
August	-0.03
November	0.04
2016	
February	-0.02
June	-0.02
August	-0.11
November	-0.14
2017	
February	-0.02
June	-0.11
August	-0.15
November	-0.04

Target Month and Year	Flashiness
2015	
February	0.00
June	-0.02
August	-0.18
November	-0.12

491. In all cases, except one month when there was no change, the comparison shows a decrease in the flashiness of flows downstream of the Vernon Project.

492. Table 30 compares flashiness between strict IEO operation and proposed operations as calculated in Table 3 and in Table 9. (Findings 74 and 120). This compares the proposal to a scenario without Project-related influences on downstream flow.

Table 30. Difference in estimated downstream flashiness metric for proposed operations and estimated inflow equals outflow operations for the Vernon Hydroelectric Project. For specific seasons and water years from driest (2009) to wettest (2015).

Target Month and Year	Flashiness
2009	
February	0.05
June	0.00
August	0.01
November	0.01
2016	
February	0.01
June	0.01
August	0.01
November	0.02
2017	
February	0.01
June	0.01
August	0.02
November	0.05
2015	
February	0.00
June	0.00
August	0.00
November	0.00

493. As estimated using the HEC-RAS model, there are minor increases in the

flashiness of downstream flow below the Project between an IEO mode and proposed operations as measured by Richard Baker Flashiness Index. These changes are slight in comparison to a regime absent the influence of Project operations and are also small in comparison to the reductions in flashiness from current operations.

494. In addition to the potential for changes in flow to reduce suitable habitat for immobile species and cause mobile species to move to seek suitable habitat. The rate of change can impact available habitat due to stranding and predation risk. (Finding 289). Another goal of proposed operations is to reduce the rate of change in flow downstream of the dams. The proposed operations seek to accomplish this goal by including transition operations that gradually increase flows, or up-ramp, and gradually decrease flows, or down-ramp, as applicable when a planned flexible operation starts and after it ends. (Findings 110-111).

495. The Applicant's proposal will reduce the magnitude of change in downstream flow, limit deviations from IEO, reduce the frequency of flow fluctuations downstream, and provide for changes in flow to occur gradually. This certification is conditioned to accept the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations as proposed. (Condition B).

Water Level Fluctuation in the Impoundment

496. The Applicant is proposing three modes of operation, IEO, flexible operations, and transition operations, which bridges changes between operating modes. Flexible operations involve water level fluctuation as the impoundment is drawn down and subsequently refilled. It is anticipated that the proposed operations will decrease the frequency and magnitude of fluctuations within the Project impoundment. Table 31 shows the difference between proposed operations and current operations for the impoundment metrics calculated in Table 5 and in Table 8. (Findings 84-85 and 118).

Table 31. Difference in estimated impoundment metrics for proposed operations and current operations for the Vernon Hydroelectric Project. For specific seasons and water years from driest (2009) to wettest (2015).

Target Month and Year	Percent of Time at Target Water Surface Elevation	Mean Daily Change in Range of Impoundment Level
2009		
Feb	28.7%	-0.27
Jun	72.9%	-0.63
Aug	37.0%	-0.21
Nov	65.0%	-0.66

Target Month and Year	Percent of Time at Target Water Surface Elevation	Mean Daily Change in Range of Impoundment Level
2016		
Feb	26.3%	0.17
Jun	62.6%	-0.43
Aug	59.2%	-0.50
Nov	51.1%	-0.41
2017		
Feb	30.4%	-0.21
Jun	68.4%	-0.60
Aug	41.0%	-0.43
Nov	57.2%	-0.38
2015		
Feb	26.2%	0.19
Jun	64.9%	-0.44
Aug	60.0%	-0.52
Nov	53.6%	-0.43

497. Table 39 shows that for all scenarios under proposed operations, except February in some years, the mean daily change in the range of impoundment fluctuations will decrease. The outliers in February are due to limitations on peaking ability at Vernon during February under current operations, and needing to run the turbines to generate heat inside the powerhouse. The amount of time spent at the target surface water level increases in all months and years.

498. Under estimated IEO operations, the percent of time at target water surface elevation would be near 100 percent, and the mean daily change in impoundment would also reflect a near zero foot change in elevation. Therefore, there would be measurable differences between estimated IEO operations and the Applicant's proposal.

499. In addition to limiting the frequency and magnitude of impoundment fluctuations, the Applicant is proposing to refill the impoundment within 48 hours of a flexible operation event. (Finding 112). This is expected to decrease the rate at which water levels change after a drawdown.

500. Maintenance activities, in particular those that require a drawdown, have the potential to impact water quality depending on the duration, extent, and season during which the drawdown may occur. The Applicant is proposing to suspend IEO operations when necessary for performing maintenance. In addition, the Applicant proposes to consult with relevant resource agencies before such deviations which may include an appropriate impoundment refill plan. (Finding 103).

501. The Applicant's proposal will create more stable impoundment levels and when fluctuations occur, it will be in a manner that is protective of aquatic habitat and complies with the hydrology criteria of the Standards. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations (Condition B), and to consult on maintenance activities that require deviation from IEO operations. (Condition J).

Stream Processes and Physical Habitat Structure

502. Stream processes are defined as the hydrologic, bed-load sediment, and large woody debris regimes of a particular stream reach and is a term used to describe stream channel hydraulics, or the erosion, deposition, sorting, and distribution of instream materials by the power of flowing water. Stream processes work toward an equilibrium condition, are governed by flow characteristics, stream morphology, channel roughness, and floodplain connectivity and, in part, determine physical habitat structure and aquatic habitat quality. (Standards, Section 29A-102 (43)).

503. Physical habitat structure is defined as the diverse combination and complexity of instream forms created within substrate and woody debris on and within the bed and banks of the channel by stream processes and flow characteristics. Physical habitat structure, in part, determines aquatic habitat quality at the stream reach and stream network scales by providing for all life cycle functions, which include the full set of forms necessary for the provision of and access to cover, overwintering, and temperature refuge and the substrates necessary for feeding and reproduction of aquatic biota and wildlife. (Standards, Section 29A-102 (34)).

504. Stream processes, including erosion, are a naturally occurring and an ongoing process in river systems. In response to change, rivers adjust to work toward an equilibrium condition. The Connecticut River has historically been straightened and continues to be confined within a narrow corridor in part due to armoring and berming. This historic manipulation continues to affect how the Connecticut River and its sediment regime responds during flow events. The lack of connectivity and access to its floodplains results in the river having increased power to move sediment and scour banks within the channel. Due to these historic changes that are not related to the Project, the river is likely to remain contained to a narrow corridor and disconnected from the floodplain. In this condition, the Connecticut River will continue to adjust in an effort to achieve equilibrium condition, which is likely to continue to lead to increased scour within the channel than would be expected in an equilibrium state where the sediment and hydrologic regimes are in balance.

505. There are many other contributing factors to erosion, some are natural and some are not. These factors include the type of soil, the shape of the channel, natural seeps, and Project operations, which are the subject of this certification. However, it is impossible to determine which of those is the primary cause of a particular erosion event.

506. The data collected in study 1 through 3 analyzed historic erosion from aerial photos and conducted an on the ground two-year study measuring bank movement. The analysis showed less areas of significant erosion and a decline in erosion rates, particularly in the Vernon impoundment. (Finding 303).

507. The two-year field study observed erosion in both the Vernon impoundment and downstream of the facility in the Vernon riverine reach. However, other than notching and sediment deposition or removal at the toe of banks, most erosion occurred at elevations higher than normal Project operations would influence. The location of some notching is consistent with median water surface elevation changes within the Project area but not where fluctuations of the highest magnitude occur. This suggests that erosion is a complex process and that other factors may also contribute to the notching at the toe of the bank.

508. A supplemental analysis of erosion utilized sediment sampling and HEC-RAS modeling and allowed for a more direct assessment of project effects. For the Vernon Project area, at high flows, generally higher than the hydraulic capacity of the Project, there are occasions when those flows entrain sediment from the bank. Areas that are potentially affected by operational flows are limited (Finding 315) and the Certification (condition B) will reduce the magnitude and frequency at which high flows associated with Project operations occur within riverine reach downstream of the Project.

509. Using the HEC-RAS model developed by the Applicant, additional analysis can occur by reviewing the nodal WSE data throughout the impoundment. This can be used to calculate metrics to characterize the regime, for example the difference between the minimum and maximum surface water elevation between IEO mode and proposed Project operations. (Table 18, Table 19, and Findings 316-320).

510. Using the methods described above, the calculated differences in the estimated fluctuation magnitudes between proposed operations and IEO mode are provided in Table 32. The data indicate that the minimum difference in water surface elevation between proposed operations and IEO for any given month is 0.0 feet, with the maximum difference being 0.7 feet.

511. Aside from the most upstream node, which may be in a transition area from the riverine environment, the nodes closest to the dam (lower nodal numbers) tend to have slightly greater differences between modes. This demonstrates that these nodes are affected by Project operations to a greater degree, whereas those furthest from the dam (higher nodal numbers) are affected to a lesser degree. This is opposite of what is observed when strictly viewing the magnitude of water surface elevation changes between the two modes under proposed operations and IEO. This indicates that the differences in the magnitude of water surface elevation change occurring in the upper impoundment may be due to channel specific considerations and inflow coming into the impoundment from upstream.

Table 32. The table includes the calculated difference in the estimated range of water surface elevations between proposed operations and inflow equals outflow mode. Each node represents a transect from Vernon Dam (smaller nodal numbers) to the upper portion of the impoundment (larger nodal numbers). The years are representative of various hydrological years ranging from wet to dry. The months (February (Feb), June, August (Aug), and November (Nov)) are representative of different seasons and numbers of flexible hours.

Year	Month	Node 55	Node 120	Node 185	Node 250	Node 315	Node 380	Node 415
2009	Feb	0.4	0.4	0.4	0.4	0.4	0.4	0.6
	June	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Aug	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Nov	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2015	Feb	0.6	0.6	0.5	0.5	0.5	0.4	0.7
	June	0.1	0.1	0.0	0.1	0.0	0.0	0.0
	Aug	0.2	0.2	0.2	0.2	0.1	0.1	0.2
	Nov	0.4	0.3	0.3	0.3	0.3	0.3	0.4
2016	Feb	0.2	0.2	0.2	0.2	0.1	0.1	0.1
	June	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	Aug	0.2	0.2	0.2	0.2	0.1	0.1	0.1
	Nov	0.4	0.4	0.3	0.2	0.1	0.0	0.1
2017	Feb	0.6	0.6	0.5	0.5	0.5	0.5	0.7
	June	0.1	0.1	0.1	0.1	0.1	0.0	0.0
	Aug	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Nov	0.3	0.2	0.2	0.2	0.2	0.2	0.3

512. Proposed operations will reduce impoundment fluctuations by operating in an IEO mode along with flexible and transition operations.

513. The hydrologic change associated with proposed operations will provide physical habitat structure and stream processes consistent with high quality aquatic habitat in the reaches affected by the Project. This certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations.

514. This certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

Protection and Support of Life Cycle Functions

515. The Applicant conducted a study in 2015 that investigated the effects of current operations on spring spawning resident fish within the Project area, including in backwaters, near islands, and near the mouths of tributaries. (Findings 321-337 There were times when it was likely that spawning beds could not be observed due to deeper and turbid waters, however most species tend to utilize shallower waters to spawn and deeper areas are less susceptible to Project related effects such as nest dewatering. Additionally, for Smallmouth Bass, only positive findings were included as opposed to estimates of duration of guarding. Lastly, although the height at which a fish spawns is influenced by the water year and conditions within the impoundment, it was assumed that in other years as estimated, locations did not vary so that hydraulic modeling could be employed.

516. Numerous nests were observed and assessed in the study. Table 33 is a subset of the reported data noting the percentage of days where water levels were below the median height of the nests as estimated for different water years.

Table 33. Estimates of the average number of days water surface elevation would be expected to fall below the median height of nests or spawning areas for various water years representing the driest to wettest. The locations are all from the Vernon Project area and include backwaters, islands, and tributaries. Each value varies depending on the species of interest.

Species	Yellow Perch	Sunfish	Fallfish	Smallmouth Bass	
Reach/habitat types	Vernon Backwater	Vernon Backwater	Vernon Islands	Vernon Tributaries	Vernon Islands
1992 Driest year	0%	1%	14%	0%	54%
1989	0%	5%	0%	0%	50%
1994 Average Year	5%	1%	5%	0%	39%
2007	0%	4%	5%	0%	48%
1990 Wettest Year	34%	16%	9%	22%	13%

517. The above table indicates that under current operations, the nests of spring spawners may be affected, which has the potential to affect the reproduction and life-cycle functions of spring spawners.

518. Proposed operations were developed with a goal of protecting the most sensitive times of year for aquatic species and lifestages. For example, the Applicant is proposing to limit flexible operations to no more than 10 hours each month from April through June, to limit impacts on spring migrants and resident spawning species.

519. Analysis of the effects of proposed operations on impoundment water levels

show that for the month of June, which is most representative of spring conditions and operational limitations, the Vernon impoundment will remain within 0.1 feet of the target surface water elevation a minimum of 96.2 and maximum of 100 percent of the time under proposed operations. (Table 8). This represents an increase of between 62.6 percent and 72.9 percent over current operations. (Table 31). The magnitude of the impoundment fluctuations will also decrease by 0.54 feet on average in June across all modeled water years.

520. In addition, Table 18 and Table 19 (with a focus only on June) indicates that change in water surface elevation throughout the impoundment will vary, with the greatest magnitude of change occurring in the upper portions of the impoundment. Proposed operations are expected to have less influence on water surface elevation changes at these locations. Variability in water surface elevation is likely driven by channel specific considerations and inflow from peaking operations upstream, and flow modifying facilities on tributaries. (Finding 511 and Table 32).

521. The Sea Lamprey spawning study noted the potential for nest dewatering in part because Sea Lamprey prefer areas of shallow faster water in gravel and cobble substrates. (Finding 339). The study and subsequent modeling indicated that under current operations in a variety of water year types, nests will become dewatered. (Finding 345). Nest dewatering events affect the reproduction and life cycle functions of Sea Lamprey, in particular reproduction, within the Project affected area.

522. Analysis of the effects of the Applicant's proposed operations on downstream flows in the riverine reach shows that in June, which is representative of the time of year that Sea Lamprey spawn, there is a decrease in the flashiness of the system. (Table 29). Additionally, the modeling shows a decrease in the magnitude of flow fluctuation in all modeled years downstream of the Project relative to current operations. (Table 26).

523. In the study specific to American Shad spawning, naturally occurring conditions in the spring generally provide suitable conditions for American Shad spawning. (Finding 350). Additionally, discharge up to the maximum station discharge also provide suitable conditions for shad spawning (Finding 350). Impacts from Project operations were most apparent with flow fluctuation, particularly when reducing flow to minimum flow. (Finding 351).

524. Analysis of the effects of the Applicant's proposed operations on downstream flows in the riverine reach shows that in June, which is most representative of shad spawning conditions, there is an increase in minimum downstream flows and a decrease in the magnitude of flow fluctuations. (Table 26). Therefore, proposed operations will protect the reproduction and life-cycle functions of American Shad.

525. Proposed operations will be protective of spring spawning resident species, Sea Lamprey, and American Shad. Therefore, this certification is conditioned to

incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

E. Wildlife and Wetlands

526. The Applicant has historically operated the Project in a daily peaking mode but now proposes to reduce the frequency of peaking operations. The number of hours during which flexible operations would be permitted would vary depending on the season. The Applicant's proposal will limit the frequency of water level fluctuation. (Finding 496). These operations will create a more stable environment for wetlands and wildlife in the next license term. (Table 31).

527. Specifically for wetlands, the maximum number of hours in which water level fluctuations may occur is in the winter months, when most wetland vegetation will be dormant because it is outside of the growing season. During the growing season, particularly in the early season as plants emerge, the Applicant will be permitted to fluctuate water levels less frequently, and therefore wetlands and wildlife will experience less hydrologic alteration.

528. The Applicant's proposal will be protective of the wetlands and wildlife within the Project area. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

F. Rare, Threatened, and Endangered Species

529. The record indicates no occurrences of Dwarf Wedgemussel, Jessup's Milk Vetch, nor Northeastern Bulrush within the Project area, so they are not further discussed as part of this certification.

Northern Long-eared Bat

530. The Northern Long-eared Bat is listed at both the state and federal level as endangered. (Table 23). There are no known occurrences in the Project area. The Applicant has not indicated a need for tree clearing activities. To avoid impacts to potential hibernacula, if tree clearing is needed, it is recommended that it be limited to the winter season for trees that are three inches in diameter at breast height or larger. As such, the Agency is conditioning this certification to include a limitation of the timeframe under which tree clearing activities can occur for trees that are three inches in diameter at breast height or larger. (Condition F).

531. Should the Applicant need to cut trees that are three inches in diameter at breast height or larger outside of the allowed timeframe, the Applicant shall first consult with the Vermont Fish and Wildlife Department and the U.S. Fish and Wildlife Service.

Dragonfly and Damselfly

532. Seven of Vermont's Species of Greatest Conservation Need (SGCN) odonates, dragonflies and damselflies, occur within the Wilder, Bellows Falls, and Vernon project affected areas.

533. Of those seven odonates, four were located within the Project affected area. These were *Gomphus abbreviates, Gomphus vastus, Ophiogomphus rupinsulensis,* and *Stylurus Amnicola*. *Ophiogomphus rupinsulensis* was only observed in the Vernon riverine reach, while the others were observed in both the Vernon riverine reach and impoundment.

534. Within the Project affected area, a total of 286 odonate observations were made, which included progression through their life cycle, specifically individuals transforming from the larval to adult stage. (Finding 387). However, the waterline was subject to change due to water level fluctuations during the study period. (Finding 388). Further, odonates are vulnerable to water level fluctuations. (Finding 382).

535. The Applicant's proposal will reduce the frequency and magnitude of flow fluctuations downstream by operating in an IEO mode, along with flexible and transition operations. (Finding 458 and Table 26). These operations will increase duration of stable water levels that will better allow for odonate larvae to complete the eclosion process and protect their life-cycle requirements. (Finding 495 and Table 31).

536. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

Cobblestone and Puritan Tiger Beetles

537. Puritan Tiger Beetle (*Cicindela puritana*) is listed federally and by Vermont as threatened, while Cobblestone Tiger Beetle (*Cicindela marginipennis)* is state listed as threatened. CTB were located within the Project area at the mouth of the West River. (Findings 395).

538. Limiting the frequency and magnitude of flow fluctuations will benefit CTB by reducing inundation risk and facilitating successful reproduction.

539. Additionally, a memorandum of understanding agreed to by the Applicant provides an opportunity to meet with the Agency to discuss potential corrective actions should the management goal for the species not be met. This goal involves maintaining multiple consecutive day periods, numbering three or greater, where operations do not exceed flow thresholds that maintain 75 percent or greater uninundated habitat for most sites during the CTB active period.

540. Proposed operations will protect the reproduction of the CTB. Accordingly, the

Agency is incorporating the Applicant's proposal to operate in an IEO mode along with flexible and transition operating modes. (Condition B).

Fowler's Toad

541. Stable water levels during the Fowler's Toad breeding season from late May through late July promote conditions that support the reproduction of Fowler's Toad. The Applicant's proposal will reduce the frequency and magnitude of flow fluctuations downstream by operating in an IEO mode, along with flexible and transition operations. (Finding 458 and Table 26). These operations will increase the duration of stable water levels and will facilitate successful Fowler's Toad reproduction and protect the life-cycle requirements of the species. (Finding 496 and Table 31).

542. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations. (Condition B).

Shortnose Sturgeon

543. Shortnose Sturgeon are state and federally listed as endangered. The presence of Shortnose Sturgeon in the reaches of the Connecticut River affected by the Project was recently documented from video, photos, and a positive detection from environmental DNA sampling.

544. The NMFS is the federal agency with jurisdiction over the research, conservation and management needs for protection and recovery of the Shortnose Sturgeon. Currently, there is little to no information on the population of sturgeon in this reach of the Connecticut River or whether spawning is occurring. However, it is believed the population is smaller than the population in the lower reach of the Connecticut River below Turners Falls. NMFS is working with partners to better understand the population of Shortnose Sturgeon in this reach of the Connecticut River and identify any potential conservation or management actions needed to protect them.

545. If as part of the Section 7 Consultation under the Federal Endangered Species Act it is determined that additional measures are needed that conflict with the condition of this Certification, the Department may seek to modify the Certification. (Condition M).

G. Recreation

546. The VWQS require that waters achieve and maintain good quality that fully support boating, fishing, and other designated recreational uses. (Standards, Section 29A-306(d)(3)(A); Standards, Section 29A-306(e)(3)(A); and Standards, Section 29A-306(f)(3)(A)).

All Recreational Activities

547. The Applicant conducted a study that included in-person surveys, surveys

mailed to residents in the region, and a recreational inventory including both Applicant-owned facilities and other facilities located within the Project affected area. The Applicant included questions on safety, adequacy of the recreation facilities, and the types of uses enjoyed. Lastly, the study addressed the current capacity of the recreational facilities and their future adequacy. (Findings 412-436).

548. The recreation surveys documented that most individuals rated the recreation facilities as scenically average to extremely appealing, and safe to extremely safe. (Table 24). While most respondents provided high rankings for the recreation facilities, some still offered suggestions for improvements, including bathrooms and trash facilities.

549. Additional proposals from the FERC record included funding recreation improvements on non-project land and were not tied to impacts from the Project or its operation. These activities are outside the scope of the water quality certification, which is limited to water quality related impacts of the activity. Other comments are included in the proposed enhancements like improvements to the fish passage viewing area and boat launch. The study also identified maintenance needs and opportunities to enhance the identification of maintenance needs. (Finding 435).

550. The existing recreation facilities provide public access to public waters. Additionally, through the formal recreation study, survey respondents generally expressed satisfaction with the condition of the existing recreation facilities, as well as the amount of recreation access provided to the Vernon Project area more generally. (Finding 429 and 431).

551. The Applicant proposes specific enhancements to recreation facilities at the Project. (Findings 139). As identified by the study and to ensure the continued use of recreation facilities, the Applicant also proposes to maintain and enhance various recreation areas as needed and incorporate the Wantastiquet-Hinsdale and Stebbins Island canoe rest areas as formal Project recreation facilities. (Finding 140). Further, the Applicant proposes to develop a recreational management plan after license issuance. (Finding 141).

552. This certification is conditioned to incorporate the Applicant’s proposal to make specific recreational improvements, enhance and maintain the existing recreational facilities, incorporate additional sites as formal Project recreation facilities, and develop a recreation management plan that includes consultation with relevant stakeholders who have a direct interest in the facilities at the Project and with approval by the Department. (Condition G).

Boating

553. For waters classified as B(2) for the boating designated use, the management objective is to maintain a level of water quality compatible with good quality boating. The criteria to meet this objective is the applicable hydrology criteria. (Standards, Section 29A-306(d)(3)).

554. Flatwater boating and motorboating were the two most popular boating activities identified by users in the Vernon Project area. (Findings 441, Table 27).

555. Although no flatwater specific study was conducted, it is assumed that flatwater paddlers prefer relatively stable flows of a suitable magnitude to avoid stranding. This is supported by comments made by American Whitewater who suggested that a flow of roughly 2,500 cfs would be adequate for boaters traversing the Connecticut River.

556. Additionally, hydrologic analysis of the Applicant's proposal show that it will improve conditions for flatwater boating by increasing the minimum flow downstream of the dam and limiting flow fluctuation. (Findings 120 and 458; Table 9 and Table 34). Proposed operations will also create a more stable impoundment levels. (Finding 118 and Table 8).

557. The Applicant has proposed to maintain the online and phone system to provide users of the river access to real-time and scheduled or day ahead flow forecasting for the Project. The USGS gages will now provide more predictable information to forecast river flows, as most of the time the Project will be operating in an IEO manner.

558. Proposed operations will support boating in the reaches affected by the Project by providing a level of water quality compatible with good quality boating and are consistent with the hydrology criteria. Accordingly, this certification is conditioned to incorporate the Applicant's proposal to operate in an IEO mode along with flexible and transition operations (Condition B).

H. Debris

559. The Applicant described, to some degree, how Project-related debris is disposed of. Some is flushed downstream via the sluiceway and other debris is pulled up with a hydraulic rake, left to be dewatered, sorted, and moved to a trailer for disposal. (Findings 444-445). The information presented in the Application does not include enough specificity on how debris is managed. (Finding 446). This certification is conditioned to assure that debris disposal is consistent with applicable regulations. (Condition I).

I. Aesthetics

560. Aesthetics is a designated use of the Standards. The management objective for waters classified as Class B(2) for aesthetics is "waters shall be managed to achieve and maintain good aesthetic quality" (Standards, Section 29A-306(c)(3)(A)). The Class B(2) criteria for aesthetics use in rivers and streams are "water character, flows, water level, bed and channel characteristics, and flowing and falling water of good aesthetic value." (Standards, Section 29A-306(c)(3)(B)(i)).

561. Aesthetics is a designated use of the Standards. The management objective

for waters classified as Class B(2) for aesthetics is “waters shall be managed to achieve and maintain good aesthetic quality.” (Standards, Section 29A-306(c)(3)(A)). The Class B(2) criteria for aesthetics in rivers and streams are “water character, flows, water level, bed and channel characteristics, and flowing and falling water of good aesthetic value.” (Standards, Section 29A-306(c)(3)(B)(i)).

562. Aesthetics of the region are varied throughout the Project area. Additionally, the recreation study noted that most participants thought the scenic quality of the Project was adequate or greater than adequate. However, only limited information specific to Project waters were provided. These included concerns related to mudflats within the Project impoundment.

563. The Applicant is proposing to operate in an IEO mode along with flexible and transition operations. The proposed operations will decrease the frequency at which the impoundment is lowered and the extent to which the impoundment is lowered. (Table 31 and Table 32).

564. The Project flow discharges directly into the area just below the dam, meaning all generation flow is discharged into the Connecticut River and there is no bypassed reach.

565. The hydrologic change associated with proposed operations will be limited to moderate differences from natural condition, which will provide good aesthetic value in the Connecticut River in the Project affected area. Accordingly, this certification is conditioned to incorporate the Applicant’s proposal to operate the facility in an IEO mode with flexible and transition operations. (Condition B).

J. Antidegradation

566. Pursuant to the Anti-Degradation Policy set forth in the Standards (Section 29A-105) and the Agency’s 2010 Interim Anti-Degradation Implementation Procedure (Procedure), the Secretary must determine whether proposed discharges or activities are consistent with the Policy by applying the Procedure during the review of applications for any permit for a new discharge if, during the application review process, compliance with the Standards is evaluated pursuant to applicable state or federal law. (Procedure, Section III(A)). This includes water quality certifications required by Section 401 of the federal Clean Water Act for a federal license or permit for flow modifying activities. (Procedure, Section III(B)(3)).

567. In making a determination that proposed activities are consistent with the Anti-Degradation Policy and Implementation Procedure, the Secretary is required to use all credible and relevant information and the best professional judgement of Agency staff. (Procedure, Section III(D)). Section VIII of the Procedure governs the Agency’s review of Section 401 applications for flow modifying activities. (Procedure, Section VIII(A)(1)). The Secretary may have to review a single waterbody under multiple tiers of review depending on whether a waterbody is impaired or high quality for certain parameters.

568. A tier 3 review is required if the project will discharge to an Outstanding Resource Water. (Procedure, Section VIII(D)). This Project does not affect any Outstanding Resource Waters and therefore does not trigger a Tier 3 review under Section VIII of the Procedure.

569. This Project affects waters classified as B(2) for all designated uses and criteria, which are presumed to be high quality waters for certain parameters that triggers a Tier 2 review under Section VIII of the Procedure. (Procedure, Section VIII(E)(1)(c)). Under Tier 2, the Secretary must determine whether the proposed discharge will result in a limited reduction in water quality of a high quality water by utilizing all credible and relevant information and the best professional judgment of Agency staff. (Procedure, Section VIII(E)(2)(b)).

570. When conducting a Tier 2 review, the Secretary may consider, when appropriate, any of the following factors when determining if a proposed new discharge will result in a reduction in water quality: (i) the predicted change, if any, in ambient water quality criteria at the appropriate critical conditions; (ii) whether there is a change in total pollutant loadings; (iii) whether there is a reduction in available assimilative capacity; (iv) the nature, persistence and potential effects of the pollutant; (v) the ratio of stream flow to discharge flow (dilution ratio); (vi) the duration of discharge; (vii) whether there are impacts to aquatic biota or habitat that are capable of being detected in the applicable receiving water; (viii) the existing physical, chemical and biological data for the receiving water; (ix) degree of hydrologic or sediment regime modifications; and (x) any other flow modifications. (Procedure, Section VIII(E)(2)(d)).

571. The Secretary considered the foregoing factors during the review of the Project to determine if the Project will result in a reduction of water quality in the affected waters. The principal impacts of the Project are in the reaches of the Connecticut River affected by the Project and consists of flow and water level management associated with Project operations and the resulting effects on aquatic biota and wildlife and aquatic habitat. The changes in operation of the Project will not result in a discharge of additional pollutants or reduce other ambient water quality criteria. As a result, factors (i), (ii), (iii), (iv), (v), and (vi) are not at issue. Conditions B, C, and D of this certification, which prescribe flow and water level management regimes and monitoring requirements, are expected to maintain or improve aquatic habitat conditions and reduce the degree of hydrologic alteration associated with operation and maintenance of the facility.

572. This Certification does not authorize any activities that would result in a reduction of water quality for those parameters that exceed the Standards.

573. For those parameters for which project waters do not exceed the Standards, the Secretary must conduct a Tier 1 review. (Procedure, Section VIII(F)).

574. When conducting a Tier 1 review, the Secretary may identify existing uses and determine the conditions necessary to protect and maintain these uses. (Procedure, Section VIII(F)). In determining the existing uses to be protected

and maintained, the Secretary must consider the following factors: (a) aquatic biota and wildlife that utilize or are present in the waters; (b) habitat that supports existing aquatic biota, wildlife, or plant life; (c) the use of the waters for recreation and fishing; (d) the use of the water for water supply, or commercial activity that depends directly on the preservation of an existing high level of water quality; and (e) evidence of the ecological significance of the use in the functioning of the ecosystem or evidence of the rarity of the use. (Procedure, Section VIII(F)(2)).

575. The Secretary considered the foregoing factors pertinent to a Tier 1 review of the Project and, based on information supplied by the Applicant and Agency staff field investigations, identified the following existing uses in the reaches of the Connecticut River affected by the Project: aquatic biota and wildlife; aquatic habitat; fishing; swimming; canoeing/kayaking-flatwater; motorboating; sculling; multi-day float trips; and aesthetics.

576. The existing dam and impoundment have changed the natural condition of the river at the Project location. Currently, aquatic biota and wildlife, aquatic habitat, canoeing/kayaking-flatwater, motorboating, sculling, multi-day float trips, and aesthetics are impacted in the Connecticut River by water level fluctuations within in the impoundment and by insufficient base flow conditions and high generation flows. The Applicant is proposing to operate the Project in an IEO mode by maintaining a target water surface elevation at the dam with limited discretionary flexible operations as a condition of this certification. The conditions of this certification were developed to reduce the frequency and magnitude of impoundment fluctuations, reduce the magnitude and rate of change in flows downstream and overall to reduce the hydrologic alteration associated with operations of the Project. The analysis demonstrates the conditions of the certification will fully support the existing uses identified in Finding 575.

577. The Secretary finds that the operation of the Project, as conditioned by this certification, will comply with the VWQS and other applicable rules. Accordingly, the Secretary finds that the Project, as conditioned, meets the requirements of the Policy and Procedure relating to the protection, maintenance, and improvement of water quality.

IV. Decision and Certification

The Department has examined the Project application and other pertinent information deemed relevant by the Department to issue a decision on this certification application pursuant to the Department's responsibilities under Section 401 of the federal Clean Water Act and 10 V.S.A. § 1253(h). After examination of these materials, the Department certifies that there is reasonable assurance that operation of the Project, in accordance with the following conditions, will not violate the Standards; will not have a significant impact on use of the affected waters by aquatic biota, fish or wildlife, including their growth, reproduction, and habitat; will not impair the viability of the existing populations; will not result in a significant degradation of any use of the waters for recreation, fishing, water supply or commercial enterprises that depend directly on the existing level of water quality; and will be in compliance with sections 301, 302, 303, 306, and 307 of the federal Clean Water Act, 33 U.S.C. section 1341, and other appropriate requirements of state law:

A. **Compliance with Conditions.** The Applicant shall operate and maintain the Project consistent with the findings and conditions of this certification. The Applicant shall not make any changes to the Project or its operations that would have a significant or material effect on the findings, conclusions, or conditions of this Certification without approval of the Department.

   See Finding 453 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-101.

B. **Flow and Water Level Management.** The Project shall be operated in an inflow equal to outflow (IEO) operation by maintaining a stable target water level at the dam of 219.63 feet (+/- 0.5 feet). Outflow shall be adjusted based on calculated inflow on at least an hourly basis. When inflow exceeds project capacity, all flow shall be passed via a combination of spillage and discharge through the powerhouse. Inflow equals outflow operations are permitted to be suspended during operation modes included in Table 2.

   Flexible Operations: At the discretion of the Applicant, Project operations may deviate from IEO operations to a mode using storage, known as flexible operations. Flexible operations shall not exceed the maximum allowable hours specified in Table 1 below. There are no limitations on the number of flexible operations events per day or the duration of the event.

   During flexible operations, the water surface elevation of the impoundment shall be maintained between 218.3 and 219.63 feet. The maximum discharge during flexible operations shall be based on the calculated inflow at the hour in which the flexible operations occur. When the calculated inflow is 1,800 cfs or less, the maximum discharge is 4,500 cfs. If the calculated inflow is greater than 1,800 cfs, the maximum discharge shall be no greater than 2.5 times the calculated inflow at the hour when flexible operations begin.

Table 1. The monthly allocation of hours for flexible operations at the Vernon Hydroelectric Project.

Month	Hours
December through March	No more than 65 hours each month
April through June	No more than 10 hours each month
July	No more than 20 hours with no more than 10 hours between July 1 – 15.
August through October	No more than 20 hours each month
November	No more than 42 hours with no more than 10 hours between November 1 - 15

Transition Operations: Transition operations are the required operations needed to transition to and from IEO during a flexible operation event. Transition operations include requirements for up-ramping, down-ramping and refill. Table 2 below specifies the applicability of transition operations to Project operations.

Up-ramping: Up-ramping is required for scheduled flexible operations events. During up-ramping flow will begin to increase over the hour preceding the flexible operations event . The up-ramping rate for the Project shall be the lesser of one cubic foot per second per square mile (approximately 6,266 cfs) or halfway between IEO and the flexible operations flow.

Down-ramping: Down-ramping shall occur after a flexible operations event by decreasing flow gradually until outflow is equal to inflow at the dam. Decreases in flow shall occur on an hourly basis as a percentage of the previous hourly flow. The first hour after a flexible operation event, flows shall be approximately 70 percent of the flexible operations flow. Each successive hour flow shall be approximately 70 percent of the previous hourly flow.

Refill: The impoundment shall be restored to the target water surface elevation of 219.63 feet within a 48-hour period beginning when post-flexible operation down ramping is complete. Refill shall occur by retaining a percentage of inflow to restore the impoundment elevation. The hourly flow rate below the Project will be the greater of approximately 70 percent of inflow or the seasonal minimum base flows.

The 48-hour refill period begins immediately after the down-ramping after a flexible operations event and ends no more than 48-hours later unless the reservoir is within 0.1 ft. of the target water surface elevation of 219.63 feet. The 48-hour period includes any temporary interruptions during the refill period.

Table 2: Operation modes of the Vernon Hydroelectric Project and the applicability of transition operations components to each operations mode.

Operations Mode	Up- Ramping	Down- Ramping	Impoundment Refill
Flexible Operations, Scheduled	Applied during the hour prior	Applied as Defined	Applied as Defined
Flexible Operations, Un-Scheduled	Not Applied	Applied as Defined	Applied as Defined
High Water Operations	Not Applied	Not Applied	Not Applied
CCA and RPD audits	Not Applied	Applied as Defined	Applied as Defined
Emergencies and System Emergencies	Not Applied	Not Applied	Not Applied

See Findings 95-120, 478-528, 532-540, 546, and 553-558 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304, § 29A-306 (b)(3), § 306 (c)(3), & § 29A-306 (d)(3).

C. **Minimum Base Flow.** Minimum base flows are required to be maintained below the Project at all times. The seasonal minimum base flows for the project are 3,000 cfs from April 1 through May 31; 1,400 cfs from June 1 through September 30; and 1,600 cfs from October 1 through March 31. Flow below the Project shall be equal or greater than the seasonal minimum flow unless the calculated inflow is less during IEO operations.

See Findings 95-120, 478-528, 532-540, 546, and 553-558 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304, § 29A-306 (b)(3), § 306 (c)(3), & § 306 (d)(3).

D. **Operations Compliance and Monitoring Plan.** The Applicant shall develop, within 180 days of the effective date of the FERC license, an operations compliance and monitoring plan detailing how the Project will operate in compliance with IEO operations, flexible operations, and transition operations. The plan shall also include when the Project is being operated in response to emergency and system operations requirements. The plan shall also include a method for continuous monitoring and reporting outflow releases (e.g. spillage and turbine discharge) at the Project, impoundment levels, and inflow. The plan shall include provisions for the operations data to be submitted to the Department.

The plan shall include procedures for reporting deviations from prescribed operating conditions to the Department. Reports shall be made within 15 days after a deviation and will include, if possible, the cause, severity, and duration of the deviation, observed or reported adverse environmental impacts from the incident, pertinent data, and measures to be taken to avoid recurrences.

The plan shall be subject to Department approval. The Department reserves the right to review and approve any material changes made to the plan.

See Finding 453 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304 & § 29A-306(b)(3).

E. Fish Passage. Upstream and downstream fish passage measures shall be implemented under the terms and conditions within the Settlement Agreement for Fish Passage (Agreement) which are summarized in Findings 121-138.[14] The Applicant shall develop a Fish Passage Management Plan (FPMP), in consultation with the Vermont Fish and Wildlife Department and other signatories to the Agreement and submit to FERC within 120 days of the effective date of the FERC license. The FPMP shall specify the implementation schedules as calendar dates and will identify anticipated subsequent, supplemental fish passage filings to FERC that may be required depending on the scope of the element to be implemented. The FPMP shall identify all anticipated consultation with the Vermont Fish and Wildlife Department and other signatories to the Agreement in development of the pre-design analysis, design, and effectiveness evaluations, as appropriate.

As required by the Agreement, the required fish passage operational periods are as follows for the Project. The upstream fish passage shall be operated April 1 - July 15 upon issuance of the FERC license.[15] Upon completion and implementation of the enhancements set forth in the Agreement, upstream fish passage measures shall be operated April 1 – July15 for anadromous species and from May 1 to November 15 for American Eel. The downstream fish passage shall be operated from April 7 - December 1 upon issuance of the FERC license.[16]

See Findings 121-138 and 465-477 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-306(b)(3)(A).

F. Northern Long-eared Bat Protection. The Applicant shall avoid tree trimming and removal of trees three inches in diameter at breast height or greater in the Project boundary between April 1 and October 31 to avoid any roost disruption of the Northern long-eared bat, except when necessary to protect public safety or respond to emergency conditions. In the case of a public safety issue or emergency where tree trimming or removal are required during the seasonal protective period, the Applicant will consult with the Department as soon as practical after conducting the trimming or removal.

See Findings 367, 369, and 530-531 for a statement of necessity. 10 V.S.A. § 5403.

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[14] Great River Hydro, LLC Settlement Agreement for Fish Passage; Vernon, Bellows Falls, and Wilder Hydroelectric Projects dated August 2, 2022. Included as Appendix A.
[15] The April 1 start date is to accommodate early spring spawners such as walleye and white suckers. The fish ladder at Vernon, shall commence operation as close as possible to April 1 annually, but no later than April 15 as long as ice conditions and/or debris conditions allow for fish ladder inspections and the ladders are fully operational.
[16] Downstream passage at Vernon is to be operational for Spring American Shad migration and shall commence operation as close as possible to April 7 annually, but no later than April 15 concurrent with the start of upstream American Shad migration season through the Vernon fishway.

G. **Recreation.** In accordance with the Applicant's proposal, the Applicant shall improve the upstream portage to include a dock, pathway, and boat slide; the downstream portage improvements to include trail improvements, new stairs, and a boat slide; the Governor Hunt/Vernon Glen recreation area to include accessibility improvements to the parking and picnic sites; the Stebbins Island canoe camp site; and update the fish ladder window to include lighting and accessibility improvements. Additionally, the Applicant shall include the Wantastiquet-Hinsdale and Stebbins Island canoe rest areas as formal Project recreation facilities. Additionally, the Applicant shall maintain a call in flow number for boating conditions and the availability of real time flow information and day ahead forecasting online.

   Within one year of the effective date of the FERC license, the licensee shall develop a recreation management plan providing additional details on the schedule for implementing the Applicant's recreation proposal summarized above and in Findings 140-142. The plan shall include the frequency at which recreational sites that the Applicant has agreed to maintain will be checked for maintenance needs, how maintenance needs will be addressed to ensure continued public use, and how future enhancements will be considered.

   The plan shall be developed in consultation with the Department and include consultation with relevant stakeholders who have a direct interest in the facilities at the Project. The plan shall be subject to review and approval by the Department.

   See Findings 92-120, 139-141, and 546-558 for a statement of necessity. 10 V.S.A. § 1421, 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 §29A- 303(d-f).

H. **Public Access.** The Applicant shall allow public access to the project lands for utilization of public resources, subject to reasonable safety and liability limitations. Such access should be prominently and permanently posted so that its availability is visible to the public. In instances when access limitations are necessary to prevent unreasonable risks to public safety or in the case where an immediate threat to public safety exists, the Applicant may restrict access. In such instances where access is restricted due to public safety issues, the Applicant shall notify the Department.

   See Findings 92-94, 139-141, 412-435, and 546-552 for a statement of necessity. 10 V.S.A. § 1421.

I. **Debris Disposal.** Debris associated with Project operations shall be disposed of in accordance with the Standards and applicable state laws and regulations.

   See Findings 444-446, and 559 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-303(1).

J. **Maintenance and Repair Work.** The Applicant shall consult with the Department prior to conducting scheduled Project maintenance or repair work that necessitates a deviation from Conditions B and C that assure compliance with water quality requirements (e.g., water level or flow management). Such maintenance and repair work shall be subject to review and approval by the Department.

See Findings 96, 102, 355, 453, and 500-501 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-304(d) and § 29A-306(b).

K. Compliance Inspection by Department. The Applicant shall allow the Department to inspect the Project area at any time to monitor compliance with certification conditions.

See Findings 2 and 453 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § § 29A-104(a).

L. Posting of Certification. A copy of the certification shall be prominently posted within the Project powerhouse.

See Findings 2 and 453 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104(a).

M. Modification of Certification. The conditions of this certification may be altered or amended by the Department to assure compliance with the VWQS and to respond to any changes in classification of the waters affected by the Project or if necessary after completion of a Federal Endangered Species Act Section 7 Consultation, when authorized by law, and, if necessary, after notice and opportunity for hearing.

See Findings 2, 451-453, and 545 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104(a).

Effective Date and Expiration of Certification

This certification shall become effective on the date of issuance, and the conditions of any certification shall become conditions of the federal permit (33 U.S.C. § 1341(d)). If the federal authority denies a permit, the certification becomes null and void. Otherwise, the certification runs for the terms of the federal license or permit.

Enforcement

Upon receipt of information that water quality standards are being violated as a consequence of the Project's construction or operation or that one or more certification conditions has not been complied with, the Secretary, after consultation with the Applicant and notification of the appropriate federal permitting agency, may, after notice and opportunity for a public hearing, modify the Certification and provide a copy of such modification to the Applicant and the federal permitting agency.

Certification conditions are subject to enforcement mechanisms available to the federal agency issuing the license and to the state of Vermont. Other mechanisms under Vermont state law may also be used to correct or prevent adverse water quality impacts from construction or operation of activities for which certification has been issued.

Appeals

Pursuant to 10 V.S.A. Chapter 220, any appeal of this decision must be filed with the clerk of the Environmental Division of the Superior Court within 30 days of the date of the decision. Pursuant to 10 V.S.A. Chapter 220, an aggrieved person shall not appeal this decision unless the person submitted to the Secretary a written comment during the applicable public comment period or an oral comment at the public meeting conducted by the Secretary. Absent a determination of the Environmental judge to the contrary, an aggrieved person may only appeal issues related to the person's comments to the Secretary as prescribed by 10 V.S.A. § 8504(d)(2). The Notice of Appeal must specify the parties taking the appeal and the statutory provision under which each party claims party status; must designate the act or decision appealed from; must name the Environmental Division; and must be signed by the appellant or their attorney. In addition, the appeal must give the address or location and description of the property, project, or facility with which the appeal is concerned and the name of the Applicant or any permit involved in the appeal. The appellant must also serve a copy of the Notice of Appeal in accordance with Rule 5(b)(4)(B) of the Vermont Rules for Environmental Court Proceedings. For further information, see the Vermont Rules for Environmental Court Proceedings, available online at www.vermontjudiciary.org. The address for the Environmental Division is 32 Cherry Street, 2nd Floor, Suite 303; Burlington, VT 05401 (Tel. 802.951.1740).

Dated: April 16, 2025

Julia S. Moore, Secretary
Agency of Natural Resources

By ______________________________

Peter LaFlamme, Director
Watershed Management Division

Vernon Hydroelectric Project

Section 401 Water Quality Certification

APPENDIX A

Settlement Agreement for Fish Passage

FERC Project Nos.
No. 1892
No. 1855
No. 1904

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

	)	**Project No. 1892-___**
Great River Hydro, LLC	)	**Project No. 1855-___**
	)	**Project No. 1904-___**

SETTLEMENT AGREEMENT FOR FISH PASSAGE

GREAT RIVER HYDRO, LLC

SETTLEMENT AGREEMENT FOR FISH PASSAGE
VERNON, BELLOWS FALLS, AND WILDER HYDROELECTRIC PROJECTS

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SETTLEMENT AGREEMENT FOR FISH PASSAGE

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INTRODUCTION

THIS SETTLEMENT AGREEMENT (Agreement), effective as of the date of the last signature affixed hereto (the Effective Date), is made and entered into by and between Great River Hydro, LLC, a Delaware limited liability company (Licensee); the United States Department of the Interior (DOI) Fish & Wildlife Service (USFWS); the New Hampshire Fish and Game Department (NHFG); and the Vermont Fish and Wildlife Department (VFWD) (each, a Party and collectively, the Parties).

This Agreement relates to the Vernon Project (FERC Project No. 1904), Bellows Falls Project (FERC Project No. 1855), and Wilder Project (FERC Project No. 1892) (collectively, the Projects), which are the subject of ongoing relicensing proceedings before the Federal Energy Regulatory Commission (FERC or Commission) for new licenses to operate the Projects (New Licenses). Specifically, this Agreement resolves all issues related to upstream and downstream fish passage for Targeted Migrants at the Projects under the New Licenses.

1 GENERAL TERMS

1.1 Term of the Agreement

This Agreement shall remain in effect, in accordance with its terms, throughout the term of the New Licenses, including any annual licenses thereafter.

1.2 Purpose and Goals

The purpose of this Agreement is to resolve among the Parties the appropriate prescriptions for fish passage pursuant to section 18 of the Federal Power Act (FPA) (16 U.S.C. § 811) and the Parties' recommended terms and conditions related to fish passage for Targeted Migrants under sections 10(a) and 10(j) of the FPA (16 U.S.C. §§ 803(e) and (j)), to be incorporated into the New Licenses for the Projects.[1]

[1] The Parties to this Agreement, along with the New Hampshire Department of Environmental Services and the Vermont Department of Environmental Conservation, also have executed a Memorandum of Understanding (MOU), dated as of December 1, 2020, governing proposed operational measures for the Projects under the New Licenses. Nothing in this Agreement is intended to modify the understanding of the Parties under the MOU.

1.3 Parties to Support Terms

The Parties agree to support the issuance of New Licenses by FERC and Water Quality Certifications pursuant to Section 401 of the Clean Water Act (CWA) (33 U.S.C. § 1341) by the New Hampshire Department of Environmental Services (NHDES) and the Vermont Department of Environmental Conservation (VDEC) that are consistent with the terms of this Agreement. For those matters addressed herein, specifically the passage of American shad, American eel, and sea lamprey, the Parties agree not to propose or otherwise communicate to FERC or any other federal or state resource agency with jurisdiction directly related to the current relicensing processes any comments, certification, or license conditions that would be materially additive to, or materially inconsistent with, the terms of this Agreement. However, this Agreement shall not be interpreted to restrict any Party's participation or comments regarding other matters that are not the subject matter of this Agreement, future proceedings regarding the Projects, or compliance with the terms and conditions of the Project Licenses or this Agreement.

1.4 Terms and Definitions

The Parties agree that the following terms shall be defined as follows:

- Agencies: Collective term used to refer to the United States Department of the Interior (DOI) Fish & Wildlife Service (USFWS); the New Hampshire Fish and Game Department (NHFG); and the Vermont Fish and Wildlife Department (VFWD).

- Date of License Issuance (DOLI): The date of FERC issuance of the New License. Implementation schedules outlined in this Agreement are stated by Month/Day within a specified calendar year following the DOLI.

- License Year: Full calendar years counted after DOLI. License Year 1 starts January 1 following DOLI.

- Licensee: Great River Hydro, LLC, or its successor or assigns. Great River Hydro, LLC is a Delaware limited liability company.

- New License: The new license issued by the Commission for a specified Project.

- Projects: The Vernon Hydroelectric Project (FERC Project No. 1904), the Bellows Falls Hydroelectric Project (FERC Project No. 1855), and the Wilder Hydroelectric Project (FERC Project No. 1892).

- Targeted Migrants: American shad, *Alosa sapidissima* (Vernon only);[2] sea lamprey, *Petromyzon marinus*; and American eel, *Anguilla rostrata*.

1.5 Successors and Assigns

This Agreement shall be binding upon and shall inure to the benefit of the Parties hereto and their respective successors and assigns.

1.6 Agency Appropriations

Nothing in this Agreement shall be construed as obligating any federal, state, or local government to expend in any fiscal year any sum in excess of appropriations made by Congress, state legislatures, or local legislatures, or administratively allocated for the purpose of this Agreement for the fiscal year; or as involving the DOI, USFWS, NHFG, or VFWD in any contract or obligation for the future expenditure of money in excess of such appropriations or allocations.

1.7 Establishes No Precedents

The Parties have entered into the negotiations and discussions leading to this Agreement with the explicit understanding that the discussions leading up to and resulting in the Agreement are privileged, shall not prejudice the position of any Party or entity that took part in such discussions and negotiations, and are not to be otherwise used in any manner in connection with these or any other proceedings. The Parties understand and agree that this Agreement establishes no principles or precedents with regard to any issue addressed herein or with regard to any Party's participation in future relicensing proceedings and that none of the Parties to this Agreement will cite this Agreement or its approval by FERC, the USFWS, NHFG, or VFWD as establishing any such principles or precedents. This Section 1.7 shall survive any termination of this Agreement. Any Party withdrawing from this Agreement pursuant to Section 1.14 will continue to be bound by this Section 1.7.

1.8 Filing of Settlement Agreement

The Parties agree that within thirty 30 days of the Effective Date, the Licensee shall file this Agreement, together with an Explanatory Statement, with the Commission pursuant to 18 C.F.R. § 385.602 in the dockets for the Projects' relicensing proceedings.

[2] While blueback herring (BBH) are not present in the vicinity of the Projects at this time, the Agencies are managing for the restoration of this species in the Connecticut River Basin and specific passage and protection measures for BBH may be needed in the future.

1.9 Filing of Preliminary Prescriptions for Projects

The USFWS shall file preliminary prescriptions in the relicensing proceedings for the Projects that are fully consistent with the terms of this Agreement within 60 days after the deadline established by FERC in its "Ready for Environmental Analysis and Soliciting Preliminary Prescriptions" notice under 18 C.F.R. § 5.22.

1.10 Trial-Type Hearing Requests and Alternatives

The Parties agree that if the USFWS files preliminary prescriptions for the relicensing proceedings with FERC that are fully consistent with this Agreement, neither the Licensee, nor any Party to this Agreement will file a request for trial-type hearing of issues of disputed fact pursuant to 16 U.S.C. § 811 or alternative prescriptions pursuant to 16 U.S.C. § 823d(b) with respect to those preliminary prescriptions.

The Licensee expressly reserves the right to challenge a new or amended fish passage prescription made by USFWS under any reservation of authority included in its final prescriptions for the Projects.

1.11 Filing of Final Prescriptions for Projects

If no party to the FERC relicensing proceedings files a request for trial-type hearing on disputed issues of material fact pursuant to 16 U.S.C. § 811 or alternative prescriptions pursuant to 16 U.S.C. § 823d(b) with respect to USFWS's preliminary prescriptions, and no fact is otherwise submitted to the record before the USFWS or the Commission that would make the preliminary prescription inconsistent with the administrative record, USFWS will file final prescriptions with FERC that are fully consistent with the terms of this Agreement within 60 days after the deadline for filing comments on FERC's draft NEPA document under 18 C.F.R. § 5.25(d), consistent with 43 C.F.R. § 45.73(a). If a party to the relicensing proceedings files a request for trial-type hearing or alternative prescription and USFWS issues a final prescription that is inconsistent with the terms of this Agreement, the Licensee may withdraw from this Agreement pursuant to Section 1.14 and reserves all right to challenge the modified prescription before FERC or the U.S. Court of Appeals.

1.12 Support For Water Quality Certifications for Projects

The Parties agree that they will support the NHDES and VDEC's issuance of Section 401 Water Quality Certifications to the extent that they include fish passage provisions not materially inconsistent with the provisions of this Agreement. The Licensee reserves its right to challenge the Water Quality Certifications with respect to conditions incorporated therein that are materially additive to or materially inconsistent with this Agreement or unrelated to fish passage.

1.13 Filing and Support of Settlement Provisions as Recommended Terms and Conditions

The fish passage provisions included in this Agreement constitute the Parties' complete and final recommended terms and conditions for fish passage to be included in the New Licenses through the relicensing proceedings. The Parties reserve their right to take any position before FERC with regard to terms and conditions unrelated to fish passage that may be proposed for inclusion in the New Licenses.

1.14 Withdrawal Rights

No Party may withdraw from this Agreement without the prior written consent of the other Parties, which consent may be withheld in another Party's sole discretion; provided, however, a Party may unilaterally withdraw from this Agreement if: (i) USFWS issues a final prescription that is materially additive to, or materially inconsistent with the terms of this Agreement; (ii) NHDES or VDEC issues a Water Quality Certification that contains fish passage conditions that are materially additive to, or materially inconsistent with, the terms of this Agreement and the Water Quality Certification is not thereafter satisfactorily modified after administrative and judicial appeals are pursued by the Licensee; (iii) any Party recommends terms and conditions for the New Licenses under sections 10(a) and 10(j) of the FPA that are materially additive to, or materially inconsistent with, the terms of this Agreement with regard to the matters addressed herein; or (iv) FERC issues New Licenses that contain fish passage conditions which are materially additive to, or materially inconsistent with, the terms of this Agreement, and the New Licenses are not thereafter satisfactorily modified as a result of the filing of a request for rehearing as provided in Section 1.15.

A Party withdrawing from this Agreement shall provide twenty (20) days' prior written notice, which notice shall include a written explanation of the reasons for withdrawing from this Agreement. In the event that a Party withdraws from this Agreement pursuant to this Section 1.14, this Agreement shall thereafter be null and void, and any Party may take the position that this Agreement is not available to support FERC's public interest determination.

1.15 Rehearing and Judicial Review of FERC License

The Parties agree not to file a request with FERC for rehearing of the New Licenses concerning matters addressed in this Agreement unless: (i) the New Licenses contain fish passage conditions that are materially inconsistent with the terms of this Agreement, including inconsistent timelines for studies and the operation of fish passage facilities; or (ii) the New Licenses contain fish passage conditions that are materially additive to the terms of the Agreement. In the event a Party files a request for rehearing in accordance with the terms of this provision, it will provide the other Parties written notice of its intention to file a request for rehearing at the earliest practicable time. Any Party, following the issuance of a FERC order on rehearing, may elect to file a petition for judicial review with respect to the matters covered by this provision, and the other Parties will not oppose such petition.

1.16 Counterparts

This Agreement may be executed in any number of counterparts, all of which taken together shall constitute one and the same instrument.

1.17 Notice

If practicable, all required notices will be provided by e-mail or comparable electronic messaging agreed to by all Parties. Notice will also be sent to all Parties by first-class mail or comparable method of distribution, and as applicable will be filed with FERC. For the purposes of this Agreement, and unless otherwise specified, notice (including notice via e-mail) will be effective upon receipt, but if provided only by U.S. Mail, seven (7) days after the date on which it is mailed.

For the purpose of notice, the list of authorized representatives of the Parties is attached as Appendix C. The Parties will provide notice of any change in the authorized representatives designated in Appendix C, and the Licensee will maintain the current distribution list of such representatives. The Parties acknowledge their responsibility to keep the other Parties informed of their current address, telephone, and e-mail information. Notice obligations under this Section 1.17 are in addition to any notice provisions required by applicable law.

2 GENERAL AGREEMENTS OF THE PARTIES

2.1 Reservation of Authority to Prescribe Fish Passage Measures

The Parties agree that in order to allow for the timely implementation of fish passage, including effectiveness measures, the DOI will propose to reserve its authority to prescribe fishways by requesting that FERC include the following condition in any new license(s) it may issue for the Projects:

"Pursuant to Section 18 of the Federal Power Act, the Secretary of the Interior herein exercises their authority under said Act by reserving that authority to prescribe fishways during the term of the License and by prescribing the fishways described in the Department of Interior's Prescription for Fishways for the Projects."

2.2 Reopeners

The Parties agree that, except as provided herein, this Agreement is not intended to limit or restrict the ability of any Party to petition FERC pursuant to any reopener condition contained in the New Licenses, including but not limited to any exercise by the Secretary of the DOI relating to her/his fishway prescription authority under section 18 of the FPA that is reserved in the New License.

No such petition may be filed which would, if granted, be materially inconsistent with this Agreement, or cause other portions of the Agreement to be reopened, unless the Party who files the petition can demonstrate with substantial evidence that a change in circumstances has occurred which provides good cause for the filing of the petition. Unless in the case of the exercise of section 18 authority, which shall be processed under procedures established by the applicable statutes and regulations, no such petition may be filed without the filer providing at least sixty (60) days written notice of its intention to do so to all the other Parties. Within thirty (30) days following the giving of notice, the Parties shall in good faith consult with the other Parties regarding the need for and the purpose of the petition. Consultation requires at least one meeting of the Parties, which may be completed electronically (e.g., virtually, via telephone, etc.) or in-person in order to accommodate the schedule/availability of the Parties. In the event such a petition is filed, the filing Party shall include with its filing documentation of its consultation with the other Parties and a summary of recommendations and responses to those recommendations. The filing Party shall also serve a copy of its petition to all the other Parties via the Commission's electronic service system. The Parties are free to take any position before the Commission on such a petition.

2.3 License Amendments and Modifications

The Parties agree that, except as provided herein, nothing in this Agreement is intended to limit or restrict the ability of the Licensee to seek amendments of the New Licenses. The Licensee may only seek a license amendment or other modification to the New Licenses that would be materially inconsistent with the provisions of this Agreement if it has substantial evidence that a change in circumstances has occurred that provides good cause for the filing of the amendment or modification and has provided the Parties at least 60 days' written notice of its intention to do so and, promptly following the notice, has consulted with the Parties regarding the need for and the purpose of the amendment or modification. For other license amendments or modifications that only relate to, but would not alter the license conditions set forth in this Agreement, the Licensee shall provide all Parties at least 30 days' notice of the proposed amendment or modification and, upon any Party's request, shall consult with the Parties regarding the amendment or modification and defer the filing for another 30 days. In any application for an amendment or modification that relates to any term or condition of this Agreement, the Licensee shall document its consultation, summarize the positions and recommendations of the Parties, and provide its response to those positions and recommendations. The Licensee shall serve a copy of any application for amendment or modification to the Parties at the time of the filing. The Licensee will not oppose an intervention request filed in a timely manner by any Party in an amendment or modification proceeding involving the New Licenses.

2.4 Agreement Amendments

No amendment to this Agreement shall be effective unless reduced to writing and signed by the Parties.

2.5 Support for Removal of Salmon Dam

The Licensee shall support and facilitate third party efforts to remove the Salmon Dam in the Bellows Falls bypass reach but in no event shall be responsible for financing removal efforts.

3 FISH PASSAGE MEASURES THE PARTIES AGREE SHOULD BE INCORPORATED INTO THE TERMS OF THE NEW LICENSES

3.1 General fish passage obligations of Licensee

The Licensee shall operate the Projects to provide safe, timely, and effective passage for Targeted Migrants, pursuant to the measures and implementation schedules detailed in subsections 3.1.1 through and including 3.8 below, and as summarized in Tables 3.4.1-1 through 3.6.2-1 (Appendix A of this Agreement) and as depicted in the Project Specific Fish Passage Implementation Chart (Appendix B of this Agreement).[3] Upstream and downstream passage systems may include physical facilities, spillage plans, reasonable operational modifications, or new (USFWS-approved) technologies as they become available. The schedules provided under this section are stated in terms of License Years based on the DOLI. They do not preclude the Licensee from proactively addressing any element on an expedited timeframe.

For all identified fish passage measures, the first year of operation shall be a shakedown year[4] followed by two years of representative quantitative effectiveness studies. Additional study years may be required in order to achieve two full representative passage seasons. A representative passage season is one where there are no anomalous[5] environmental or operational conditions, or incomplete data (e.g., due to equipment malfunction). Additional study years also may be warranted in response to any fish passage/project modifications made. A single

[3] In case of inadvertent conflict between Tables in Appendix A or the Gannt Chart in Appendix B and the narrative under Section 3, the narrative under Section 3 shall control.

[4] Shakedown refers to assessing whether all components of the fish passage facility are operating as designed.

[5] Anomalous conditions are those outside the bounds of the 25th to 75th percentile conditions for a given parameter.

representative study year may suffice should results clearly suggest measures are effective, as agreed to in writing by the Agencies.

The Parties may, by mutual written agreement, modify any time limit to implement the identified fish passage measures, if there is good and substantial reason for the modification. The Parties acknowledge that modifications to time limits under the New Licenses may require FERC approval. Delay in completing one element shall not be justification for a delay in subsequent elements.

The Licensee will develop Fish Passage Management Plans (FPMP) for each of the Projects, in consultation with the Agencies, and will submit each to the Commission for approval within approximately 120 days of the DOLI. The FPMPs will specify the implementation schedules as calendar dates and will identify anticipated subsequent, supplemental fish passage filings to the FERC that may be required dependent upon the scope of the element to be implemented. The FPMP will identify all anticipated consultation with the Agencies in the development of pre-design analyses, design, and effectiveness evaluations, as appropriate. The proposed implementation schedule and deadlines for actions under this Agreement will be discussed further with the Agencies, with timelines/schedules being advanced, where feasible, in light of the actual DOLI, particularly if the DOLI occurs between January 1 and March 31.

Table 3-1. Required fish passage operational periods.

Project	**Direction**	**Dates**	**Beginning**
Vernon	Upstream	April 1[a] – July 15	Upon New License issuance
		April 1[a] – November 15	Upon completion and implementation of enhancements (including interim eel passage)
	Downstream	April 7[b] – December 1	Upon New License issuance
Bellows Falls	Upstream	April 1[a] – July 15	Upon New License issuance
		April 1[a] – November 15	Upon completion and implementation of enhancements (including interim eel passage)
	Downstream	August 1 – December 1	Upon New License issuance
Wilder	Upstream	April 1[a] – July 15	Upon New License issuance
	Downstream	August 1 – December 1	Upon completion and implementation of enhancements

a. The April 1 start date is to accommodate early spring spawners such as walleye and white suckers only. The fish ladders at Vernon, Bellows Falls, and Wilder shall commence operation as close as possible to April 1 annually, but no later than April 15 as long as ice conditions and/or debris conditions allow for fish ladder inspections and the ladders are fully operational.
b. Downstream passage at Vernon is to be operational for Spring American Shad migration and shall commence operation as close as possible to April 7 annually, but no later than April 15 concurrent with the start of upstream American Shad migration season through the Vernon fishway.

3.2. Study Plan Review

For all study plans under this Agreement, the Licensee shall consult with and reach agreement with the Agencies, addressing their comments and concerns, on study plan design on a schedule that allows sufficient time to procure equipment, materials, etc. necessary to conduct the study during the specified study period. The Licensee shall provide the Agencies with draft study, survey, and assessment plans associated with provisions under Section 3 (e.g., hydraulic study, Passive Integrated Transponder (PIT) studies, eel surveys, etc.) and provide a minimum of 30 days for review and comment.

3.3. Fish Passage Design Review

For all provisions under subsections 3.4 through 3.6, design of passage facilities shall occur in consultation with, and require approval by, the Agencies and shall meet USFWS Design Criteria (USFWS 2019, or as modified) to the extent practicable from an engineering perspective. The Licensee shall provide plan sets for review and comment to the Agencies at the 30%, 60%, and 90% level.

3.4 Fish Passage and Protection Measures at the Vernon Project

The Licensee shall design, construct, operate, maintain, and evaluate the effectiveness of fish passage and protection facilities for Targeted Migrants at the Vernon Project.

3.4.1 Downstream Passage and Protection

The Licensee shall undertake a hydraulic study or a suitable alternative, designed to inform downstream passage/design options. The study plan shall be developed in consultation with the Agencies and shall be initiated no later than January 1 of License Year 2; the study initiated, completed and reported on no later than December 31 of License Year 3. The Licensee will use results of the study to develop design alternatives to provide safe, timely, and effective passage for Targeted Migrants. The Licensee shall initiate design consultation with the Agencies no later than July 1 of License Year 3, and final design plans (sufficient for construction bid purposes) shall be completed no later than December 31 of License Year 4. Construction shall be initiated during License Year 5 and completed no later than December 31 of License Year 6. Approved structural facilities and/or operational measures shall be fully operational no later than April 7 of License Year 7.

Specific passage/protection and effectiveness study requirements and their associated implementation schedules and operational periods are provided in Table 3.4.1-1.

3.4.2 Upstream American Eel and Sea Lamprey Passage

3.4.2.1 Within Ladder Measures for Eel and Lamprey Passage for the period April 7 through July 15

The Licensee shall undertake a hydraulic study within the existing Vernon fish ladder together with an engineering assessment of the ladder to inform potential modifications for improved effectiveness for passage of American eel and sea lamprey (this is the same hydraulic study and engineering assessment discussed under section 3.2.3). The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective eel and sea lamprey ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The Licensee shall initiate consultation with the Agencies on the hydraulic study design and scope of engineering assessment no later than November 15 of License Year 2. The Licensee shall initiate the study no later than July 16 of License Year 3 and complete and report on the study no later than December 31 of License Year 4.

During the License Year 5 upstream anadromous passage season, the Licensee shall undertake studies, using PIT technology to assess passage performance of American eel and sea lamprey within the Vernon fish ladder. Consultation with the Agencies on the PIT study design will be initiated no later than July 1 of License Year 3; and the study will be initiated no later than May 1 and completed and reported on no later than December 31 of License Year 4. Should the Agencies deem results of the study insufficient to determine where passage impediments occur within the Vernon ladder, the study design will be modified through consultation with the Agencies (e.g., additional PIT antennas deployed or moved to different locations) and an additional year of study will take place in License Year 5.

The Licensee will use results of the hydraulic and PIT studies to develop design alternatives to improve eel and lamprey passage through the ladder during the period April 7 through July 15. The Licensee shall initiate design consultation with the Agencies in Year 4 and final design plans (sufficient for construction bid purposes) shall be completed no later than July 15 of License Year 5. Approved eel/lamprey ladder modifications shall be initiated starting on July 16 of License Year 5 and completed no later than April 6 of License Year 6 and be fully operational no later than April 7 of License Year 6. These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies, and date of commencing operation shall be extended 1 year if an additional year of PIT study is necessary.

3.4.2.2 Within Ladder Interim Measures for Eels for the period July 16 through November 15

The Licensee shall design, construct, operate, and maintain interim (possibly temporary) measures approved by the Agencies to pass American eels for the July 16 to November 15 period. The interim upstream eel passage facility shall consist of an eel ramp-trap, or similar design, as specified in USFWS Design Criteria (USFWS 2019). The eel ramp-trap will be located below the station, potentially within or near the entrance to the existing fish ladder at a location to be determined in consultation with the Agencies. The Licensee shall initiate design consultation with the Agencies for interim upstream eel passage facilities no later than January 1 of License Year 2, and final design plans shall be completed no later than December 31 of License Year 2. Construction of approved interim upstream eel passage facilities shall be completed by July 15 of License Year 3 and shall be fully operational no later than July 16 of License Year 3. Interim eel passage facilities shall be operated annually until permanent upstream eel passage facilities are operational. The first two years of interim passage operation will include monitoring and reporting eel use and upstream passage. Based on the results of the monitoring, if the interim measure does not appear to pass eels in anticipated and consistent numbers, the Licensee will consult and reach agreement with the Agencies on the need for further monitoring and/or adjustment to the interim measure (e.g., location or design).

3.4.2.3 Permanent Upstream Eel Passage Measures for the period July 16 through November 15

Based on the PIT and hydraulic studies required pursuant to Section 3.4.2.1, ladder monitoring results, and upstream interim eel passage data, the Licensee shall consult with the Agencies no later than July 1 of License Year 9 to determine whether existing information is sufficient to identify permanent upstream eel passage measures for the period July 16 through November 15 (i.e., via the interim means, alternate permanent ramps or via the fish ladder), or if additional studies are needed.

Should the Agencies determine additional studies are not warranted, the Licensee shall select, subject to approval by the Agencies, the preferred method of upstream permanent passage no later than January 31 of License Year 10. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 10, and the Licensee shall complete final design plans no later than December 31 of License Year 10. Construction of permanent upstream eel passage facilities approved by the Agencies shall be completed such that they are fully operational no later than July 16 of License Year 11. Agencies acknowledge the 6.5 month construction window may be negatively impacted or delayed by weather and river conditions or ability to procure materials.

Should the Agencies determine additional studies are warranted, the Licensee shall undertake them in License Year 10. Consultation with the Agencies on the additional study design will be initiated promptly following notification of additional study requirement and no later than February 15 of License Year 10, with the study initiated, completed, and reported on no later than December 31 of License Year 10. Based on study results, the Licensee shall decide on an Agency-approved preferred method of upstream permanent passage no later than January 31 of License Year 11. The Licensee shall initiate design consultation with the Agencies for permanent upstream eel passage facilities no later than February 1 of License Year 11, and complete final design plans no later than December 31 of License Year 11. Construction of permanent upstream eel passage facilities approved by the Agencies shall be completed such that they are fully operational no later than July 16 of License Year 12. Parties acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.4.2-1.

3.4.3 Upstream Anadromous Fish Passage

No later than July 16 of License Year 7, the Licensee shall assess if the physical configuration of the collection gallery below the powerhouse could trap American shad. If trapping conditions exist, the Licensee shall identify a solution in consultation with, and requiring approval by, the Agencies. The approved solution shall be fully implemented no later than April 7 of License Year 9.

The Licensee shall design and implement improvements to the public viewing window and counting room. The Licensee shall initiate design consultation with the Agencies during License Year 4, complete final designs by December 31 of License Year 4, initiate the improvements in License Year 5, and complete the improvements no later than April 1 of License Year 6.

The Licensee shall undertake a hydraulic study and engineering assessment of the existing Vernon fish ladder to inform potential modifications for improved effectiveness for American shad passage (this is the same hydraulic study discussed under section 3.4.2). The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective fish ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The Licensee shall initiate consultation with the Agencies on design of the hydraulic study and scope of the engineering assessment no later than November 15 of License Year 2. The Licensee shall initiate the study no later than July 16 of License Year 3, and complete and report on the study no later than December 31 of License Year 4. The Licensee will use results of the study to develop design modifications to improve shad passage through the Project. The Licensee shall initiate design consultation with the Agencies no later than January 1 of License Year 4 and complete final design plans (sufficient for construction bid purposes) no later than July 15 of License Year 5. The Licensee shall initiate approved shad ladder modifications by July 16 of License Year 5 and complete modifications no later than April 6 of License Year 6. Modifications shall be fully operational no later than April 7 of License Year 6.

The Licensee shall make any necessary repairs to the existing fish trap to achieve full functionality. Fish trap repairs shall be initiated in License Year 8 and completed no later than December 31 of License Year 9.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.4.3-2.

3.5 Fish Passage and Protection Measures at the Bellows Falls Project

The Licensee shall construct, operate, maintain, and evaluate the effectiveness of fish passage and protection facilities for Targeted Migrants at the Bellows Falls Project.

3.5.1 Downstream Passage and Protection

In License Years 3 and 4, the Licensee shall undertake a hydraulic study or a suitable alternative, designed to inform downstream passage/design options to achieve safe, timely, and effective passage for American eel. The Licensee shall initiate consultation with the Agencies on study design no later than January 1 of License Year 6, and complete and report on the study no later than December 31 of License Year 7. The Licensee will use results of the study to develop supplemental or additional operational and/or structural passage and protection measures at the dam and/or in the canal. The Licensee shall initiate design consultation with the Agencies no later than January 1 of License Year 8, and complete final design plans (sufficient for construction bid purposes) no later than December 31 of License Year 9. The Licensee shall initiate construction of approved eel passage and protection measures no later than July 16 of License Year 10 and complete construction by December 31 of License Year 11. Approved structural facilities and/or operational measures shall be fully operational no later than August 1 of License Year 12.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.5.1-1.

3.5.2 Upstream American Eel and Sea Lamprey Passage

3.5.2.1 Within Ladder Measures for Eel and Lamprey Passage for the period April 1 through July 15

The Licensee shall monitor eel and lamprey fish ladder use from April 1 through July 15 during License Years 2 and 3.

In License Year 4 the Licensee shall undertake a study using PIT technology to assess passage performance of American eel and sea lamprey within the Bellows Falls fish ladder. The Licensee shall initiate design consultation with the Agencies on the PIT study no later than September 1 of License Year 3. The Licensee shall initiate the field study no later than May 1 of License Year 4; and complete and report on the study no later than December 31 of License Year 4. Should the Agencies deem results of the monitoring or PIT-tag study insufficient to determine where passage impediments occur within the Bellows Falls ladder, the study design will be modified through consultation with the Agencies (e.g., additional PIT antennas deployed or moved to different locations) and an additional year of study will take place in License Year 5.

Should the Agencies determine that hydraulic-based impediments to passage exist within the fish ladder based on results from the PIT-tag study, the Licensee shall undertake a hydraulic study and engineering assessment of the existing Bellows Falls fish ladder to inform potential modifications for improved effectiveness for passage of American eel and/or sea lamprey. The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective eel and/or sea lamprey ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The study and assessment shall be developed in consultation with the Agencies. The Licensee shall initiate consultation with the Agencies on the hydraulic study design and scope of engineering assessment no later than July 16 of License Year 5; and complete and report on the study no later than December 31 of License Year 6.

The Licensee will use results of these studies to develop design alternatives to improve eel and/or lamprey passage through the ladder for the period April 1 through July 15. The Licensee shall initiate design consultation with the Agencies no later than January 1 of License Year 7 and complete final design plans (sufficient for construction bid purposes) no later than July 15 of License Year 8. Approved eel/lamprey ladder modifications shall be completed by the Licensee no later than April 6 of License Year 9 and be fully operational no later than April 7 of License Year 9. These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies, and date of commencing operation shall be extended 1 year if an additional year of PIT tag study is performed.

3.5.2.2 Within Ladder Interim Measures for Eels for the period July 16 through November 15

The Licensee shall design, construct, operate, and maintain interim (possibly temporary) measures approved by the Agencies to pass American eels upstream for the period July 16 through November 15. The interim upstream eel passage facility shall consist of an eel ramp-trap, or similar design, as specified in USFWS Design Criteria (USFWS 2019). The eel ramp-trap will be located below the station, potentially within or near the entrance to the existing fish ladder at a location to be determined in consultation with the Agencies. The Licensee shall initiate design consultation for temporary upstream eel passage facilities with the Agencies no later than July 16 of License Year 2 and complete final design plans no later than December 31 of License Year 3. The Licensee shall complete construction no later than July 15 of License Year 4 and approved interim upstream eel passage facilities shall be fully operational no later than July 16 of License Year 4. Interim eel passage facilities shall be operated annually until dedicated upstream eel passage facilities are operational. The first two years of interim passage operation will include monitoring and reporting eel use and upstream passage. Based on the results of the monitoring, if the interim measure does not appear to pass eels in anticipated and consistent numbers, the Licensee will discuss next steps with the Agencies such as further monitoring and/or adjustment to the interim measure (e.g., location or design).

3.5.2.3 Permanent Upstream Eel Passage Measures for the period July 16 through November 15

Based on the PIT and hydraulic studies required pursuant to Section 3.5.2.1, ladder monitoring results, and upstream temporary eel passage data, the Licensee shall initiate consultation with the Agencies no later than July 1 in License Year 9 to determine whether existing information is sufficient to identify necessary locations for permanent upstream eel passage measures for the period July 16 through November 15 (i.e., via the temporary means, alternate permanent ramps or via the fish ladder), or if additional studies are needed.

Should the Agencies determine additional studies are not warranted, the Licensee shall select, subject to approval by the Agencies, the preferred method of upstream permanent passage no later than January 31 of License Year 10. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 10, and complete final design plans no later than December 31 of License Year 10. The Licensee shall complete construction of approved permanent upstream eel passage facilities such that they are fully operational no later than July 16 of License Year 11. Agencies acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

Should the Agencies determine additional studies are warranted, the Licensee shall undertake them in License Year 10. The Licensee shall initiate consultation with the Agencies on the design of additional studies no later than February 15 of License Year 10. Results shall be provided to the Agencies by December 31 of License Year 10. Based on study results, the Licensee shall decide on an Agency-approved preferred method of permanent upstream passage no later than January 31 of License Year 11. The Licensee shall initiate design consultation for permanent upstream eel passage facilities no later than February 1 of License Year 11, and complete final design plans no later than December 31 of License Year 11. The Licensee shall complete construction of approved permanent upstream eel passage facilities such that they are fully operational no later than July 16 of License Year 12. Agencies acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

3.5.2.4 Permanent Upstream Eel Passage Measures in the Bellows Falls Bypass Reach

The Licensee shall initiate consultation with the Agencies on an eel survey study plan no later than July 1 of the year the Salmon Dam is removed or License Year 6, whichever is later. The first passage season after removal of the Salmon Dam or License Year 7, whichever is later, the Licensee shall undertake the upstream eel survey between May and October to determine where juvenile eels congregate (e.g., near the fish ladder, in the tailrace, near the spillway, etc.). The Licensee will report the results and consult with the Agencies upon completion of the study and prior to initiating designs for a permanent upstream eel passage design. Should study results indicate an area of eel concentration in the vicinity of the spillway, the Licensee shall install a single upstream eel passage facility within the bypass reach.

Design of a permanent upstream eel passage facility in the bypass reach, if determined necessary by the Agencies, shall occur in consultation with, and require approval by the Agencies. The Licensee shall initiate design consultation no later than January 1 and complete final design plans no later than December 31 of the year following the results of the upstream eel survey or License Year 8, whichever is later. The Licensee shall complete construction of an approved bypass reach upstream eel passage facility no later than July 31 of the second year following completion of the upstream eel survey or License Year 9, whichever is later. Agencies acknowledge the 7 month window to construct may be negatively impacted by weather and river (spill conditions in the bypass) conditions or ability to procure materials. If the Licensee successfully completes construction by July 31 of the second year following the results of the upstream eel survey or License Year 9, whichever is later, it will immediately begin operating the permanent bypass eel passage on August 1 of that same year. Otherwise, the Licensee will operate the permanent bypass eel passage no later than May 1 of the following year (i.e., the third year following the results of the upstream eel survey or License Year 10).

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.5.2-1.

3.6 Fish Passage and Protection Measures at the Wilder Project

The Licensee shall construct, operate, maintain, and evaluate the effectiveness of fish passage and protection facilities for American eel and sea lamprey at the Wilder Project.

3.6.1 Downstream Passage and Protection

The Licensee shall undertake a hydraulic study or a suitable alternative, designed to inform downstream passage/design options to achieve safe, timely, and effective passage for American eel. The Licensee shall initiate consultation with the Agencies on study design no later than January 1 of License Year 10 and undertake, complete and report on the study no later than December 31 of License Year 11. The Licensee will use results of the study to develop alternatives to provide safe, timely, and effective passage for American eels. The Licensee shall initiate design consultation of the passage and protection system(s) with the Agencies, no later than January 1 in License Year 12 and complete final design plans (sufficient for construction bid purposes) no later than December 31 of License Year 13. The Licensee shall initiate construction of approved eel passage and protection measures no later than July 16 of License Year 14 and complete construction by December 31 of License Year 15. Approved structural facilities and/or operational measures shall be fully operational no later than August 1 of License Year 16.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.6.1-1.

3.6.2 Upstream American Eel and Sea Lamprey Passage

3.6.2.1 Within Ladder Measures for Eel and Lamprey Passage for the period April 7 through July 15

The Licensee shall monitor 2 years of eel and lamprey fish ladder use (number, timing and size estimation) from April 7 through July 15 during License Years 1 and 3. Monitoring data will be used by the Agencies to determine if fish ladder operational dates need to be adjusted to protect downstream migrants (i.e., manage the number of eels passing upstream until downstream measures in place).

During License Year 8, the Licensee shall undertake a study using PIT technology to assess passage performance of American eel and sea lamprey within the Wilder fish ladder. The Licensee shall initiate consultation with the Agencies on the PIT study design no later than September 1 of License Year 7. The Licensee shall initiate the study no later than May 1 and complete and report on the study no later than December 31 of License Year 8. Should the Agencies deem results of this study insufficient to determine where passage impediments occur within the Wilder ladder, the study design will be modified through consultation with the

Agencies (e.g., additional PIT antennas deployed or moved to different locations) and an additional year of study will take place in License Year 9.

Should the Agencies determine that hydraulic-based impediments to passage exist based on PIT study results, the Licensee shall undertake a hydraulic study and an engineering assessment of the existing Wilder fish ladder to inform potential modifications for improved effectiveness for passage of American eel and/or sea lamprey. The objectives of the hydraulic study are to determine the hydraulic conditions of the fish ladder and identify hydraulic related barriers to effective eel and/or sea lamprey ladder passage. The engineering assessment will evaluate the condition of current as-built fish ladder components. The Licensee shall initiate consultation with the Agencies on the hydraulic study design and scope of engineering assessment no later than July 16 of License Year 9 and complete and report on the study and assessment no later than December 31 of License Year 10.

The Licensee will use results of the PIT study, hydraulic study, engineering assessment, and monitoring study to develop design alternatives to improve eel and/or lamprey passage through the ladder during the upstream anadromous fish passage season. Design of ladder modification(s) shall occur in consultation with, and require approval by, the Agencies. The Licensee shall initiate design consultation no later than January 1 of License Year 11 and complete final design plans (sufficient for construction bid purposes) no later than July 15 of License Year 12. Approved eel/lamprey ladder modifications shall be completed no later than December 31 of License Year 13 and be fully operational no later than April 7 of License Year 14.

3.6.2.3 Permanent Upstream Eel Passage Measures

The Licensee shall undertake an upstream eel survey in the vicinity of the powerhouse and spillway to determine areas of eel concentration at the Project. The Licensee shall initiate study design consultation for the upstream eel survey with the Agencies no later than July 1 of License Year 7. The Licensee shall conduct the study from May through October and provide survey results to the Agencies no later than December 31 in License Year 8.

Based on the PIT and hydraulic studies required pursuant to Section 3.6.2.1, ladder monitoring results, upstream temporary eel passage data, and the upstream eel survey, the Licensee shall consult with the Agencies in License Year 11 to determine whether existing information is sufficient to identify the location for permanent upstream eel passage measures, or if additional studies are needed.

Should the Agencies determine additional studies are not warranted, the Licensee shall decide on an Agency-approved preferred method of upstream permanent passage no later than December 31 of License Year 11. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 12, and complete final design plans no later than December 31 of License Year 12. The Licensee shall complete construction of approved permanent upstream eel passage facilities (potentially consistent with eel/lamprey ladder modifications) such that they are fully operational no later than July 16 of License Year 13.

Should the Agencies determine additional studies are warranted, the Licensee shall initiate study design consultation with the Agencies no later than January 1 in License Year 12. Results shall be provided to the Agencies by December 31 of License Year 12. Based on study results, the Agencies shall decide the preferred method of permanent upstream passage no later than January 31 of License Year 13. The Licensee shall initiate design consultation for permanent upstream eel passage facilities with the Agencies no later than February 1 of License Year 13, and complete final design plans no later than December 31 of License Year 13. The Licensee shall complete construction of approved permanent upstream eel passage facilities such that they are fully operational no later than July 16 of License Year 14. Agencies acknowledge the 6.5 month window to construct may be negatively impacted by weather and river conditions or ability to procure materials.

Specific passage and protection requirements and their associated implementation schedules and operational periods are provided in Table 3.6.2-1.

3.7. Fish Passage Facilities Operations and Maintenance Plan

The Licensee shall develop and implement a Fish Passage Facilities Operations and Maintenance Plan (FOMP). The FOMP shall detail how and when the fishways will be operated and describe routine maintenance activities that will occur both during and outside of the fish passage seasons. The FOMP will include a provision to provide annual fishway Operation and Maintenance (O&M) reports that summarize the status of the fish passage facilities, identify needed repairs or equipment replacement, etc. The O&M report shall be submitted to the Agencies by January 31 annually. The FOMP shall be developed in consultation with and require approval by the Agencies prior to submitting the final FOMP to the FERC for approval. The FOMP shall be in place no later than six (6) months from the first fish passage facilities (or passage facility improvements) coming on-line, and shall be updated as needed as new passage facilities, or modifications to existing facilities, are placed into service; and based on information obtained from operation of the facilities pursuant to the annual O&M reports.

3.8 Fish Passage Facilities Effectiveness Testing

The Licensee shall conduct a shakedown assessment for each fish passage facility during the first year of operation followed by two years of representative, quantitative effectiveness studies (except as provided in Section 3.1). No later than six (6) months prior to each identified fish passage facility becoming operational, the Licensee shall file a facility-specific Passage Effectiveness Studies Plan (PESP) for Commission approval. The PESP shall be developed in consultation with and require approval by the Agencies, prior to submitting PESPs to the FERC for approval. The PESP shall detail how the constructed and operational passage facilities will be evaluated for their effectiveness at passing Targeted Migrants. Study results will be used to inform potential remedial measures to improve passage efficiency of the measures designed and constructed under this Agreement. Each PESP may be supplemented based on information obtained from operation of the facilities pursuant to the annual O&M reports and/or previous study results.

American shad performance standards upon which the results of any required effectiveness studies shall be reviewed and compared are summarized in Table 3.8-1.

Table 3.8-1. Summary of upstream and downstream performance standards for American shad passage facilities at the Vernon Project.

Facility	Efficiency	Delay
Downstream Passage and Protection	95% through-Project survival based on the number of test fish that approach within 1 km of a project area [(# passed alive/# arrive)*100].	Test fish that pass the project do so within 24 hours of arriving within 1 km of the project area.
Upstream Anadromous Passage	75% upstream efficiency based on the number of test fish that approach within 1 km of the project area [(# passed/# arrive)*100].	Test fish that pass the project do so within 48 hours of arriving within 1 km of the project area.

In addition, given regional management objectives and cumulative effects of downstream passage through multiple hydropower projects, the Agencies have a goal of 95% through-project survival for American eels.

REFERENCES

USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their duly authorized representatives as of the date first above written.

Great River Hydro, LLC

By: [signature]

Name: Scott D. Hall

Title: President & CEO

United States Fish and Wildlife Service

By: ______________________

Name: ______________________

Title: ______________________

New Hampshire Fish and Game Department

By: Scott R. Mason

Name: Scott R. Mason

Title: Director, New Hampshire Fish and Game

Vermont Department of Fish and Wildlife

By: [signature]

Name: Christopher A. Herrick

Title: Commissioner, Vermont Fish & Wildlife

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their duly authorized representatives as of the date first above written.

Great River Hydro, LLC

By: ______________________

Name: ____________________

Title: ____________________

United States Fish and Wildlife Service

By: DAVID SIMMONS Digitally signed by DAVID SIMMONS Date: 2022.07.15 14:03:45 -04'00'

Name: David Simmons

Title: Acting Supervisor, New England Field Office

New Hampshire Fish and Game Department

By: Scott R. Mason

Name: Scott R. Mason

Title: Director, New Hampshire Fish and Game

Vermont Department of Fish and Wildlife

By: [signature]

Name: Christopher A. Herrick

Title: Commissioner, Vermont Fish & Wildlife

APPENDIX A

FISH PASSAGE IMPLEMENTATION TABLES

Table 3.4.1-1. VERNON DOWNSTREAM PASSAGE & PROTECTION				
Item	**Measure**	**Implementation Schedule**	**Operation Period**	**Effectiveness Studies**
1	Hydraulic study above the dam to inform downstream passage design/options.	• Initiate Study Design Consultation NLT 1/1 of License Year 2. • Initiate and Complete Study NLT 12/31 in License Year 3.		
2	Design, construct, operate, maintain, and study effectiveness of measures to pass eels and alosines downstream.	• Design consultation initiated by 7/1 of License Year 3; design completed NLT 12/31 License Year 4. • Initiate construction/modifications (mods) in License Year 5 and complete no later than Dec. 31 of License Year 6. • Operate no later than April 7 of License Year 7.	April 7 to December 1[A]	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Downstream passage initiated concurrent with upstream passage for shad. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.

B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating as designed.

C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.

D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.4.2-1. VERNON UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
3a	Undertake fish ladder hydraulic study.	• Initiate Study Design Consultation NLT 11/15 in License Year 2. • Initiate Study NLT 7/16 in License Year 3. • Complete Study NLT 12/31 in License Year 4.		
3b	Conduct upstream Eel/Lamprey passage study using Passive Integrated Transponder technology.	• Initiate Study Design Consultation NLT 7/1 in License Year 3. • Conduct PIT study from May through July 15 in License Year 4 (during License Year 5, if needed).	May 1 to July 15	
3c	Design, construct, operate, maintain, and study effectiveness of permanent upstream ladder improvement measures to pass eels and lamprey upstream.	• Initiate design consultation in License Year 4 and complete design consultation NLT 7/15 in License Year 5. • Initiate construction of permanent upstream ladder improvement measures NLT 7/16 in License Year 5 and complete improvement measures NLT 4/6 in License Year 6. • Operate permanent upstream ladder improvement measures NLT 4/7 in License Year 6. • All deadlines stated above extended 1 year if additional study under 3b required in License Year 6.	May 1 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).
4a	Design, construct, operate, maintain, and monitor interim, possibly temporary, measures to pass eels upstream after the anadromous passage season.	• Initiate design consultation in License Year 2. • Complete construction of interim eel passage measures NLT 7/15 in License Year 3. • Operate interim eel passage measures NLT 7/16 in License Year 3.	July 16 to November 15	Yr 1: shakedown.[B]

Table 3.4.2-1. VERNON UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period**[A]	**Effectiveness Studies**
4b	Permanent upstream eel passage outside of anadromous passage season.	• Consultation and determination on need for additional studies regarding permanent eel passage measures initiated NLT 7/1 in License Year 9 and completed NLT 1/31 in License Year 10. • If no additional studies required: ○ Design Consultation initiated 2/1 of License Year 10 and Completed by 12/31 in License Year 10. ○ Complete construction NLT 7/15 in License Year 11. ○ Operate measure NLT 7/16 in License Year 11. • If additional studies are required: ○ Study design consultation initiated NLT 2/15 in License Year 10 and completed NLT 1/1 in License Year 11. ○ Initiate design consultation in February of License Year 11 and complete design consultation by 12/31 in License Year 11. ○ Complete construction of permanent upstream eel passage measures NLT 7/15 in License Year 12. ○ Operate permanent eel passage measure NLT 7/16 in License Year 12.	July 16 – November 15	

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.4.3-2. VERNON UPSTREAM ANADROMOUS				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
5a	Evaluate whether fish are trapped behind collection gallery below powerhouse.	Complete by 7/16 in License Year 7.		
5b	Design and implement solution if fish are trapped behind collection gallery.	Construct or implement mitigation solutions NLT 12/31 in License Year 8 in order to have no issues during the fish passage season starting 4/7 in License Year 9.	April 7 to July 15	
6	Design and implement improvements to counting window and room.	• Design Consultation initiated in License Year 4 and completed by 12/31 in License Year 4. • Initiate construction of improvements during License Year 5 and complete NLT 4/1 in License Year 6. • All improvements in place to operate and function NLT 4/7 in License Year 6.		
7a	Undertake fish ladder hydraulic study and engineering assessment.	• Initiate Study Design Consultation NLT 11/15 in License Year 2. • Initiate study and assessment NLT 7/16 in License Year 3. • Complete Study NLT 12/31 in License Year 4.		
7b	Additional fish ladder modifications (mods): consult/design, install, operate, maintain, and study effectiveness of mods.	• Initiate design consultation in License Year 4 and complete design consultation NLT 7/15 in License Year 5. • Construct additional ladder modifications NLT 7/16 in License Year 5 and complete NLT 4/6 in License Year 6. • Operate additional ladder modifications NLT 4/7 in License Year 6.	April 7 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).
7c	Fish trap repair.	Initiate overhaul of Vernon Fish ladder trapping facility in License Year 8 and complete overhaul NLT 12/31 in License Year 9.		

A. Actual dates of operation are based on passage of fish at the previous downstream fishway. Vernon ladder shall be operational within three days of the Turners Falls fishways being opened.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.5.1-1. BELLOWS FALLS DOWNSTREAM PASSAGE & PROTECTION				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
8a	Hydraulic study above the dam to inform downstream passage design/options.	• Initiate Study Design Consultation NLT 1/1 of License Year 6. • Initiate and Complete Study NLT 12/31 of License Year 7.		
8b	Design, construct, operate, maintain, and study effectiveness of measures to pass eels downstream.	• Design consultation initiated NLT 1/ 1 of License Year 8; design completed NLT 7/15 of License Year 10. • Initiate construction/modifications (mods) NLT 7/16 in License Year 10 and complete no later than 12/31 of License Year 11. • Operate no later than 4/7 of License Year 12.	August 1 to December 1	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/modifications made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/modifications made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.5.2-1. BELLOWS FALLS UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
9a	Monitor fish ladder use by American eel (eel) and Sea Lamprey (lamprey).	Monitor during License Years 2 and 3.	May 1 – July 15	
9b	Upstream eel/lamprey passage studies (PIT tag study of ladder).	• Initiate Study Design Consultation NLT 9/1 in License Year 3. • Conduct PIT study from May through July 15 in License Year 4 (during License Year 5, if needed).	May 1 to July 15	
9c	Undertake fish ladder hydraulic study and engineering assessment, if necessary.	• Initiate Study Design Consultation NLT 7/16 in License Year 5. • Conduct study and assessment NLT 12/31 in License Year 6.		
9d	Consultation, design, and construction of upstream fish ladder modifications for eel and lamprey during the anadromous fish passage season.	• Initiate design consultation in License Year 7 and complete design consultation NLT 7/15 in License Year 8. • Construct permanent upstream ladder improvement measures NLT 7/16 in License Year 8 and complete NLT 4/6 in License Year 9. • Operate permanent upstream ladder improvement measures NLT 4/7 in License Year 9. • All deadlines stated above extended 1 year if additional study under 9b required in License Year 5.	May 1 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).
10a	Design, construct, operate, maintain, and monitor interim, possibly temporary, measures to pass eels upstream after the anadromous passage season (excluding the bypass reach).	• Initiate design consultation NLT 7/16 in License Year 2 and complete design consultation NLT 12/31 in License Year 3. • Complete construction of interim eel passage measures NLT 7/15 in License Year 4. • Operate interim eel passage measures NLT 7/16 in License Year 3.	July 16 to November 15 (until permanent measures become operational)	

Table 3.5.2-1. BELLOWS FALLS UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
10b	Permanent upstream eel passage outside of anadromous passage season (excluding the bypass reach).	• Consultation and determination on need for additional studies regarding permanent eel passage measures initiated NLT 7/1 in License Year 9 and completed NLT 1/31 in License Year 10; • If no additional studies required: ○ Design consultation initiated 2/1 of License Year 10 and completed by 12/31 in License Year 10 ○ Complete construction NLT 7/15 in License Year 11 ○ Operate measure NLT 7/16 in License Year 11 • If additional studies are required: ○ Study design consultation initiated NLT 2/15 in License Year 10 and completed NLT 1/1 in License Year 11 ○ Initiate design consultation in February of License Year 11 and complete design consultation by 12/31 in License Year 11 ○ Complete construction of permanent upstream eel passage measures NLT 7/15 in License Year 12 ○ Operate permanent eel passage measure NLT 7/16 in License Year 12	July 16 to November 15	
10c	Undertake upstream eel survey in bypass reach.	• Study design consultation initiated NLT 7/1 in License Year 6 or year fish barrier dam is removed, whichever is later. • Conduct eel survey study from May through October in License Year 7 or in first year following barrier dam removal, whichever is later.	May 1 to November 15	

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.5.2-1. BELLOWS FALLS UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE (cont'd)				
Item	Measure	Implementation Schedule	Operation Period[A]	Effectiveness Studies
10d	Consultation, design, and construction of additional upstream eel passage facilities in bypass reach.	• Initiate design consultation in February of License Year 8 and complete design consultation by 12/31 in License Year 8 or the year following the completion of the eel survey study, whichever is later. • Complete construction of permanent upstream eel passage measure in bypass NLT 7/31 in License Year 9 or in the second year following the completion of the eel survey study, whichever is later. • If the Licensee successfully completes construction by 7/31 of the second year following the results of the upstream eel survey or License Year 9, whichever is later, it will immediately begin operating the permanent bypass eel passage on August 1 of that same year. Otherwise, the Licensee will operate the permanent bypass eel passage NLT 5/1 of the following year.	May 1 to November 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.6.1-1. WILDER DOWNSTREAM PASSAGE & PROTECTION				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
11a	Hydraulic study above the dam to inform downstream passage design/options	• Initiate study design consultation NLT 1/1 of License Year 10. • Initiate and complete study NLT 12/31 of License Year 11.		
11b	Design, construct, operate, maintain, and study effectiveness of measures to pass eels downstream.	• Design consultation initiated NLT 1/1 of License Year 12; design completed NLT 12/31 of License Year 13. • Initiate construction/modifications (mods) NLT 7/16 in License Year 14 and complete NLT 12/31 of License Year 15. • Operate NLT 8/1 of License Year 16.	August 1 to December 1	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.6.2-1. WILDER UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
12a	Monitor fish ladder use by American eel (eel) and Sea Lamprey (lamprey).	Monitor during License Years 1 and 3.	April 7 to July 15	
12b	Upstream eel/lamprey passage studies (PIT tag study of ladder).	• Initiate study design consultation NLT 9/1 in License Year 7. • Conduct PIT study from May through July 15 in License Year 8 (during License Year 9, if needed).	April 7 to July 15	
12c	Undertake fish ladder hydraulic study and engineering assessment, if necessary.	• Initiate study design consultation NLT 7/16 in License Year 9. • Conduct study and assessment NLT 12/31 in License Year 10.		
12d	Consultation, design, and construction of upstream fish ladder modifications for eel and lamprey during the anadromous fish passage season.	• Initiate design consultation in License Year 11 and complete design consultation NLT 7/15 in License Year 12. • Construct permanent upstream ladder improvement measures NLT 7/16 in License Year 12 and complete NLT 12/31 in License Year 13. • Operate permanent upstream ladder improvement measures NLT 4/7 in License Year 14. • All deadlines stated above extended 1 year if additional study under 12b required in License Year 9.	May 1 to July 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

Table 3.6.2-1. WILDER UPSTREAM AMERICAN EEL & SEA LAMPREY PASSAGE (cont'd)				
Item	**Measure**	**Implementation Schedule**	**Operation Period[A]**	**Effectiveness Studies**
13a	Undertake upstream eel survey in the vicinity of the powerhouse and along the spillway.	• Eel survey study design consultation initiated NLT 7/1 in License Year 7. • Conduct eel survey study from May through October in License Year 8.	May 1 to November 15	
13b	Consultation, design, and construction of dedicated upstream eel passage facilities.	• Consultation and determination on need for additional studies regarding dedicated eel passage measures initiated NLT 7/1 in License Year 11 and completed NLT 12/31 in License Year 11. • If no additional studies required: ○ Design consultation initiated 2/1 of License Year 12 and completed by 12/31 in License Year 12. ○ Complete construction NLT 7/15 in License Year 13. ○ Operate measures NLT 7/16 in License Year 13. • If additional studies are required: ○ Initiate study design consultation NLT 1/1 in License Year 12 and complete study NLT 12/31 in License Year 12. ○ Initiate design consultation in February of License Year 13 and complete design consultation by 12/31 in License Year 13. ○ Complete construction of permanent upstream eel passage measures NLT 7/15 in License Year 14. ○ Operate permanent eel passage measures NLT 7/16 in License Year 14.	May 1 to November 15	Yr 1: shakedown[B]; Yr 2: quantitative effectiveness study[C]; Yr 3: additional study year, if needed (i.e., Yr 2 anomalous[D], incomplete, etc. or issues found/mods made); Yr 4: additional study year, if needed (Yr 3 anomalous, incomplete, etc. or issues found/mods made).

A. Future refinement of the timing may be made by the Agencies as information on the behavior of migrants at the Project is documented.
B. Shakedown refers to assessing whether all components of the upstream fish passage facility are operating correctly.
C. Quantitative effectiveness studies are based on a study design that allows for numeric, objective assessments of data collected.
D. Anomalous conditions are those outside the bounds of 25th to 75th percentile conditions for a given parameter (e.g., flow, temperature, etc.).

APPENDIX B

PROJECT SPECIFIC FISH PASSAGE IMPLEMENTATION CHART

Appendix B - Project Specific Fish Passage Implementation Chart

Project and Fish Passage Mitigation Measure	License Issue Year 0	LICENSE YEAR (Year Following License Issuance or Year 0) 1	2	3	4	5	6	7	8
VERNON	*MONITOR*	*STUDY*	*DESIGN*	*CONSTRUCT*	*OPERATE*				
3.4.2.1 Design and Complete Vernon Ladder Hydraulic Study for eels/lamprey (NLT): design, perform, report			Initiate study design NLT 11/15 Y2	Initiate study NLT 7/16 Y3	complete NLT 12/31 Y4				
3.4.3 Hydraulic and Engineering Assessment of Ladder - shad passage same as 3.2.2.1									
3.4.2.1 Complete Vernon Ladder PIT Study for eels/lamprey: design, perform, and report				Initiate study design NLT 7/1 Y3	complete NLT 12/31 Y4*				
3.4.2.1 Design Consultation and Final Design on Upstream ladder passage measures					Initiate Y4	Complete NLT 7/15 Y5			
3.4.3.1 Design Consultation and Final Design - shad related ladder passage measures					Initiate 1/1 Y4	Complete NLT 7/15 Y5			
3.4.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements						Initiate NLT 7/16 Y5	Complete NLT 4/6 Y6		
3.4.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS							NLT 4/7 Y6		
3.4.3 Construction of Permanent Upstream Ladder shad related measures						Initiate NLT 7/16 Y5	Complete NLT 4/6 Y6		
3.4.3.1 OPERATE PERMANENT UPSTREAM SHAD LADDER IMPROVEMENTS							NLT 4/7 Y6		
3.4.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)			initiate NLT 1/1 complete NLT 12/31 Y2						
3.4.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)				complete NLT 7/15 Y3					
3.4.2.2 OPERATE & MONITOR INTERIM UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS				NLT 7/16 Y3					
3.4.2.3 Study info determination for permanent eel passage measures (7/16-11/15)									
3.4.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.4.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.4.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE 7/16-11/15									
3.4.2.3 IF FURTHER STUDY: Design, Perform and Report additional study									
3.4.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.4.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.4.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.4.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report			initiate study design NLT 1/1 Y2	complete & report on study NLT 12/31 Y3					
3.4.1 Design Consultation and Final Design on Downstream passage measures				Initiate NLT 7/1 Y3	complete NLT 12/31 Y4				
3.4.1. Construction of Shad/Eel Downstream measures						Initiate Y5	complete NLT 12/31 Y6		
3.4.1 OPERATE PERMANENT DOWNSTREAM SHAD/EEL MEASURES								NLT 4/7 Y7	
3.4.3 Complete overhaul and repairs to existing fish trap									Initiate Y8
3.4.3 Evaluate, determine and report if fish are trapped behind collection gallery								Complete NLT 7/16 Yr 7	
3.2.3 IF TRAPPED: Implement Prevention Solution									complete NLT 12/31 Y8
3.4.3 Design improvements to public viewing and counting windows					complete NLT 12/31 Y4				
3.4.3 Make and complete improvements to public viewing and counting windows						Initiate Y5	complete NLT 4/1 Y6		
3.4.3 Complete improvements to public viewing and counting windows							NLT 4/7 Y6		
BELLOWS FALLS	*MONITOR*	*STUDY*	*DESIGN*	*CONSTRUCT*	*OPERATE*				
3.5.2.1 Monitor eel and lamprey fish ladder use			4/1 - 7/15 Y2	4/1 - 7/15 Y3					
3.5.2.1 Complete Bellows Falls Ladder PIT Study for eels/lamprey: design, perform, report				Initiate study design NLT 9/1 Y3	complete NLT 12/31 Y4*				
3.5.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey if needed						Initiate NLT 7/16 Y5	complete NLT 12/31 Y6		
3.5.2.1 Design Consultation and Final Design on Upstream ladder passage measures								Initiate NLT 1/1 Y7	complete NLT 7/15 Y 8
3.5.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements									Initiate NLT 7/16 Y8
3.5.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS									
3.5.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)			Initiate NLT 7/16 Y2	complete NLT 12/31 Y3					
3.5.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)					complete NLT 7/15 Y 4				
3.5.2.2 OPERATE INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)					NLT 7/16 Y4				
MONITOR INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)					7/16-11/15	7/16-11/15			
3.5.2.4 Survey Bypass Reach for where juvenile eels congregate 1 Yr after barrier dam is out: design, perform, report							Initiate Survey design NLT 7/1 Y6	Initiate study May - Oct Y7 Earliest	
3.5.2.4 Consultation and Finalize Design for permanent bypass reach eel passage facility									initiate NLT 1/1 complete NLT 12/31 Y8 Earliest
3.5.2.4 Construction of permanent bypass reach eel passage facility									
3.5.2.4 OPERATE PERMANENT BYPASS EEL PASSAGE (end of spring runoff-11/15)									
3.5.2.3 Study info determination for permanent eel passage measures (7/16-11/15)									
3.5.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.5.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.3.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.5.2.3 IF FURTHER STUDY: Design, Perform and Report additional study									
3.5.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.5.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.5.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.5.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report							initiate study design NLT 1/1 Y6	complete NLT 12/31 Y7	
3.5.1 Design Consultation and Final Design on Downstream passage measures									Initiate NLT 1/1 Y8
3.5.1. Construction of Eel Downstream measures									
3.5.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES									
WILDER	*MONITOR*	*STUDY*	*DESIGN*	*CONSTRUCT*	*OPERATE*				
3.6.2.1 Monitor eel and lamprey fish ladder use		4/7 - 7/15		4/7 - 7/15					
3.6.2.1 Complete Wilder Ladder PIT Study for eels/lamprey (NLT): design, perform, report								Initiate study design NLT 9/1 Y7	Complete NLT 12/31 Y8*
3.6.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey (NLT) if needed: design, perform, report									
3.6.2.1 Design Consultation and Final Design on Upstream ladder passage measures									
3.6.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements									
3.6.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS									
3.6.2.3 Survey tailrace and spillway for where juvenile eels congregate: design, perform, report								Survey design initiate NLT 7/1 Y7	Complete NLT 12/31 Y8
3.6.2.3 Study info determination for permanent eel passage measures (7/16-11/15)									
3.6.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.6.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.6.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.6.2.3 IF FURTHER STUDY: Design, Perform and Report additional study									
3.6.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)									
3.6.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)									
3.6.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)									
3.6.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report									
3.6.1 Design Consultation and Final Design on Downstream passage measures									
3.6.1. Construction of Eel Downstream measures									
3.6.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES									

*These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies and date of commencing operation shall be extended 1 year if an additional year of PIT study is necessary.

Appendix B - Project Specific Fish Passage Implementation Chart

Project and Fish Passage Mitigation Measure	LICENSE YEAR (Year Following License Issuance or Year 0)							
	9	10	11	12	13	14	15	16
VERNON								
3.4.2.1 Design and Complete Vernon Ladder Hydraulic Study for eels/lamprey (NLT): design, perform, report								
3.4.3 Hydraulic and Engineering Assessment of Ladder - shad passage same as 3.2.2.1								
3.4.2.1 Complete Vernon Ladder PIT Study for eels/lamprey: design, perform, and report								
3.4.2.1 Design Consultation and Final Design on Upstream ladder passage measures								
3.4.3.1 Design Consultation and Final Design - shad related ladder passage measures								
3.4.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements								
3.4.2.1 **OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS**								
3.4.3 Construction of Permanent Upstream Ladder shad related measures								
3.4.3.1 **OPERATE PERMANENT UPSTREAM SHAD LADDER IMPROVEMENTS**								
3.4.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)								
3.4.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)								
3.4.2.2 **OPERATE & MONITOR INTERIM UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS**								
3.4.2.3 Study info determination for permanent eel passage measures (7/16-11/15)	*Consult: initiate NLT 7/1/ Y9*	*Complete NLT 1/31 Y10*						
3.4.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)		*Initiate NLT 2/1 complete NLT 12/31 Y10*						
3.4.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)			*complete NLT 7/15 Y11*	*Complete by 7/15 if needed*				
3.4.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE 7/16-11/15			*NLT 7/16 Y11*					
3.4.2.3 IF FURTHER STUDY: Design, Perform and Report additional study		*Initiate NLT 2/15 complete by NLT 12/31 Y10*						
3.4.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)			*Initiate NLT 2/1 complete NLT Dec 31 Y11*					
3.4.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)				*complete NLT 7/15 Y12*	*Complete by 7/15 if needed*			
3.4.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)				*NLT 7/16 Y12*				
3.4.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report								
3.4.1 Design Consultation and Final Design on Downstream passage measures								
3.4.1. Construction of Shad/Eel Downstream measures								
3.4.1 OPERATE PERMANENT DOWNSTREAM SHAD/EEL MEASURES								
3.4.3 Complete overhaul and repairs to existing fish trap	*Complete NLT 12/31 Y9*	*NLT 4/7 Y10*						
3.4.3 Evaluate, determine and report if fish are trapped behind collection gallery								
3.2.3 IF TRAPPED: Implement Prevention Solution	*NLT 4/7 Y9*							
3.4.3 Design improvements to public viewing and counting windows								
3.4.3 Make and complete improvements to public viewing and counting windows								
3.4.3 Complete improvements to public viewing and counting windows								
BELLOWS FALLS								
3.5.2.1 Monitor eel and lamprey fish ladder use								
3.5.2.1 Complete Bellows Falls Ladder PIT Study for eels/lamprey: design, perform, report								
3.5.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey if needed								
3.5.2.1 Design Consultation and Final Design on Upstream ladder passage measures								
3.5.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements	*Complete NLT 4/6 Y9*							
3.5.2.1 **OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS**	*NLT 4/7 Y9*							
3.5.2.2 Design Consultation and Final Design for Interim In-ladder eel passage (7/16-11/15)								
3.5.2.2 Construction of Interim In-ladder eel passage (7/16-11/15)								
3.5.2.2 **OPERATE INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)**								
MONITOR INTERIM IN-LADDER EEL PASSAGE (7/16-11/15)								
3.5.2.4 Survey Bypass Reach for where juvenile eels congregate 1 Yr after barrier dam is out: design, perform, report								
3.5.2.4 Consultation and Finalize Design for permanent bypass reach eel passage facility								
3.5.2.4 Construction of permanent bypass reach eel passage facility	*complete NLT 7/31 Y9 Earliest*							
3.5.2.4 OPERATE PERMANENT BYPASS EEL PASSAGE (end of spring runoff-11/15)	*Y9 Earliest if operational before 8/1*	*If needed NLT 5/1 Y10 Earliest*						
3.5.2.3 Study info determination for permanent eel passage measures (7/16-11/15)	*Consult: initiate NLT 7/1/ Y9*	*Complete NLT 1/31 Y10*						
3.5.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)		*Initiate NLT 2/1 complete NLT 12/31 Y10*						
3.5.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)			*complete NLT 7/15 Y11*	*complete by 7/15 if needed*				
3.3.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)			*NLT 7/16 Y11*					
3.5.2.3 IF FURTHER STUDY: Design, Perform and Report additional study		*Initiate NLT 2/15 complete NLT 12/31 Y10*						
3.5.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)			Initiate NLT 2/1 complete NLT 12/31 Y11					
3.5.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)				*complete NLT 7/15 Y12*	*complete by 7/15 if needed*			
3.5.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)				*NLT 7/16 Y12*				
3.5.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report								
3.5.1 Design Consultation and Final Design on Downstream passage measures	*complete NLT 12/31 Y9*							
3.5.1. Construction of Eel Downstream measures		*Initiate NLT 7/16 Y10*	*complete NLT 12/31 Y11*					
3.5.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES				*NLT 8/1 Y12*				
WILDER								
3.6.2.1 Monitor eel and lamprey fish ladder use								
3.6.2.1 Complete Wilder Ladder PIT Study for eels/lamprey (NLT): design, perform, report								
3.6.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey (NLT) if needed: design, perform, report	*Initiate NLT 7/16 Y9*	*complete NLT 12/31 Y10*						
3.6.2.1 Design Consultation and Final Design on Upstream ladder passage measures			*Initiate NLT 01/01 Y11*	*complete NLT 7/15 Y12*				
3.6.2.1. Construction of Permanent Upstream Eel/Sea Lamprey Ladder improvements				*Initiate NLT 7/16 Y12*	*Complete NLT 12/31 Y13*			
3.6.2.1 OPERATE PERMANENT UPSTREAM EEL/SEA LAMPREY LADDER IMPROVEMENTS						*NLT 4/7 Y14*		
3.6.2.3 Survey tailrace and spillway for where juvenile eels congregate: design, perform, report								
3.6.2.3 Study info determination for permanent eel passage measures (7/16-11/15)			*Consult and Determination NLT 12/31 Y11*					
3.6.2.3 IF NO FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)				*Initiate NLT 2/1 complete NLT 12/31 Y12*				
3.6.2.3 IF NO FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)					*complete NLT 7/15 Y13*			
3.6.2.3 IF NO FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)					*NLT 7/16 Y13*			
3.6.2.3 IF FURTHER STUDY: Design, Perform and Report additional study				*initiate NLT 1/1 complete NLT 12/31 Y12*				
3.6.2.3 IF FURTHER STUDY: Design for permanent eel passage systems (7/16-11/15)					*Initiate NLT 2/1 complete NLT 12/31 Y13*			
3.6.2.3 IF FURTHER STUDY: Construction of Permanent eel passage (7/16-11/15)						*complete NLT 7/15 Y14*		
3.6.2.3 IF FURTHER STUDY: OPERATE PERMANENT EEL PASSAGE (7/16-11/15)						*NLT 7/16 Y14*		
3.6.1 Hydraulic Study or Alternative above dam for downstream passage: design, perform, report		*initiate study design NLT 1/1 Y10*	*complete NLT 12/31 Y11*					
3.6.1 Design Consultation and Final Design on Downstream passage measures				*Initiate NLT 1/1 Y12*	*complete NLT 12/31 Y13*			
3.6.1. Construction of Eel Downstream measures						*Initiate NLT 7/16 Y14*	*complete NLT 12/31 Y15*	
3.6.1 OPERATE PERMANENT DOWNSTREAM EEL/SEA LAMPREY MEASURES								*NLT 8/1 Y16*

*These dates associated with initiating design consultation with the Agencies, finalizing design plans, final design approvals by the Agencies and date of commencing operation shall be extended 1 year if an additional year of PIT study is necessary.

APPENDIX C

AUTHORIZED REPRESENTATIVES OF THE PARTIES

APPENDIX C

AUTHORIZED REPRESENTATIVES OF THE PARTIES

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