Wilder 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: Wilder Hydroelectric Project
Great River Hydro, LLC
69 Milk Street; Suite 306
Westborough, MA 01581

APPLICATION FOR WILDER 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 the Application is 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 Wilder 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. 1892) 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 FERC Additional Information Request including March 15, 2021, June 24, 2021, fish passage settlement agreement August 2, 2022, the memorandum of understanding executed December 1, 2020; and many other documents related to the Project and its relicensing filed through December 13, 2024. 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) (Standards). (Standards, Section 29A-101 Applicability).

The Department held a hearing on January 16, 2025, at 5:30 PM, at the Hartford Area Career and Technology Center 1 Gifford Rd White River Junction, VT 05001, to receive oral comments. The Department also accepted written or voicemail comments through February 6, 2025. Comments were received from 32 persons, representing themselves or organizations. For additional information on the final decision, draft decision, application, and any pertinent information 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 (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, § 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, § 29A-104(d)).

4. The affected reaches of the Connecticut River have been classified as Class B(2) for all uses, as defined pursuant to 10 V.S.A. § 1252(a).

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 the Secretary determines are salmonid spawning or nursery areas important to the establishment or maintenance of the fishery resource, the dissolved oxygen (D.O.) 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 (nephelometric turbidity units) 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 "Sludge 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]Waters 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 requires that "[c]hanges to flow characteristics, physical habitat structure, and stream processes [be] 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, § 29A-304(a)). For waters classified as Class B(2) for aquatic habitat, the hydrology criteria requires 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 "the 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, § 29A-304(d)(2)).

17. The management objective for waters classified as Class B(2) for aesthetics is "[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 requires "[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 objective for waters classified as Class B(2) for boating is "[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)).

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 objective for waters classified as Class B(2) for fishing is "[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 "measures 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 roughly 407 miles long starting near the Canadian border and flows southerly through several states to the Long Island Sound. The river has a drainage area of 11,250 square miles. It flows 255 miles along the border of Vermont and New Hampshire from Canaan, Vermont to the Massachusetts border at Vernon, Vermont.

22. The Connecticut River has long been used for various economic purposes, including for large log drives from the 1800s through approximately 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 U.S. Army Corps of Engineers flood control facilities.

24. The Wilder Hydroelectric Project (FERC No. 1892) is an existing licensed project located at river mile 217.4 on the Connecticut River in the towns of Hartford Vermont, and Lebanon New Hampshire. The Project is located between two major Vermont rivers, the White River located roughly 1.5 miles downstream of the Project, and the Ompompanoosuc River located roughly 7 miles upstream of the Project. The drainage area at the Project is 3,375 square miles.

25. Originally licensed in 1944 to the Bellows Falls Hydro-Electric Corporation, the Wilder Hydroelectric facility was redeveloped at a site occupied by a paper mill and hydroelectric plant. The site had been occupied since 1910 and was originally known as Olcott Falls. Wilder began operations, after reconstruction in 1950, and after the license was transferred to the New England Power Company.

26. The original license expired in 1970. The Project continued to operate on an annual license until a new license was issued in 1979. During this renewal process, FERC approved a settlement agreement between multiple parties including, the states of Massachusetts, Connecticut, New Hampshire, and Vermont, the U.S. Fish and Wildlife Service (USFWS), and four non-governmental organizations.

27. This agreement included the installation of fish passage facilities, which was completed in 1987. A minimum flow generation unit was also installed at this time. In 1990, the licensee entered into a memorandum of agreement with Connecticut River Atlantic Salmon Commission for downstream passage, which began at the Wilder Project in 1988.

28. In 1998, FERC approved a transfer of the license from New England Power Company to USGen New England, Inc. In 2005, FERC approved the transfer of the license to TransCanada Hydro Northeast Inc. In 2017, the licensee changed its name from

TransCanada Hydro Northeast LLC. to Great River Hydro, LLC. There was no legal identity change with this change in name.

B. Project and Civil Works

29. The Wilder Project area encompasses 123 acres of land. 59 acres are available to outdoor public recreation, 10 acres are currently leased to Dartmouth College, and 11 acres are made up of other lands short distances upstream and downstream on either the Vermont or New Hampshire side of the river, and the remaining acreage, roughly 43, are associated with the dam and generation facilities.

30. The dam is a concrete gravity structure that includes an earthen embankment about 400 ft long, a concrete forebay intake 208 ft, gravity spillway roughly 526 ft long and 29 ft at maximum height, followed by another earthen embankment about 180 feet long. The southern earth embankment has a maximum height of 13 ft, while the north embankment is primarily natural that has been reinforced.

31. The spillway portion of the dam contains four main sections, the skimmer gates (2), the Tainter gates (6), and stanchion flashboards (4). Each of the bays is separated by concrete piers.

32. The impoundment created by Wilder extends approximately 46 miles upstream, with an operating range elevation between 382.0 and 384.5 feet (NGVD 29). It has a total volume of 34,350 acre-feet and a usable storage of 13,350 acre-feet with the currently licensed five-foot drawdown.

33. The powerhouse consists of a steel frame with brick construction, that is 181 ft by 50 ft and 50 ft high. The powerhouse contains various electric infrastructure, a switchboard and control room. The control room is only used as backup to the Connecticut River Control Center, which is not located at Wilder. The powerhouse contains 3 generating units. The Project currently has a 35.6 MW authorized generating capacity.

34. Units 1 and 2 are Morgan Smith Kaplan adjustable blades each rating at 19 MW at 49 feet of head. Unit 3 is a Voith vertical Francis turbine measuring 3 MW at 49 feet of head. The minimum and maximum hydraulic capacity for Units 1 and 2 is roughly 1,000 cubic feet per second (cfs) to 6,000 cfs. Unit 3's hydraulic capacity ranges from 700 cfs to 3,000 cfs.

35. The trashracks for Units 1 and 2 have five-inch clear bar spacing and the trashracks located on Unit 3 have 1.625-inch clear bar spacing. The river debris is cleared off using a manually operated hydraulic rake. The debris is then transferred to a trailer for disposal.

36. There are two draft tubes that enter the powerhouse - one is directed to Unit 3 and the other is shared between Units 1 and 2. The water then leaves the units and enters a short tailrace that is built partly in the bank and partly within the river channel. Due to this short tailrace and design, there is little to no bypass at the Wilder development.

37. Unit 3 is intended to pass minimum flows at the facility in addition to providing attraction flows for the fish ladder entrance. Both Unit 3 and the fish ladder were installed in 1987.

38. Additional facilities at the Project include a garage housing maintenance equipment, an office for administrative space and support functions, and recreational spaces which include a picnic area, dam portage, and parking for fish ladder viewing and anglers.

39. The electrical facilities owned and operated by Great River Hydro include the generators and their terminals, which extends to the 13.8 KV outdoor substations, and station service transformers located inside the substation.

40. Other equipment, some of which lies within the powerhouse and within the Project boundary, are owned and operated by New England Power Company. This includes the high-voltage transmission line and substation transformers.

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

Fish Passage Infrastructure

42. The fish ladder is a concrete structure with various accessory electrical, mechanical, and pneumatic equipment. The ladder was originally designed to pass upstream migrating Atlantic salmon.

43. The main entrance weir is located at the northwest end of the powerhouse, in the tailrace area. The entrance weir is a gated entrance slot used for fish attraction away from the spillway area. Fish may congregate during high-water spill conditions.

44. Fish can enter a six-foot wide entrance with attraction flows provided by either Unit 3 while generating or a Unit 3 bypass if generation is not available. The attraction waters are not adjustable and when used are considered fully open.

45. Once in the entrance, the passage channel moves along the powerhouse to the attraction water floor diffuser between the powerhouse and the concrete dam. Fish then enter a six-foot-wide fish ladder to ascend the forebay through 58 pools, each created by a sequence of overflow weirs. Each weir is placed 10 feet apart and is 12 inches higher than the previous weir.

46. After the first 28 pools, the fish enter a counting/trapping area with a viewing window after traveling through a 3-foot wide flume. While the fish are within the counting/trapping area, they can either be trapped and moved to a holding pool, which only occurs when a pneumatic trapping gate is manually activated.

47. Once through the counting and trapping area, the fish ascend an additional 30 pools to a five-foot-wide fish ladder exit channel in the spillway area next to the

powerhouse. The final pool has widely spaced trashracks, 12 inches, and slots for wooden stop logs.

48. The head gates located at the top of the fish passage channel are either open or closed. Additionally, the last five weirs of the system are adjustable, so the facility is able to provide relatively constant flow as the forebay to the ladder changes in water surface elevation with the impoundment.

49. Downstream fish passage is provided by an existing sluiceway between Unit 3 and the fish ladder. A motorized gate is operated locally when downstream passage is needed. This gate is also operated on occasion to pass river debris or ice.

C. River Hydrology

50. 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 United States Army Corps of Engineers (USACE) flood control dams.

51. At Wilder Dam, the drainage area is 3,375 square miles. Inflow from an approximately 2,210 square miles is regulated, while inflow from a 1,165 square mile drainage area, or 34.5 percent of the total drainage is representative of unmanaged inflow.

52. Upstream of Wilder is Dodge Falls, a run-of-river facility. [1] Above Dodge Falls 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.[2]

53. Two additional FERC regulated facilities are upstream of FMF, the Gilman (FERC No. 2392) and Cannan (FERC No. 7528) hydroelectric projects. Both of which are run-of-river facilities.

54. Three additional facilities are located upstream of the Cannan project and are not FERC regulated. These facilities are located on Second Connecticut Lake, First Connecticut Lake and the Murphy dam located on Lake Francis. These facilities regulate the lakes that form the headwaters of the Connecticut River.

55. Fifteen Mile Falls continues to have peaking impacts at the Wilder facility. Project operations at the McIndoes facility takes approximately eight hours to reach Wilder

[1] 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 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.

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

Dam. Great River Hydro operates their generation facilities in conjunction with each other, which includes Fifteen Mile Falls. The degree of storage at the Fifteen Mile Falls Project provides for flow regulation on larger timeframes, up to seasonally.

56. Downstream of the Project are the Bellows Falls and Vernon hydroelectric projects, also owned by the Applicant and are concurrently undergoing relicensing. These three projects are operated together to enhance power production, which results in substantial flow regulation, primarily on an intraday and interday basis. Downstream of the Vernon Project are the Turners Falls and Holyoke Projects located in Massachusetts.

57. There are no known water withdrawals within the impoundment of the Wilder Project.

58. However, it should be noted that not all water withdrawals may be known. As of 2023, Vermont enacted a water withdrawal registration program. An individual or applicant that 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 must 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 water than New Hampshire or Vermont registration requirements, then it is likely that these locations would remain unknown.

59. There are numerous water gaging stations located on the Connecticut River and its tributaries near their confluence with the Connecticut. The gaging stations located on the Connecticut River bordering 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.

60. As noted above, the Connecticut River is highly regulated starting at the First Connecticut and Second Connecticut lakes and continuing through the Connecticut River to the boundary with the state of Massachusetts. Although the gages on the mainstem would reflect regulation, there are a number of gages in the Connecticut River watershed that are unregulated and reflect the natural hydrology. For these reasons, the natural hydrology of the Connecticut River system can be estimated with some assumptions.

61. Table 1 below reflects the hydrologic conditions of the Connecticut River in the vicinity of the Project. The first column represents an estimate of unregulated flows. The unregulated column represents the average of the unregulated gages within the watershed upstream of the Project prorated to the location of the dam. The list of gages where data was used, the drainage area in square miles and the period of record is provided in Table 2.

62. The second column in Table 1 is an estimate of the observed regulated flows above the Wilder project prorated to the dam site. The data was collected from USGS gage 01138500 at the Wells River, with a period of record from 1980-2022.

63. The last column in Table 1 are the estimated regulated flows below Wilder Dam. These data were collected from USGS gage 01144500 at West Lebanon minus the White River Flows from data collected at the USGS gage 01144000. The data was then prorated to the Wilder dam.

Table 1. Estimated unregulated and regulated monthly median and 7Q10[3] flows of the Connecticut River at the Wilder dam. Estimates vary depending on location so gages used for calculations. Data is in cubic feet per second per square mile (csm).

7Q10 or Monthly Median	Unregulated Flows Averaged (csm)	Pro-rated observed regulated flows above dam (csm)	Pro-rated observed regulated flows below dam (csm)
7Q10	0.17	0.35	0.27
January	0.79	1.44	1.29
February	0.68	1.33	1.22
March	1.09	1.89	1.80
April	4.04	3.78	3.60
May	2.68	2.48	2.36
June	1.15	1.44	1.32
July	0.61	0.99	0.89
August	0.47	0.81	0.73
September	0.47	0.73	0.65
October	0.79	1.08	1.00
November	1.27	1.64	1.51
December	1.05	1.65	1.51

Table 2. USGS gages on unregulated streams used to estimate natural monthly median and 7Q10 flow into the Connecticut River above the Wilder Project.

USGS Gage Number	USGS Gage Name	Drainage Area (square miles)	Period of Record
1127880	Big Brook ear Pittsburg, NH	6.36	1964-1984
1129300	Halls Stream near East Hereford, Quebec	85	1963-1992

[3] The 7Q10 is defined as a flow equal to the lowest mean flow for seven consecutive days that has a 10% chance of occurring in any given year.

Table 2. Continued.

USGS Gage Number	USGS Gage Name	Drainage Area (square miles)	Period of Record
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
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

64. In addition to the monthly estimates provided by the USGS gages the Applicant also developed an operations model as part of the relicensing process (study 5). This study allows for additional metrics to be estimated. This 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 understand inflow equals outflow (IEO) from the Project and develop metrics.

65. The model was then used to simulate water flows and 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 conducted the same modeling as 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 Wilder impoundment to the Wilder dam, roughly 46 miles in length. The water is then simulated to pass through the Project and discharged downstream through the Wilder riverine reach, roughly 17 miles in length. Each of the simulations were developed at an hourly timestep.

66. There are a variety of metrics that can be estimated when characterizing the downstream flow regime for an IEO. These include, but are not limited to, daily

minimum flow downstream, mean daily amplitude, and the flashiness of the reach downstream.

67. 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.

68. 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.

69. The flashiness analysis is calculated by the Richard-Baker Flashiness Index equation (Figure 1) to calculate an index value. 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 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 provided by GRH. 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.

70. While this information is not indicative of the natural flow regime, it does provide estimates of Connecticut River hydrology 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. Metrics for downstream flows below the Wilder 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	3501	850	0.02
June	3620	2377	0.04
August	4444	2155	0.03
November	5366	1771	0.02

Table 3. Continued.

Target Month and Year	Mean Minimum downstream flow	Mean daily amplitude	Flashiness
2016			
February	8440	869	0.01
June	3526	1319	0.01
August	2250	1437	0.02
November	4427	1493	0.03
2017			
February	8377	900	0.01
June	3557	1299	0.02
August	2248	1403	0.03
November	4472	1366	0.02
2015			
February	2722	693	0.02
June	8188	1278	0.01
August	2125	1749	0.04
November	3331	766	0.02

D. Current Operations

Description of current operations

71. The Wilder Hydroelectric Project has both license conditions, agreements, and self-imposed restrictions. As a license condition, the Project is required to pass a conservation flow of 675 cfs, or inflow if less, downstream. This flow is typically provided by Unit 3.

72. Project operations are automated and controlled from a consolidated hydro operations control center located in Wilder, Vermont. Great River Hydro typically operates the Project in a coordinated manner with other Great River Hydro hydroelectric generating facilities on the Connecticut River, taking into consideration variations in electricity demand as well as flow conditions in order to maximize the use of available water.

73. Reservoir drawdown rates do not exceed 0.3 feet per hour based on self-imposed restrictions. Approximately 3,000 cfs per hour equates to a 0.1 foot of elevation. Wilder is authorized to drawdown the impoundment 5 feet, from elevation 385 to elevation 380. However, normal generation ranges from 382 to elevation 384.5.

74. The Project maintains self-imposed restrictions beginning on the Friday before Memorial Day through the last weekend in September. Great River Hydro will maintain a reservoir elevation of 382.5 feet from Friday at 4 p.m. through Sunday at midnight. Great River Hydro maintains a similar elevation during summer holidays.

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

76. Flood operations include guidelines set forth in the 1949 Indenture and Flowage Easement with the Boston and Maine Railroad. The purpose is to ensure the backwater of the Wilder Project, when drawn down to elevation 380, would not exceed those impoundment elevations of the previous dam – a paper mill plant. Those flood flows are defined as those that had previously experienced 11,000 cfs to 100,000 cfs. This operation is also described as "river profile" operations. Below is a table summarizing the impoundment drawdown with anticipated inflows.

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

6- hour Inflow (cfs)	Maximum Elevation at Dam (NGVD 29)
<10,000	385
10,000	384.5
12,000	384
14,000	383
16,000	382
18,000	381
20,000	380

77. The Project spillway is designed to have a capacity to discharge 160,000 cfs at normal full pond. This value is 75 percent greater than the maximum recorded flows of 91,000 cfs, which occurred prior to the development of the U.S. Army Corps of Engineers flood control dams along the Connecticut.

78. 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

79. There are several metrics that can be calculated to characterize the hydrologic effects of 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 may occur within a day that mean monthly type metrics would otherwise obscure. Refer to findings 64-69 for specifics on how these metrics are estimated.

Impoundment

80. One metric is the amount of time the impoundment is stable at the target water surface elevation. In the case of the Wilder Project, this value is 384.5 feet (NGVD 29). Although current operations do not require a target of 384.5 feet (NGVD 29), surface elevations are maintained within a range. For the purposes of estimating this metric, a value of 384.5 feet was used. Additionally, the metric includes instances when the Project implemented river profile operations as described above. This was estimated by comparing the hourly water

surface elevation to within 0.1 feet of the target mean surface elevation and viewing it as a percentage of the entire month (Table 5).

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

Table 5. Daily metrics of current operations within the impoundment at Wilder Hydroelectric Project for the periods and months representing wet years to dry years and seasonality.

Target month and year	Percent time at target SWE	Mean daily change in impoundment
2009		
Feb	0.3	1.5
Jun	0.1	1.3
Aug	4.0	1.6
Nov	0.4	1.7
2016		
Feb	6	1.1
Jun	1	1.1
Aug	12	1.2
Nov	17	1.1
2017		
Feb	7	1.0
Jun	7	1.3
Aug	17	1.0
Nov	4	1.3
2015		
Feb	6	1.1
Jun	1	1.2
Aug	13	1.2
Nov	16	1.0

Downstream flows

82. In addition to water level fluctuation within the impoundment, the Project also regulates downstream flows in the current peaking mode of operation. Using the HEC-RAS model that allowed for estimates of water surface elevation, the Applicant also included downstream flows for current operations. There are a variety of metrics that can be estimated to characterize the downstream flow regime. These include, but are not limited, to mean daily amplitude, daily minimum flow downstream, and the flashiness of the reach downstream (findings 64-69).

83. Using the model outputs provided by the Applicant, the minimum daily flow for each target month and year were calculated. Those values are then averaged over the target month (Table 6).

84. Similarly to the methodology used to estimate the daily amplitude of downstream flows. The minimum and maximum daily flow value was first calculated. The difference between those two values were then calculated and averaged over the course of the month (Table 6).

85. The flashiness analysis used the Richard- Baker Flashiness Index equation (Figure 1) to calculate an index value. 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 24-hour period was then averaged to obtain a monthly value. This was done for each year, and scenario provided (Table 6).

Table 6. Metrics for downstream flows below the Wilder Project under current operations.

Target Month and Year	Average Minimum downstream flow	Mean daily amplitude	Flashiness
2009			
February	700	7741	0.26
June	1325	7071	0.14
August	1659	7241	0.13
November	1941	8050	0.05
2016			
February	5269	1850	0.03
June	2131	3521	0.03
August	1326	4198	0.11
November	1871	5679	0.16
2017			
February	5267	1866	0.03
June	2174	3464	0.11
August	1329	4302	0.17
November	2041	5395	0.11
2015			
February	720	6761	0.37
June	5462	4868	0.07
August	844	7317	0.29
November	730	7653	0.31

Fish Passage Measures

86. In an agreement with the Connecticut River Atlantic Salmon Commission (CRASC), now referred to as the Connecticut River Migratory Fish Cooperative (CRMFC), the fish ladder upstream operates in accordance with the Fish Passage Notification schedule issued each

year, once there is evidence that an Atlantic salmon is located immediately below the Wilder Project. Because the salmon restoration program was discontinued, Wilder has not operated the ladder for upstream fish passage.

87. Since 2016, CRMFC no longer requires downstream passage for Atlantic Salmon smolts. Wilder does not provide downstream fish passage for other species. In previous years when downstream passage was in use, flows were provided via the skimmer gate, and typically ran from October 15 to December 31.

Recreation measures

88. A recreational requirement of the previous license was to install signs, lights, sirens, and barriers and to warn the public of water fluctuations and to protect individuals while using the recreational facilities at the Project.

89. The Applicant maintains a phone line and website to make generation schedules and real time flow information available to boaters and anglers.

90. There are numerous recreational facilities adjacent to the Project impoundment and downstream. The Applicant owns and manages six formal project sites, although some are operated by neighboring towns with agreements. Kilowatt Park is maintained by the Town of Hartford. The Project portage and picnic area, picnic area vista and hiking trails, and Wilder dam fish ladder are maintained by the Applicant. Gilman Island is operated and maintained by Dartmouth College under a lease agreement (see findings 369-372 for additional details).

E. Applicant's Proposal

91. The Applicant is proposing a new operating regime that is primarily characterized by an IEO operation, but also includes flexible operations under which the Project can deviate from IEO and operate out of storage for short periods of time typically no less than one hour. The proposed operational regime is intended to create a more stable impoundment by reducing the average duration, frequency and range of impoundment fluctuations. In addition, it will also reduce the magnitude and frequency of sub-daily change in discharge from the Project.

92. Under the Applicant's proposal, the Project could deviate from IEO operations for flexible operation for a limited number of hours each month with 'transition' operations governing departures and returns to outflow equals inflow mode, as specified. The Project could also suspend IEO operation due to high water operations, or emergency and systems operation, requirements and audits, or non-emergency maintenance requirements. Non-emergency maintenance requirements would require consultation with relevant state and federal resource agencies prior to initiating a necessary deviation and developing a suitable refill plan and schedule.

93. The proposed operational regime will generally increase the amount of time the Project is operated in an IEO mode, while maintaining a stable reservoir.

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

Inflow equals outflow operations

95. The Applicant proposes to implement IEO operations by maintaining a target elevation at the dam of 384.5 feet (NGVD 29). The Applicant will target this elevation within a range of plus or minus 0.5 feet of elevation change or 'bandwidth'. The purpose of providing a bandwidth to maintain the water level is to absorb changes in inflow, such as differences between changes in hourly inflow and hourly discharge to forecasting or turbine limitations, and wave action.

96. To implement IEO operations, the Applicant is proposing to monitor the impoundment for water fluctuations 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 and accuracy of the unit controls. The Applicant anticipates that station discharge would change no more than once per hour, unless there are rapid changes in inflow.

97. To protect dwarf wedgemussels (DWM) (see Rare Threatened and Endangered Species section for more information) the impoundment elevation is lowered in the fall each year. The impoundment will be temporarily lowered for roughly 10 to 21 days when water temperatures consistently drop from 15°C to 10°C. Once water temperatures are consistently below 10°C, the impoundment will be adjusted upward back to the target elevation. Additionally, DWM and Cobblestone Tiger Beetle protection is provided by allowing multiple consecutive day period (three of more days) at inflow equals outflow during active periods.

98. Under the Applicant's proposal, IEO operations would be suspended under high water operations, maintenance activities, emergency systems operations, requirements and audits.

99. Additionally, the IEO operations may be suspended for needed maintenance. Non-emergency maintenance activities would be completed only after consultation with relevant agencies, including the Department.

Flexible operations

100. The Applicant proposes to maintain 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, up-ramping, down-ramping, a maximum discharge, and maximum drawdown. These restrictions are further described in the findings below.

101. The Applicant is proposing the following number of hours for flexible operations: December through March, no more than 65 hours 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.

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

103. During flexible operations, the Applicant will maintain the water surface elevation within the impoundment between 383.0 and 384.5 feet (NGVD 29). This equates to a maximum drawdown of 1.5 feet.

104. For any flexible event that lasts less than one hour, the Applicant will consider the event to have lasted for one hour. Should the flexible event last longer than 15 minutes past the following hour, then the flexible event has lasted for two hours. The number of flexible hours in a single event does not include the up-ramping hour, down-ramping hour, or number of hours it takes to refill the impoundment.

Transition Operations

105. 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 impoundment refill provisions.

106. Up-ramping occurs over the one-hour period preceding flexible operations when these events are planned in advance, as further specified in finding 109. The goal is to provide a gradual increase in flow from inflow to the maximum planned discharge of the flexible operations event. At the Wilder Project, the Applicant proposes to discharge from either Unit 1 or Unit 2 approximately 5,000 cfs or the flow that is half-way between the inflow to the Project and the maximum of the flexible operation, whichever is less.

107. 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 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.

108. 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 ft of the target WSE after the completion of down-ramping. The Applicant proposes to refill by passing 70 percent of inflow and using the remaining 30 percent to store and refill the impoundment, provided it maintains the proposed minimum flows downstream of the facility. The time that flexible operations end for the purpose of determining the number of allowed hours which have been used each month is when down-ramping begins.

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

110. The minimum flow below the powerhouse varies depending upon the time of year. At a minimum, the following flow will be provided when not in IEO operations: October 1 through

March 31 - 1,500 cfs; April 1 through May 31 - 2,000 cfs; and June 1 through September 30 - 1,100 cfs. When in IEO operations, discharge may be less than the seasonal minimum flow when calculated inflow is less than the applicable flow.

111. 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 operation measures (up-ramping, down-ramping, impoundment refill) to flexible operations 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 River Profile 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.

112. 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 next month's allocation if none were available in the current month.

Hydrology of proposed operations

113. Similar to current operations, a number of metrics can be calculated to estimate how the Applicant's proposed operations will affect the hydrology of a river system (see findings 64-69 and 79-85). The same model used to generate metrics for current operations was used by the Applicant to estimate the effects of proposed operations. The model uses the same intensive HEC-RAS model with inputs of known flows and water surface elevation data collected at various nodes within the impoundment and downstream of the facility, inflow estimates, and generation data to estimate Project effects.

Impoundment

114. The same metrics and methodology used in characterizing current operations was also applied to the proposed operations (findings 80- 81). These are provided in Table 8.

Table 8. Impoundment metrics for Proposed operations at the Wilder Project.

Target month and year	Percent time at target SWE	Mean daily change in impoundment
2009		
Feb	55	0.40
Jun	91	0.07
Aug	86	0.15
Nov	79	0.25
2016		
Feb	71	0.28
Jun	96	0.07
Aug	88	0.12
Nov	75	0.31
2017		
Feb	64	0.36
Jun	94	0.08
Aug	81	0.16
Nov	74	0.26
2015		
Feb	71	0.27
Jun	96	0.07
Aug	88	0.12
Nov	75	0.30

Downstream flows

115. In addition to water level fluctuation in the impoundment, the Project will regulate downstream flow during the flexible and transition modes of the proposed operation. Using the HEC-RAS model that allowed for estimates of metrics related to water surface elevation, the Applicant also estimated metrics to characterize the downstream flow regime for proposed operations.

116. The same methodology described in findings 82 through 85 was used to generate metrics for flows downstream of the Wilder Project. These metrics are presented in Table 9 for each target year and month.

Table 9. Metrics for flows downstream of the Wilder Project as estimated by the Applicant from modeling.

Target Month and Year	Average Minimum downstream flow	Mean daily amplitude	Flashiness
2009			
February	2721	4936	0.12
June	3530	2885	0.05
August	4385	2613	0.04
November	4702	3452	0.05
2016			
February	8249	1646	0.02
June	3415	1643	0.02
August	2127	1770	0.03
November	3902	3713	0.05
2017			
February	8179	1704	0.02
June	3446	1623	0.03
August	2125	1770	0.05
November	3948	3586	0.06
2015			
February	2138	3090	0.09
June	8202	1344	0.01
August	2071	2038	0.06
November	2811	2622	0.06

Fish Passage Measures

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

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

119. The Applicant is proposing to operate upstream fish passage measures at the Project from April 1 through July 15 upon license issuance. The April 1 start date is to accommodate early spring spawners such as walleye and white suckers. Dedicated American eel passage will be provided from May 1 to November 15 upon completion of the implementation of enhancements as set forth in the fish passage settlement agreement. The Applicant also proposes to operate downstream fish passage measures from August 1 through December 1 upon completion and implementation of enhancements.

120. The Applicant notes that the fish passage measures are intended to provide safe, timely, and effective passage for targeted migrating species. 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 design 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.

121. The Applicant is proposing to consult with relevant agencies to reach agreement on study plan designs and schedules.

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

Downstream passage

123. No later than January 1st of the tenth year after license issuance, the Applicant is proposing to initiate consultation with the relevant agencies on a study design to inform downstream passage for American eel.

124. The Applicant is proposing to use that information and no later than January 1st of the twelfth year after license issuance complete final design plans for downstream American eel passage, with construction beginning no later than July 16th of the fourteenth year after license issuance. Approved facilities and/or operational measures will be in effect no later than August 1st after the sixteenth year of license issuance.

Upstream passage

125. The first two years after license issuance the Applicant shall monitor American eel and sea lamprey passage upstream. Monitoring data will be provided to the relevant agencies for review to determine if fish ladder operational timing is effective.

126. In the eighth year after license issuance, the Applicant will conduct a Passive Integrated Transponder (PIT) tag study on upstream migrating fish to test the effectiveness of the fish passage design, with the potential to do another study in year 9.

127. If needed, the Applicant proposes to implement design consultation no later than January 1st in the eleventh year post license issuance, and any modification will be completed no later than December 31st of thirteenth year after license issuance.

128. In the eleventh year after the issuance of the license, the Applicant proposes to consult with the relevant agencies to determine if the existing information is adequate to identify a permanent location of upstream American eel and sea lamprey passage. Should no additional studies be needed, the Applicant is proposing to complete final designs for permanent upstream passage. The Applicant proposes to complete construction and have the passage fully operational no later than July 16th of the thirteenth year after license issuance.

129. Should additional studies be needed, the Applicant proposes to initiate the final designs no later than December 31st of the thirteenth year. The construction of the permanent passage would be completed and operational no later than July 16th of the fourteenth year after license issuance.

Additional Proposed Measures

130. The Applicant proposes several specific improvements to recreation facilities at the Project including; upstream portage improvements including a dock, pathway, and boat slide; downstream passage improvements including trail improvements, new stairs, and a boat slide; a fishing platform with stairs to the water; an elevated birding platform; expanding the Gilman Island canoe campsites; improvements to the picnic sites for accessibility; and maintaining both the phone line and website for day-ahead and real-time flow information.

131. The Applicant proposes to maintain and enhance the existing recreational areas at the Project as needed. Additionally, the Applicant is proposing to develop a recreation management plan after license issuance in consultation with applicable state agencies and will be submitted for FERC approval.

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

133. 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 operations control center to assist in inflow monitoring, inflow forecasting and managing the impoundment to the target water surface elevation in order to successfully operate the Project under the proposed operations.

F. Current Status of Waters in the Project Area

134. 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 the list under section 303(d) of the Federal Clean Water Act.

135. According to the State of Vermont's 2022 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 unrelated to operation of the Project.

136. The Connecticut River in the vicinity of the Wilder Project area is not listed as an impaired surface in need of a TMDL, an impaired water where no TMDL is required, or as an impaired water with a TMDL.

137. The Department concurrently issued a five-part list of priority surface waters outside the scope of Section 303(d) of the Clean Water Act in 2022. These waters correspond to Category 4c of EPA's Consolidated Assessment Listing Methodology. To the extent, this listing may be affected by the Applicant's proposal, these waters are described below.

138. Part F lists surface waters affected by flow regulation. The 30-mile reach of the Connecticut River above Wilder Dam to Bradford is listed as a priority water in Part F due to reservoir

water level fluctuation at the dam and unstable/eroding streambanks upstream. The Connecticut River is also listed in Part F from Wilder Dam to Ascutney Village for artificial flow condition and fluctuating flows associated with hydropower production.

139. The Connecticut River is listed as a priority water in Part E above Wilder dam, for locally abundant Eurasian Watermilfoil growth (*Myriophyllum spicatum*).

140. The Agency's publication Hydropower in Vermont, *An Assessment of Environmental Problems and Opportunities*, is a state comprehensive plan. The plan describes hydroelectric development as 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.

141. The Wilder Project area is located within Vermont's basin 14 of its tactical basin planning system. The tactical basin plan for the Stevens, Wells, Waits, Ompompanoosuc and Connecticut River direct tributaries is a state comprehensive plan.[4] The tactical basin plan notes the development of the Long Island Sound TMDL. In 2013, a Vermont specific enhanced implementation plan 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 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.[5]

142. It is estimated that 12 percent of the total nitrogen load comes from Vermont, of which approximately 60 percent 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.

143. Strategies within the basin 14 tactical basin plan that are pertinent to the Application include: Coordinate with agricultural service providers to determine if there is a gap in outreach and implementation of water quality best management practices along the Connecticut river; Identify priority wetland restoration sites in agricultural fields; Expand and

[4] Vermont Department of Environmental Conservation. 2020. Ompompanoosuc, Stevens, Wells, Waits & Connecticut River Direct Tributaries Basin 14 Tactical Basin Plan. Montpelier, Vermont. December 2020. https://dec.vermont.gov/sites/dec/files/documents/2020%20Basin%2014%20Tactical%20Basin%20PlanSigned.pdf

[5] Vermont Enhanced Implementation Plan for the Long Island Sound TMDL.

protect riparian buffers within the FERC jurisdictional impoundment associated with Widler dam; Increase conservation flows below the Wilder Dam and reduce the magnitude of peaking operations and water level fluctuations in the impoundment which would improve aquatic habitat in the Connecticut River; and provide outreach, technical assistance, and workshops to private forestland owners on best management practices.

144. The 2015 Wildlife Action Plan is another applicable state comprehensive plan.[6] 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 (*Anguilla rostrata*), 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 identified later in the applicable section of this water quality Certification (e.g. rare, threatened, and endangered species and aquatic biota sections).

G. Water Chemistry

145. There are numerous 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 Wilder, Bellows Falls, and Vernon hydroelectric projects.

146. There are 18 wastewater treatment facilities in the Connecticut River watershed above the Wilder project. These facilities are in Colebrook NH, Stratford NH, Stratford Mill House NH, Groveton NH, Northumberland NH, Lancaster NH, Lancaster Grange NH, Whitefield NH, Bethlehem NH, Littleton NH, Lisbon NH, Woodsville NH, Lunenburg VT, Lyndon VT, Ryegate VT, St. Johnsbury VT, Bradford VT, and Hanover NH.

147. The Wilder Project has also been issued a NPDES permit issued by the state of Vermont to discharge minor, non-generation related wastewaters which includes non-contact cooling water. These are non-generation related wastewaters used as non-contact waters to cool Units 1, 2, and 3. This permit requires quarterly sampling effort for temperature, pH, and oil or greases. Throughout the required monitoring period, the required permit levels have not been exceeded.

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

149. The 2012 baseline study collected temperature, dissolved oxygen (DO), specific conductivity, pH, nutrients and chlorophyll-a at various locations. Data was collected during the summer and was representative of low-flow, warm weather periods at four locations within the Wilder project area, the upper impoundment, mid impoundment, forebay, and in the 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

[6] 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

forebay as a composite sample. Additionally, vertical profiles were collected within the impoundment.

150. The 2015 study followed a similar methodology to that 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.

151. In 2012, temperatures gradually warmed and peaked in August, which is the expected seasonal pattern for this region. Maximum observed temperatures occurred in the forebay at 26.5°C and the lowest occurred in the upper impoundment at 17.3°C. The minimum DO level was 5.7 mg/L or 69 percent saturation, in the forebay which corresponded to a slight stratification within the water column.

152. Over the course of the 2015 sampling effort, water temperatures ranged from 6.4°C to 25.8°C, following the expected seasonal trend as observed in 2012. The warmest temperatures were observed in the middle impoundment and forebay stations in late August. The coolest temperatures were observed in the upper impoundment and riverine stations in the spring and late fall.

153. For the additional tributary monitoring in the 2015 study, temperature was continuously recorded in the Waits and Ompompanoosuc rivers. For the Waits River a minimum temperature of 0.02°C and a maximum of 25.97°C was recorded. For the Ompompanoosuc River, a minimum of 0.61°C and a maximum of 26.43°C were recorded.

154. Dissolved oxygen (DO) was continuously measured in the Wilder forebay and within the tailrace throughout the 2015 monitoring period. From August 30 to September 8, all mainstem stations collected DO data. DO followed a nearly opposite trend as water temperature. Seasonally, DO levels were relatively high in June and reached their lowest levels in mid-September, before beginning to increase into the fall.

155. DO concentrations within the forebay ranged from 6.6 mg/L to 10.2 mg/L with saturation ranging from 78 to 111 percent. Within the tailrace, DO concentrations ranged from 6.9 mg/L to 9.8 mg/L with saturation ranging from 81 to 106 percent.

156. Within the mainstem, the vertical profiles indicated that the water column was not stratified, with some warming at the surface only during the summer. The waters remained oxygenated with values ranging from 7.2 mg/L to 10.4 mg/L and saturation ranging from 83 to 102 percent.

157. When considering mean DO concentrations, the upstream riverine and upper impoundment locations had higher levels than those in the middle impoundment and forebay locations. However, at all locations mean DO was 7.9 mg/l or higher and mean percent saturation was 90 percent or greater.

158. The following table (Table 10) includes the minimum, maximum, and mean statistics for the DO vertical profiles collected in 2015. Additionally, it includes the minimum, maximum, and

mean values for the Wilder forebay and tailrace where continuous measurements occurred in 2015.

Table 10. A summary of statistics for the vertical profiles and continuous monitoring of dissolved oxygen concentrations and percent saturation at locations within the Wilder project area collected during the 2015 water quality study. Maximum (max), Minimum (min) and Mean or average values are provided.

Locations	Dissolved Oxygen (mg/L)			Dissolved Oxygen (% saturation)		
	Max	Min	Mean	Max	Min	Mean
Vertical profile locations						
Upstream Riverine	10.1	8.3	9	102	93	98
Upper Impoundment	10.4	8	8.9	102	91	97
Middle Impoundment	10.3	7.5	8.5	100	88	93
Forebay	10.2	7.2	8.2	101	82	91
Tailrace	9.2	7.4	7.9	100	86	90
Continuous monitoring						
Forebay	10.2	7.2	8.3	111	78	92.6
Tailrace	9.8	6.9	8.22	106	81	92.2

H. Aquatic Biota

159. "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.

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

161. There is a wide variety of resident fish species located in the Wilder impoundment or the riverine reach downstream from the dam. Some of the species include longnose sucker, white sucker, bluegill, largemouth bass, rock bass, slimy sculpin, blacknose dace, bluntnose minnow, common shiner, creek chub, fallfish, golden shiner, longnose dace, spottail shiner, chain pickerel, banded killifish, tessellated darter, walleye, yellow perch, brook trout, and brown trout.

162. In addition to the resident fish species, some diadromous fish species, such as the American eel and Sea Lamprey can be located as far upstream as Wilder Dam. Sea Lamprey and American eel have been observed utilizing the Wilder fish ladder when it is in operation. Sea lamprey have been observed in the White River, a tributary to the Connecticut a short distance downstream of the Wilder development. Diadromous species must be able to pass upstream and downstream of the Wilder dam to complete their lifecycle.

163. 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 Wilder, such as the White River, are stocked with rainbow trout.

164. Macroinvertebrates and mussels, which are typically associated with benthic zones, also inhabit the reaches affected by the Wilder project. Mussel species include Eastern elliptio, Eastern lampmussel, creeper, triangle floater and dwarf wedgemussel.

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

166. Applicable fishery management goals for the Connecticut River around Wilder include: restoration for American eel by improving flow regimes below hydroelectric generation and flood control projects; increase and/or maintain available habitat in terms of quantity and quality required for all life stages; restore fish passage at dams to provide safe, timely and effective upstream and downstream fish passage; and operate and maintain existing fishways for peak passage performance.

Protection measures for aquatic biota

167. Downstream passage intended for Atlantic Salmon from the Wilder impoundment is provided via the existing log sluiceway, with reinforced concrete, located between Unit 3 and the upstream fish ladder entrance. Downstream passage at Wilder has not been provided since 2016. While downstream fish passage provides passage by the dam, fish impingement and entrainment can occur.

168. 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 the turbine, which conflicts with the management objectives for aquatic biota.

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

170. The fish assemblage study was used to select target species from the Wilder Project impoundment. The target species were narrowed down to represent various major family groups and trophic guilds, so all areas of the water column were represented. Target resident fish species for the impingement and entrainment study included white sucker, largemouth bass, smallmouth bass, fallfish, golden shiner, spottail shiner, Northern pike, tessellated darter, walleye, yellow perch, bluegill, and brown bullhead.

171. One measure of a fish's ability to swim quickly for short distances or time intervals less than 15 seconds, is commonly 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 a fish's ability to capture prey, avoid predators, or in the case of hydroelectric facilities, avoid water velocities at the trashracks and into the turbines. Burst speeds have been estimated in the scientific literature and are often presented as a range.

172. Additional measures of swimming ability for fish are "sustained" swimming, or the ability to swim potentially indefinitely, and "prolonged" swimming, which refers to a fish's ability to swim for shorter periods of time, but longer than those initial bursts of temporary speed. The

Applicant reviewed scientific literature and the EPRI database to develop a range of a fish's swim speeds as shown in Table 11.

Table 11. Various swimming speeds of target species and life stages for estimation of entrainment. Burst speed typically is the speed a fish can swim for less than 15 seconds. A prolonged speed can be sustained by a fish between 15 and 200 seconds. A 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 literature data include 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	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 (f/s)	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)	
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)	360-450 (cm/s)
Channel catfish	Juvenile	6.3-8.3	1.3 (f/s)	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)	

173. In addition to understanding the target species burst speed, calculating the velocity through the trashracks is also required. The through rack velocity was calculated conservatively assuming maximum turbine discharge. For the Wilder Project, Units 1 and 2 have a calculated intake velocity of 2.2 feet per second (fps) and Unit 3 has a calculated intake velocity of 1.4 fps.

174. Fish impingement describes the action of a fish being held in contact with a trashrack or screen. The ability of a fish to get caught depends on the width of the fish and the spacing between trashrack bars, or clear bar spacing, along with the velocity of the water pinning the

fish. The clear bar spacing at Wilder for Units 1 and 2 is 5 inches, and at Unit 3 is 1.625 inches.

175. For the target species and representative lengths, there are no fish that are wider than 5 inches, therefore it is unlikely that any fish would be impinged in the trashracks of Units 1 or 2. Unit 3, which has narrower clear bar spacing, results in most of the target species that reach 15 inches or more in total length being vulnerable to impingement. Ultimately, the rate of impingement will be a function of a fishes ability to escape the flow field of the intake.

176. If an individual fish is unable to escape the velocity through the trashracks and are small enough to avoid impingement, they may become entrained, which is when a fish or other aquatic organism is drawn into a water intake and travels into a turbine. The survival of a fish through a turbine depends on the length of the fish and the type of turbine.

177. There are two turbine types at the Wilder Project, Units 1 and 2 are adjustable blade Kaplan runners and Unit 3 is a traditional Francis runner. The following estimates provided in Table 12 is based on survival using the methodology employed by Franke et al. 1997.[7]

Table 12. The survival potential of fish who become entrained in turbines at the Wilder Hydroelectric Project is based on length of an individual fish.

Fish length	Kaplan Turbine	Francis Turbine
4-6 inches	85-99%	72-93%
15 inches	72-96%	45-75%
30 inches	44-92%	0-50%

178. The likelihood of a fish becoming entrained not only depends on the size of the individual but also their expected life histories and where they reside within the riverine system, both in terms of depth and mesohabitat types. A 5-step qualitative assessment was performed using the EPRI database to determine the potential for a fish becoming entrained from low to high.

179. For example, at the Wilder Project there are limited number of obligatory migrates, in addition to the facility having trashracks located relatively deep within the water column. Other considerations include the approach velocities, the distance of the intakes relative to the shoreline. Lastly the analysis included the life history, and behavioral characteristics of fish species, including the swim speeds.

180. The following Table 13 summarizes the overall entrainment potential for the target fish species and life stages from low to high.

[7] 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.

Table 13. The potential for a fish species and life stage to become entrained in the Wilder Hydroelectric Project turbines based on characteristics of each species and life stage type.

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 Eel				
Juvenile	L	M	L	M-L
Adult	H	L	H-M	H
Bluegill				
Juvenile	M	H-M	H-M	H-M
Adult	L	M-L	M-L	M-L
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	M-L	H-M	M
Adult	L	M-L	M-L	M-L
Northern Pike				
Juvenile	L	L	M-L	L
Adult	L	L	M-L	L
Sea Lamprey				
Juvenile	M	H-M	L	M-L
Adult	L	ND	L	L
Smallmouth Bass				
Juvenile	M	H	M	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	M-L	M-L	M-L
Adult	L	M-L	M-L	M-L

Table 13. Continued.

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
Walleye				
Juvenile	M	M-L	H-M	M
Adult	L	L	M-L	M-L
White Sucker				
Juvenile	M	M-L	H-M	M
Adult	L	L	M	M-L
Yellow Perch				
Juvenile	M	M-L	H	H-M
Adult	L	M-L	M-L	M-L

I. Fish Passage

181. There are both upstream and downstream fish passage facilities intended for Atlantic Salmon at Wilder Project. These were installed in 1987 as part of a settlement agreement. The operating schedules of both the upstream and downstream passage are typically provided by CRMFC each year. Operation of the passage facilities, in the original agreement had been based upon the presence of Atlantic salmon, either above or below Wilder dam. Therefore, dates and years of operation vary depending on the presence of Atlantic salmon. The Wilder fish ladder has operated 45 percent of the years (1987-2024).

Upstream

182. The upstream fish passage facility is described in findings 42 through 48. The current fish ladder was originally designed to pass Atlantic salmon, which was the primary focus when fish passage was initiated in the 1980's. There are a number of fish species that currently migrate up the Connecticut River as part of their life history, including American eel and sea lamprey.

183. As part of the relicensing process, the Applicant conducted several studies to understand upstream fish passage. One study was specific to American eel (study 18) and its goal was to collect baseline data on American eel attempting to move upstream. The methods included visual nighttime surveys within the tailrace and the spillway, in addition to setting baited eel pots in specific locations.

184. Visual surveys were conducted once a week from May 2015 to October 2015. No eels were observed over the course of the 24-week period.

185. Eel pots were deployed starting May 2015 and continued through August 2015. No eels were collected in the baited pots. However, American eel have been observed upstream of the Wilder Project and have been observed using the Wilder fish ladder when in operation.

186. In addition to the migratory species of interest, there are a number of resident species that have also used the upstream passage facilities. Study 17 involved continuous monitoring of the upstream fish ladder at the Project through 2015 from ice out to ice-in using a camera and motion activated software. The purpose was to capture all movements during the open water period and assess fish ladder usage for periods of higher use for either resident or diadromous species.

187. At the Wilder Project, the target diadromous species for the study were Atlantic salmon, American shad, sea lamprey, and American eel. Of those, only three were observed in the ladder Atlantic salmon, sea lamprey, and American eel.

188. A number of resident species were also targeted as part of the study including smallmouth bass, largemouth bass, white sucker, walleye, trout species (including brook trout, rainbow trout, and brown trout), sunfish (bluegill and pumpkinseed), bullhead (brown and yellow bullhead), crappie (black and white), 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 Wilder ladder, five resident species were identified: bass; white sucker; walleye; trout; and sunfish.

189. Fish were observed using the fish ladder from May 12, 2015, through the time the ladder was shut down on January 7, 2016. An additional camera was used as a backup and quality control of the recordings. Despite the weekly checks of the secondary camera, there were occasional outages. These outages occurred September 28, October 18-28, and December 28-30.

190. 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. The following table notes the target species, the date of fish passage, the date of last passage, the day of the peak passage, in addition to when 80 percent of the fish had passed through the ladder.

Table 14. Observed fish moving upstream at the Wilder fish ladder in 2015. Net fish is the number observed going up minus the number observed going down. The first date indicates date of fish species or genera moving up, peak date is when maximum number of observations were made, 80% date is the date at which 80% of the fish had passed, and the 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	1	10/5	NA	NA	10/5
Sea Lamprey	2	5/30	NA	6/2	6/2
American Eel	52	6/2	6/27, 7/24, 7/8, 7/9, 8/22, 9/30, 10/17	9/30	11/9
Bass	49	5/21	5/26, 5/28, 5/29, 6/7	7/22	12/21
White Sucker	1	5/12	NA	NA	6/8
Walleye	22	5/12	5/12, 5/13, 6/18, 7/04, 8/02, 10/1	8/2	10/16
Trout	64	5/16	8/2	7/30	1/7
Sunfish	-5	5/21	NA	8/25	9/15

191. The number of fish observed moving upstream in the ladder were relatively few, making it difficult to determine if movement varied with operational changes. For example, how the river discharge was partitioned through the facility (i.e., fish ladder, attraction water, operational discharge, spillage) are elements that introduced uncertainty to assessing the effects of operations on ladder performance.

192. In 2015, it was noted that most species movements occurred in the spring which covered a wide range of river flows. Additionally, there was considerable upstream movement of American eel, bass, and walleye in the fall, which could have been associated with a short duration of increased discharge, particularly through spillage.

193. In 2015 the date of fish passage occurred earlier than the current operating period which is triggered by the passage of Atlantic salmon at the Bellows Falls dam. With the exception of sea lamprey, 80 percent of passage for other species such as American eel, bass, walleye, trout, and sunfish did not occur until after the current operating period of July 15. The majority of resident species moving either upstream or downstream within the ladder, as indicated by net passage numbers occurred during the prescribed operation period, in the years when it is in operation, of the fish ladder which is typically from spring until July 15.

Downstream

194. The downstream fish passage facilities are described in finding 49.

195. In addition to the potential for impingement and entrainment, there are also concerns regarding migratory fishes who utilize areas upstream of the Project and must pass downstream to complete their lifecycle. For the Wilder Project, these include American eel and sea lamprey.

196. As part of the relicensing process, 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 investigating the migratory cues that downstream migrating American eel may utilize.

197. American eel undergo metamorphosis before out-migrating to reproduce in the Sargasso Sea. For the life stages in the Connecticut River, this includes the ‘silvering’ phase where the individual begins to change color pigmentation and eye diameter increases. The timing of metamorphosis and out-migration can vary.

198. The Applicant conducted a literature review of various potential cues that may trigger American eel to migrate. While much of the specificity for triggers focused on literature from the Connecticut River basin, other basins were also reviewed for commonality among cues.

199. Although there are several studies related to the out-migration timing of American eel, the anticipated cues continue to only be generally defined. However, there seems to be some evidence that falling water temperatures and increased river flow may act as a cue. To what extent, or if there is a specific discharge or temperature threshold, remains unknown and could be location specific.

200. The Project specific study (study 19) had two major components: quantifying turbine survival of American eel using the turbines as a means of downstream passage and quantifying movement rates, timing, and route selection at the Project.

201. There are two types of turbines within the Wilder facility, a Kaplan and a Francis turbine. Originally, the study design included testing both units 2 and 3 to assess turbine survival, however, Unit 3, the Francis turbine, was designed in such a way that the number of American eel recaptures were not adequate for the purposes of the study. As a result, the findings in this Certification will reference the assessment of Unit 4 at the Vernon Hydroelectric Project. The Vernon Project, also owned by the Applicant and currently undergoing the same relicensing process, conducted similarly designed studies as those for Wilder. Unit 4 closely resembles the characteristics of Unit 3 at the Wilder Project, including being a relatively small Francis unit.

202. The Applicant utilized a power analysis to determine the number of eels needed at each turbine for a statistically valid result. For Unit 2, 50 American eel were used, and for Unit 4, 48 American eel were used. Before fish were inserted below the ceiling of the turbines intake a number of tags were implanted.

203. Eels were tagged with a variety of tags. The first were three to six HI-Z balloon tags. These tags are designed to rapidly bring large adult eels to the water surface for rapid 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 balloon 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.

204. In addition to those fish released into the turbines, a smaller number of control fish were released into the tailrace.

205. 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 the 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 for delayed mortality or related injuries and assessed for shear effects via a necropsy.

206. 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.

207. 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 American eel were combined for the three Connecticut River projects (Wilder, Bellows Falls, and Vernon).

208. Fifty American eel were released through Unit 2. Of those, 40 were captured alive, 7 were recaptured dead. Of the control fish released into the tailrace, only 3 were recaptured. The recapture rate for the combined control group was 97.4 percent, which was assumed for all

facilities. Of the 48 American eel released at Unit 4 at the Vernon Hydroelectric Project, 45 were recaptured alive and none were recaptured dead.

209. At Unit 2, 20 of the 47 (43%) recaptured eels had passage related injuries. At Unit 4, 16 of the 45 (36%) recaptured fish had passage-related injuries. The table below indicates the tag-recaptured fishes and estimates of 1 hour and 48-hour survival for Unit 2 at the Project and Unit 4 at Vernon.

Table 15. Estimates of turbine survival of American eel at turbines representative of the Project turbines, or the Project turbines themselves.

Metric	Vernon Unit 4		Wilder Unit 2		Combined Controls	
	Number	%	Number	%	Number	%
No. Released	48		50		39	
No Alive	45	94	40	80	38	97
No. Recaptured dead	0		7	14	0	
No. Assigned Alive	0		0		1	3
No. Assigned Dead	1	2	3	6	0	
Tags only	1		3		0	
Stationary Signal	0		0		0	
No. Unknown	2	4	0		0	
Survival at 1 hour (%)	97.80%		80%			
Std Error (%)	2.20%		5.70%			
No. Held	45		40		38	
Died in Holding	2		9		0	
Alive at 48 hours	43		31		38	
Survival at 48 hours (%)	93.50%		62%			
Std Error (%)	3.60%		6.90%			
90% CI*(%)	6%		11.30%			

210. Survival estimates after 48 hours at the Wilder Project for American eel passing through Unit 2 was 62 percent, which is lower than any other units tested including those at the Bellows Falls and Vernon projects. However, the 48-hour survival of American eel passing through Unit 4 at Vernon was 93.5 percent and it would be anticipated that similar results would occur at Unit 3 at Wilder. This study does indicate that American eel fare better passing through Francis type turbines than through Kaplan type turbines.

211. The Applicant also examined the timely passage of American eel through the Project. This was accomplished by releasing 50 radio tagged individuals into the Project impoundment, roughly 3 miles upstream. The radio tags were surgically implanted into the fish. Fish were released in 5 different groups in the fall on October 27, 29, 31, and November 3 and 5, 2015.

212. The fish were then 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, tailrace, turbines,

downstream fish bypass route and spillways. The following table depicts the route individual American eel passed through the Project (Table 16).

Table 16. Route selection of 50 American eel through the Wilder Hydroelectric Project from the downstream eel passage study conducted in 2015.

Passage route	Number of fish	Percent of all individuals who passed	Percent of all those individuals released
Unit 1 or 2	33	73	66
Unit 3	5	11	10
Trash/ ice sluice	2	4	4
Unknown	5	11	10
Total Passed	45	100	90
Did not pass	3		6
Did not approach	2		4
Total released	50		100

213. In addition to route selection through the facility, radio telemetry allowed estimates of the time it took an individual to move through the facility or how long an individual spent in any one location. The following table is a summary of all American eel passage durations with all groups combined (Table 17).

Table 17. Duration (hours) of American Eel passing through various portions of the Wilder Hydroelectric Project in 2015.

Location of interest	Min	Max	Mean	Median	No.
Approach duration	1.7	194.5	35.6	25.1	48
Forebay residency	<0.1	39.6	4.6	0.2	47
Tailrace Duration	0.1	217.8	23	0.8	45
Total Project Duration	0.1	240.8	27.8	1.7	45

214. After release, the number of fish detected through the Project continued to decline, indicating that some individuals were no longer detected. This could be because an individual did not survive or was missed by the receiver. The majority of the fish passed the Project during the evening and early nighttime hours. The last American eel passage event occurred on November 14, 2015.

215. When fish were passing through the Project, the Units were running, and for roughly half of the study, the trash/ice sluice was open, although it is anticipated there is leakage flow when the sluice is closed.

216. When considering potential project effects, one metric to consider is duration in the forebay. The assumption is that fish exhibiting back and forth behavior could indicate a potential Project effect, because the individual has shown interest in migration (moving into the forebay) but is unable to locate downstream passage. Time spent wandering or searching for greater than 8 or 24 hours is worth noting. Two fish were observed for 24 or more hours,

six fish exhibited this behavior for 8 to 24 hours, and the remaining 37 fish exhibited this behavior for less than 8 hours.

217. The American eel tagging study took place at all three hydroelectric facilities owned by the Applicant including Bellows Falls, the next downstream barrier. As a result, the travel time to the next facility for those individuals can be estimated.

218. Fifty American eel were released upstream of the Wilder Project and 29 of those reached the Bellows Falls Hydroelectric Project. The time it took to travel to the bypass reach and power canal area at Bellows Falls from the Wilder tailrace could be estimated for 27 of those individuals. The total time ranged from 26 hours to 169.9 hours with an average time of 65.7 hours.

I. Aquatic Habitat

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

220. Waters classified as Class B(2) for the 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 reproduction requirements. (Standards, Section 29A-306(b)(3)(A)).

221. The Wilder impoundment extends roughly 46 miles upstream to the Newbury, Vermont area. The gross storage is 34,350 acre-feet with a usable storage of 13,350 acre-feet assuming, a 5-foot drawdown. At the normal full pond elevation (385.0 feel NGVD 29), the surface area is 3,100 acres.

222. Below the Wilder dam there is a 17-mile stretch of riverine habitat up to the backwater of the impoundment Bellows Falls project. The riverine habitat below Wilder Dam can be broken into three reaches at the major tributaries entering the Connecticut River.

223. The first reach is 1.5 miles long, extending to where the White River, enters the Connecticut River. The next reach is 5.2 miles long, extending to where the Ottauquechee River enters the Connecticut River. The last reach is from the Ottauquechee River to Chase Island, which is 11 miles long and is the most downstream riverine extent before the Bellows Falls impoundment begins.

224. Sumner Falls lies below Wilder dam downstream of both the White and Ottauquechee rivers. Flows released from Wilder dam is likely to affect this feature within the Connecticut River. Sumner Falls consists of steep riffles, rapids, chutes, and pools. It has been observed that Sumner Falls provide habitat for fish rearing and potentially spawning life stages.

Flow Needs for the Protection of Aquatic Habitat

225. The Applicant has proposed to operate the Project in an IEO manner for the majority of the time, with flexible operations that vary from season to season. As part of the relicensing

(Study 9), the Applicant conducted a flow habitat study, also referred to as a physical habitat simulation (PHABSIM) or hydraulic habitat study.

226. Six mesohabitat types were identified in the Wilder riverine reach. These mesohabitat types include pool (deep pool, shallow pool), glide, run, riffle, rapid, and cascade. Transects were selected in the field in consultation with the Applicant, consultants, applicable agencies, and non-governmental stakeholders.

227. A total of 44 transects were selected in the Wilder riverine reach. A total of 14 transects were located in either deep or shallow pools, 13 were located in runs, 10 were located in glides, and 6 were located in riffles. It is important to note that the Wilder riverine reach accumulates additional drainage area depending on the location of the transects due to accretion of additional direct drainage, but primarily drainage captured by tributaries (e.g. White River and Ottauquechee River).

228. 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.

229. Within each section, depth and velocity were also collected at three flows for model calibration. The target flows for calibration were 700 -2,000 cfs, 5,000 cfs, and 10,000-12,000 cfs. Depth and velocity measurements were primarily obtained with an ADCP (acoustic doppler current profiler) which was moved across the river channel multiple times.

230. 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 (675 cfs) and maximum (10,700 cfs) hydraulic capacity of the Project.

231. Each section across a transect was then evaluated for suitability for a series of target species and life stages. Target species and life stages include 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, dwarf wedgemussels, and co-occurring mussels.

232. 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 would offer an opportunity to review available habitat in a broader context, in addition to species specific information.

233. Habitat suitability curves typically include information on 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.

234. 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.[8]

235. 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 who is considered immobile and therefore cannot readily move to a location with suitable habitat when habitat suitability changes.

236. 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 who could be expected to move from one location to another to seek suitable habitat.

237. 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 Wilder riverine reach, rather than a flow that accommodates all species. This is understandable given the wide variety in species of interest and the variances in habitat preferences. However, some general conclusions can be made.

238. The amount of suitable habitat that remains under either a dual flow or two flow analysis is greatest when the magnitude of those changes is reduced. For example, white sucker fry are considered an immobile species and were evaluated under a dual flow analysis. When flows change from the minimum capacity of the project, 700 cfs, to the maximum capacity of the Project, 10,700 cfs, the amount of habitat lost is 90 percent. However, if the base flow is increased and the magnitude of change between the two flows is 5,000 cfs to 10,700 cfs the percent of habitat lost is reduced to 40 percent. This trend is repeated for most immobile species, although some not to the same degree observed for white sucker fry.

239. 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 habitats as needed, although this comes at an energetic cost for any mobile species. With a base flow of 700 cfs to a high flow of 10,700 cfs, 62 percent of the

[8] The delphi process is a discussion between a group of experts in an effort to reach consensus on a topic. For the delphi based HSC curve development, the process 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 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.

habitat is lost. If the base flow is increased to 5,000 cfs and the peak is 10,700 cfs 43 percent of the habitat is lost. This trend is similar for other mobile species.

240. In addition to the potential energetic cost of changing locations for suitable habitat, there is a concern that if these fluctuations occur too rapidly some fish could become stranded. The likelihood of this occurrence depends on the species, its swimming ability, and preferred habitat. For example, a fish species that prefers shallower depths are more likely to become stranded than a fish that prefers pool type habitats.

241. Lifestages such as spawning, incubation, and fry are not present year-round, and the specific timing can fluctuate from year to year. These lifestages are often, depending on the species, more sensitive to changes in flow due to their immobility and weak swimming capabilities, and on occasion more limited range in suitable depths, velocities, or substrate types. Sensitive species are those that are considered immobile and as a result the immobile species typically have less available habitat under fluctuating flows.

242. Study results indicate that when considering a single optimized flow at a seasonal level there is 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 smaller the change, the greater the amount of suitable habitat.

Water Level Fluctuation in the Impoundment

243. 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.

244. The Project will also operate in a flexible operations mode, of which the allowable frequency varies seasonally. During flexible operations, the impoundment will fluctuate which may effect, immobile species such as dwarf wedgemussel (see Rare, Threatened, and Endangered Species section), 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).

245. 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 an area of the impoundment may be dewatered. Specifically, the employment of up ramping rate and the requirement to refill within 48-hours after flexible operations have ended.

246. 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 available within the impoundment.

Stream Processes and Physical Habitat Structure

247. 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 § 29A-102 (43)).

248. 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, § 29A-102 (34)).

249. Erosion is a natural process that occurs in waterbodies. There are a number of forces acting on the substrates, channels, and corridors of rivers. 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.

250. The Connecticut River has been historically straightened and armored. Reasons for this have typically been to facilitate economic activity, for example log drives and armoring of railroads. Channel 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 with 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.

251. As part of the Project relicensing, the Applicant conducted erosion studies (studies 1-3) along roughly 250 miles of streambank over the course of 2 years. In addition to the physical measurements that took place over the 2-year study, the Applicant also acquired historical photos in an effort to examine the historical erosion rates through time.

252. 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 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 rate of movement per year.

253. It is important to note that this analysis is imperfect, 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.

254. Within the Wilder impoundment there was considerable change between the 1939/1940 photos and the 1953/1955 photos, with the rate of change occurring most dramatically in the area close to the Wilder dam. It is worth noting that the original Wilder license authorized the removal of the Olcott Falls dam and construction of the current Wilder Dam, resulting in an increase in generating capacity and the maximum operating elevation was raised sixteen

feet. It is likely the changes in photos are a result of bank inundation and not explicitly erosion.

255. Aerial photos taken after 1953/1955 within the Wilder impoundment suggested changes occurred more often in the upper reaches of the impoundment and lack of change closer to the dam. The rate of change post 1953/1955 was less than that of the previous historic photos.

256. The two-year field study was conducted between 2013 and 2015 visiting 10 sites within the Wilder Project area (six within the impoundment and four in the riverine reach) on eight different occasions. At the time of the study the Applicant was operating under the previous license and not under the Applicant's current proposal. The Applicant did surveys along a single transect, took repeated photos of the bank, and monitored water levels at 15-minute intervals. Additionally, the Applicant described the banks' sediments and did a one-time survey across the full river channel at the site.

257. Over the course of the study within the impoundment, four of the six sites' erosion was observed. Within the riverine reach of the Project, erosion was observed at two of the four sites. At one of the sites within the impoundment erosion was observed at the top of bank between the fall and spring observation, suggesting high spring flows may have contributed.

258. The Applicant examined the water surface elevation data for changes during normal operations relative to the height of erosion along the banks. 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.

259. At the most upstream impoundment site, 0.5 feet of sediment was removed at the mid-bank scarp. This location was located higher up on the bank outside of normal Project operations median water surface elevation fluctuations and was not considered to be eroding due to Project operation.

260. The second site was located on a bend within the river. This is the location of erosion along the upper bank which resulted in 4.5 feet of material moving. This material eventually moved down the slope and was removed over the course of the two years. The original upper bank erosion was located roughly 10 feet higher than the median water surface elevation fluctuations.

261. The third site is located within the mid impoundment across from a wetland marsh. At this location, minor material loss was observed at the top of bank where there was an overhang, at the mid bank, and at the toe of the bank where some notching occurred. Along the base of the toe, material was both added and removed over the course of the two years. Both the top and mid banks are outside the height of normal Project operations. The notching near the lower bank is near or within the median water surface elevation fluctuations and the base of the toe where sediment was added and removed is within the median water surface elevation of water level fluctuations.

262. The fourth site is located in the mid lower section of the impoundment across from the railroad on a slight bend in the river. There was no movement at the top of bank and some sediment fell from overhang in the upper bank. Material was lost at the mid bank and

removed from the transect by notching at the lower bank. The material loss within the upper bank and mid bank are higher than the higher of normal Project operations. Material removal and notching at the lower bank in addition to the removal and added material at the base of the bank are within the median water surface elevation fluctuations of the Project.

263. The fifth site located within the impoundment is further downstream from site four and is across from a wetland marsh. Material was observed falling from an overhang at the top of the bank. A planar slip developed and moved lower down the bank, eventually depositing at the toe of the bank where notching occurred. All sediment movement observed above the notching were higher than the median water surface elevation fluctuation.

264. The sixth site located within the impoundment was located closest to the dam a short distance downstream of Girl Brook, and across from an armored bank. There were no observed changes at this site during the two-year study period.

265. The first riverine site is located the furthest upstream a short distance from the Wilder facility. There were no observed changes along the upper bank or the toe of the bank. Some sand was removed from a wider face during the winter. This was considered as an eroding site. All locations of bank movement were higher up on the bank than median water surface elevation fluctuations.

266. The second riverine site was located further downstream across from the outlet of the Ottauquechee River. There were no observed changes at any location of the bank at this site.

267. The third riverine site was located further downstream, a short distance upstream of Blow-me-down Brook. Any movement of material was limited to sand and silt deposition on a grassy bench. This area of the bank is higher than the median water surface elevation fluctuations.

268. The fourth Wilder riverine site was located further downstream and a short distance downstream of Chase Island. At this transect, there were multiple clay detachment slumps that occurred through the two-year monitoring, with a clay delta being observed at the base of the bank. This site was considered as an eroding site. One noteworthy aspect of this site is that a number of seeps at the upper extent of the bank were observed. Except for the very lowest clay slump, all other slumps occurred higher than the median water surface elevation fluctuations under normal Project operations. It is likely the seeps at the top of a clay-based bank caused the numerous slumps at the fourth riverine site.

269. 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 what conditions substrates would be moved into the water column.

270. The Applicant used the D50 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 sites, substrate size results indicate that the next dominant size class was only slightly larger or smaller than the substrate size used in the analysis.

271. The HEC- RAS model simulated a consistent surface water elevation and then modeled low (700 cfs), medium (5,000 cfs), and high (12,000 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.

272. 10 sites were evaluated within the Wilder project area for project effects. Three of the seven sites showed that under some circumstances near bank velocity was greater than the critical shear stress. In two circumstances it required a velocity associated with a flow of 12,000 cfs, in the other it had the potential to occur at either 5,000 or 12,000 cfs.

273. The preceding findings (findings 257- 272) describe observations at specific monitoring locations, but there is recognition that the magnitude of impoundment water surface elevation changes depends on the location within the impoundment related to Project operations. This is in part due to the hydraulic controls located within the impoundment shorelines and the inflow from both upstream and tributaries to the impoundment. As part of relicensing, the Applicant developed water surface elevation nodal data from the top of the impoundment to the Wilder Dam. This allows the Applicant for representative years and months to model the minimum and maximum daily average elevation changes throughout the impoundment (findings 64- 66). There are a total of 381 different nodes or locations where water surface elevation is modeled between the Wilder dam and the top of the impoundment. These nodes are located at relatively equal segments. A series of nodal data from the dam area to the most upstream of the impoundment can be analyzed to assess changes in water surface elevation using the model provided by the Applicant.

274. In the tables below, eight nodes are roughly evenly spaced between the Wilder dam and the upper impoundment and should be representative of what is occurring within most of Wilder impoundment. Due to the intensity of the model, the years and months are intended to represent both seasonal operational changes and a range of hydrologic conditions that would be anticipated.

275. Table 18 is the modeled results of the difference between average minimum water surface elevation per month and the average maximum daily surface water elevation for proposed operations. Table 19 is the modeled results of the difference between average minimum water surface elevation in each month and the average maximum daily surface water elevation in an IEO mode, or as if the Project were strictly passing any inflow downstream.

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

Year	Month	Node 920	Node 970	Node 1020	Node 1070	Node 1120	Node 1170	Node 1120	Node 1250
2009	Feb	0.4	0.4	0.4	0.4	0.4	0.6	1.2	0.7
	June	0.1	0.2	0.3	0.5	0.8	1.5	3.0	1.7
	Aug	0.2	0.2	0.3	0.5	0.8	1.5	2.9	1.6
	Nov	0.3	0.4	0.5	0.7	0.9	1.4	2.3	1.3
2015	Feb	0.2	0.3	0.3	0.3	0.3	0.5	1.0	0.6
	June	0.2	0.3	0.6	1.0	1.3	1.8	2.1	1.0
	Aug	0.1	0.1	0.2	0.2	0.4	0.9	2.7	1.5
	Nov	0.3	0.3	0.3	0.3	0.3	0.4	1.0	0.6
2016	Feb	0.4	0.4	0.5	0.6	0.8	1.3	2.3	1.3
	June	0.1	0.1	0.1	0.2	0.3	0.5	1.4	0.8
	Aug	0.1	0.1	0.2	0.2	0.3	0.6	1.7	1.0
	Nov	0.3	0.3	0.3	0.3	0.4	0.5	0.8	0.5
2017	Feb	0.4	0.4	0.5	0.6	0.8	1.1	1.7	0.9
	June	0.1	0.2	0.3	0.4	0.7	1.2	2.2	1.3
	Aug	0.1	0.1	0.2	0.2	0.2	0.4	1.9	1.0
	Nov	0.3	0.3	0.4	0.5	0.7	1.0	1.5	0.8

Table 19. Modeled results of the difference between average minimum water surface elevation per month and the average maximum daily surface water elevation for inflow equals outflow, or as if the Project was only passing flows that entered the impoundment. Years represent different types of hydrological years from wet to dry. The months (February (Feb), June, August (Aug), and November (Nov)) are representative of different seasons and number of flexible hours.

Year	Month	Node 920	Node 970	Node 1020	Node 1070	Node 1120	Node 1170	Node 1120	Node 1251
2009	Feb	0.0	0.0	0.1	0.1	0.2	0.5	1.2	0.7
	June	0.0	0.1	0.2	0.5	0.8	1.5	3.0	1.7
	Aug	0.0	0.1	0.2	0.5	0.8	1.5	2.9	1.6
	Nov	0.0	0.1	0.2	0.5	0.8	1.3	2.3	1.3

Table 19. Continued.

Year	Month	Node 920	Node 970	Node 1020	Node 1070	Node 1120	Node 1170	Node 1120	Node 1251
2015	Feb	0.0	0.0	0.0	0.1	0.2	0.3	1.0	0.6
	June	0.1	0.3	0.5	0.9	1.3	1.8	2.1	1.0
	Aug	0.0	0.1	0.1	0.2	0.4	0.8	2.7	1.5
	Nov	0.0	0.0	0.1	0.1	0.2	0.4	1.0	0.6
2016	Feb	0.0	0.1	0.3	0.5	0.8	1.3	2.3	1.3
	June	0.0	0.0	0.1	0.1	0.2	0.5	1.4	0.8
	Aug	0.0	0.0	0.1	0.2	0.3	0.6	1.7	1.0
	Nov	0.0	0.0	0.0	0.1	0.2	0.3	0.8	0.4
2017	Feb	0.0	0.1	0.2	0.4	0.6	1.0	1.7	0.9
	June	0.0	0.1	0.2	0.4	0.6	1.2	2.2	1.3
	Aug	0.0	0.0	0.0	0.1	0.2	0.4	1.9	1.0
	Nov	0.0	0.1	0.2	0.4	0.6	0.9	1.5	0.8

276. There are several similarities between the two tables, including greater changes in water surface elevation in the upper reaches of the impoundment (higher numbered nodes), and the range of water surface elevations. For the proposed operations, the daily average difference between minimum and maximum surface water elevation ranges from 0.1 to 3.0 feet. Similarly, under an IEO mode the range of the difference in minimum and maximum water surface elevation changes is 0.0 to 3.0 feet.

Protection and Support of Life Cycle Functions

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

278. The Applicant conducted a spawning study as part of the relicensing effort. The study involved observing various nesting sites for species of interest, both backwater spawners and tributary spawners, in both early-spring and late spring. It also included an analysis of the effects of fluctuating impoundment water levels and downstream flows associated with current operations.

279. 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 targeting depths less than five to six feet deep.

280. Six backwater sites were selected within the Wilder impoundment and seven 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 fisherman reports, or Agency reports.

281. Within the riverine reach, site selection again 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.

282. Seven sites were selected at riffles and seven sites were selected at islands in the Wilder 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 fisherman reports or Agency reports.

283. Additional data was collected within the vicinity of each study site. These include 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.

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

285. 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 2015 spawning observations to five different water years using the operations model developed in study 5.

286. 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 would abandon a nest, and if depths were less than one foot, smallmouth bass species 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.

287. 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 the 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.

288. Within the Wilder impoundment and riverine areas, two sites, both tributaries, revealed white sucker eggs, on 11 of the 66 egg blocks deployed, but no evidence of walleye eggs were documented. Northern pike and chain pickerel were not observed to have any spawning sites, despite extensive effort expended. Angling encountered the occasional individual that had recently spawned or would be spawning imminently.

289. Within the Wilder impoundment, numerous yellow perch egg masses, largemouth bass nests, and sunfish nests were located (bluegill, pumpkin seed, and unknown species), totaling 225, 3, and 4, respectively.

290. Of the Wilder impoundment sites, the percentage of yellow perch egg masses that were vulnerable to dewatering ranged from 45 percent to 84 percent and averaged 71 percent in 2015. It should be noted that there is the assumption that the day the eggs were fish observed constituted day one of the incubation period.

291. Within the Project impoundment, two of the three (67%) largemouth bass nests were not considered to be dewatered in 2015. The water surface elevation at the third nest dropped below the one foot criteria for a short period of time. Only two of the four observed sunfish nests were evaluated for dewatering due to logger malfunction. It was estimated that neither of those nests were vulnerable to dewatering in 2015.

292. For the late spring spawning species, a total of 14 smallmouth bass nests were located within the impoundment, five fallfish nests were located in the riverine reach, along with 21 smallmouth bass nests. Three of the five (60%) fallfish nests and four of the 35 (11%) smallmouth bass nesting sites were determined to be vulnerable to dewatering in 2015.

293. 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 fish nest locations were then compared to five different hydrologic years, spanning a range of hydrologic conditions from dry to wet. Table 20 provides an estimate of the average proportion of days 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 the 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 % days below min (Precent of days below minimum elevation of nest), % days below median (percent of days below median height of nest), and % days below max (percent of days below the maximum elevation of nests). The locations are all from the Wilder Project area and include BW (back waters), Island type areas, and Tribs (tributaries). Each value varies depending on the species of interest.

		Species	**Yellow Perch**	**Sunfish**	**Fallfish**	**Smallmouth Bass**	
		Reach/habitat types	**Wilder BW**	**Wilder BW**	**Wilder Islands**	**Wilder Tribs**	**Wilder Islands**
1992	**Driest year**	% days below min	10%	62%	61%	6%	48%
		% days below median	45%	64%	61%	41%	54%
		% days below max	77%	70%	61%	46%	79%
1989		% days below min	8%	42%	33%	0%	44%
		% days below median	33%	50%	34%	22%	50%
		% days below max	69%	61%	34%	35%	74%
1994	**Average Year**	% days below min	21%	26%	40%	2%	38%
		% days below median	53%	33%	40%	11%	39%
		% days below max	83%	45%	42%	31%	64%
2007		% days below min	21%	26%	35%	2%	38%
		% days below median	42%	43%	35%	20%	48%
		% days below max	65%	49%	36%	31%	70%
1990	**Wettest year**	% days below min	27%	32%	31%	0%	40%
		% days below median	62%	37%	32%	19%	45%
		% days below max	90%	42%	32%	31%	69%

294. 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. While many visual surveys took place, the likelihood of observing spawning areas lower in the water column and early in the season was limited due to turbidity. Therefore, it is likely that there were additional spawning areas not observed.

295. The Applicant also conducted a spawning study specific to sea lamprey (study 16). The study involved first identifying suitable spawning locations within the Wilder riverine reach

downstream of the Project. The Wilder reach was divided into 3 reaches; subreach one from Wilder dam downstream to the confluence with the White River; subreach 2 from the White River downstream to Sumner Falls; and subreach 3 from Sumner Falls to the Bellows Falls impoundment. Within those areas a total of 7 sites were identified that contained suitable habitat.

296. In addition to locating areas with suitable habitat for evaluation migrating sea lamprey were tagged with radio transmitters in order to determine specific spawning habitat locations. Following standard methodology for tag implantation and after a period of time which allowed sea lamprey to recover, they were released into the Bellows Falls impoundment approximately 1.25 miles above the Bellows Falls dam.

297. Of the 20 fish that were released upstream of Bellows Falls, one was never relocated, two moved downstream, one into the Vernon impoundment and one in the Bellows Falls riverine reach, 10 remained in the Bellows Falls impoundment, leaving 7 that moved upstream into the Wilder riverine reaches. Relocated lamprey were used to confirm spawning activity and site locations, or change the pre selected spawning habitat locations

298. The results of the lamprey tagging indicated that lamprey migrate long distances with some being observed movign up into a tributary, returning to the Connecticut River mainstem, them migrating into another tributary. Additionally, multiple fish were observed at multiple spawning survey locations. This could indicate simply circumstantial observations as individuals were in the vicinity of suitable habitat.

299. Two spawning survey locations within the Wilder riverine reach did not have verified spawning activity, through either the radio telemetry, or visual observations during the spring or later in the year when sites were visited again under low water conditions. It was observed at some sites that there were high concentrations of spawning activity including around an island downstream of the Wilder Project.

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

301. There were 7 sites of interest in the Wilder riverine reach. One site was considered to have a Project effect, meaning the nest was exposed in all modeled years. Four of the sites were considered to have a moderate project effect, meaning the nest was dewatered in one or more modeled years or the nests were continuously submerged for all modeled years. The last two sites were not assigned because the area was considered to be unsuitable habitat or there was no observed spawning.

K. Wildlife and Wetlands

302. The Vermont Water Quality Standards 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).

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

304. 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 in acreage.

Cover Type	Wilder Impoundment	Wilder Riverine
Deciduous Forest	141.3	7.7
Coniferous forested	0.7	0
Mixed forested	5.3	0
Deciduous forested/shrub	1.7	0
Deciduous forested/emergent	0	0
Scrub-shrub	48.3	1.8
Scrub-Shrub/emergent	25.6	0.6
Emergent	133.1	4.7
Phragmites	7.3	0
Perennial stream	7.1	1.9
Intermittent stream	1.2	0.4
Pond	11.6	0
Possible vernal pool	0.5	0.3
Submergent aquatic vegetation	318.0	0
Total	**701.7**	**17.4**

305. A total of 701.7 acres of wetland habitats are contained within the Wilder impoundment and 17.4 in the riverine reach below Wilder. These wetland types consist of a wide 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.

306. Deciduous forest, emergent, and submergent aquatic vegetation are the three wetland types that are most prevalent within the Wilder impoundment. Deciduous forested wetlands are generally found in the medium to large backwater areas, along point bars, and some tributaries. 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.

307. 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, water-horse tail among others. These types of wetlands are typically saturated or frequently inundated. Emergent wetlands can be found in coves, protected shorelines, and the mouths of tributaries. In the Wilder impoundment, these wetland types are located primarily in the upstream reach of the Project from Fairlee, Vermont to Bradford, Vermont.

308. Submerged aquatic vegetation wetlands consist of floating or submerged vegetation and typically grow in shallow water zones, which for the Wilder project is at the mouths of tributaries and in the lower portions of the impoundments. The most common vegetation species found in the Connecticut River for these types of wetlands are water lily, Eurasian water-milfoil, water celery, waterweed and water stargrass. While these species are the most common, they vary in density and canopy cover depending on the location.

309. 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. The following table (Table 22) provides the six most common wetland types and the functions and values provided.

Table 22. Six most observed wetland types and the functions and values provided within the Wilder 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.

310. 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 included, 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.

311. 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 most affected by artificial hydrologic alteration like operations of a peaking facility.

312. 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 but are outside of the capacity of the Project. The specific communities evaluated include submerged aquatic vegetation and emergent and scrub/shrub wetlands. Water level fluctuations were recorded in Wilder impoundment as part of an aquatic habitat mapping study.

313. There were two locations within the impoundment where wetland vegetation and a depth logger were within the same vicinity. Those were at the Lake Morey brook confluence with submerged aquatic vegetation and emergent and scrub/shrub wetlands. At this location, where the impoundment at the dam fluctuated 2.5 feet, the study site experienced a change of 3.8 feet. This is, in part, due to the location of the wetland in the mid impoundment. 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.

314. Both wetland types occurred 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.

L. Rare, Threatened, and Endangered Species

315. 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*), northern long-eared bat (*Myotis septentrionalis*), Fowlers toad (*Anaxyrus fowleri*), cobblestone tiger beetle (*Cicindela marginpennis*), shortnose sturgeon (*Acipenser brevirostrum*), 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*).

316. While all rare, threatened, and endangered species have the potential to be affected by Project related activities, not all are subject to the Vermont Water Quality Standards. The following table includes those 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 Wilder 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	Fowlers 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	*Jessups Milk Vetch*	E	E
Scirpus ancistrochaetus	Northeastern bulrush	E	E

a T=Threatened; E=Endangered.

317. 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

318. 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 1st and October 31st. 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

319. 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.

320. While Jessup's Milk Vetch is not located within the Project boundary, it is located within the vicinity of the Project area. Flows released from Wilder can potentially impact the plant located at Sumner Falls, or in the most upstream portion of the Bellows Falls impoundment at the Jarvis Hill site.

321. 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.

322. Jessup's Milk Vetch requires high flows to successfully grow and reproduce year after year. Debris from vegetation covers individual plants in the fall, which helps with protection during the winter season. However, for successful growth, debris should be removed starting in the spring and remain uncovered in the summer months. This requires high flow events to remove vegetative material covering the plants.

323. In consultation with Vermont's state botanist, it is estimated that the ideal flow that would be required to remove debris from Jessup's Milk Vetch would be between 40,000 cfs and 60,000 cfs.

Dwarf wedgemussel

324. Dwarf wedgemussel (*Alasmidonta heterodon*) is state and federally listed as endangered. Known occurrences of dwarf wedgemussel (DWM) occur within the Wilder impoundment and within the riverine reach downstream of the dam. DWM habitat includes slow to moderate velocities, with substrate preferences of gravel, sand, and cobble. They do not prefer silt but may burrow in sand with a small layer of silt.

325. The U.S. Fish and Wildlife Service has identified actions needed for the protection of DWM. These actions are to collect basic data needed for protection; preserve populations and occupied habitats; develop educational programs; conduct life history studies and identify ecological requirements of the species; re-establish populations within the species historical range; implement a program to monitor population levels and habitat conditions; and periodically reevaluate the recovery program.

326. For DWM, fertilization 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.

327. 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.

328. The glochidia are not released until spring, beginning in early March. The glochidia must attach to host fish to complete their development. Additionally, this helps with dispersal of the species.

329. Host species for DWM within the Wilder project area include the tessellated darter (*Etheostoma olmstedi*) and the slimy sculpin (*Cottus cognatus*). Tessellated darters were the primary focus for the DWM host species for the relicensing effort. Tessellated darter are known to occur in the Wilder impoundment and in the riverine reach. Their distribution and habitat may be affected by Project operations, and therefore potentially affect DWM.

330. The Applicant conducted numerous studies related to DWM as part of the relicensing process. These studies included a habitat flow study, hydraulic model and operations assessment, tessellated darter study, and development of habitat suitability criteria for the species.

331. Multiple fish surveys collected tessellated darters within the Wilder impoundment and downstream reach. The quantity or catch-per-unit varied depending on the sampling technique used. There was a significantly higher ($p = 0.0025$) catch-per-unit effort of tessellated darted in the Wilder impoundment relative to the other reaches sampled. These included the Wilder Riverine, Bellows Falls Impoundment, Bellows Falls Riverine, Vernon Impoundment, and Vernon Riverine.

332. The tessellated darter study found that most individuals were collected in waters less than eight feet deep. Tessellated darter were observed in locations of mussel activity or near mussel locations and were widely distributed within the Wilder impoundment and riverine reaches.

333. The habitat flow study conducted by the Applicant suggested that suitable habitat availability for tessellated darter is relatively moderate at the lowest flows, increases with rising flow rates, maximizes near 2,000 cfs, and then gradually decreases.

334. DWM were also part of the habitat flow study. (findings 225-237). The steady state analysis indicated that the availability of suitable habitat for DWM declined steadily with increasing flow. Similar effects occurred at locations specifically chosen to be analyzed for DWM habitat, including areas around Chase Island and Johnston Island. Additionally, the dual flow analysis showed that the amount of habitat remaining under either a dual flow or two flow analysis is greatest when the magnitude of flow change is reduced.

335. In addition to the downstream flow considerations, mussels are also located within the impoundment. The operations study indicated that there are potential impacts of water level fluctuation on DWM primarily through the potential for dewatering.

336. As part of the relicensing effort, the Applicant conducted field surveys for DWM within the Wilder impoundment, the riverine reach below Wilder, the Bellows Falls impoundment and riverine reach, and the Vernon impoundment. During the field survey for DWM 64 sites

within the Wilder impoundment were surveyed. DWM were found at 17 of the 64 sites (26.6 %) primarily at sites located 27 to 41 miles upstream of the Wilder dam.

337. A total of 69 DWM were found during the survey of all the study area, with a total of 45 DWM being found in the Wilder impoundment for an average of 0.7 mussels/site and an average catch per unit effort (CPUE) of 0.68 mussels/hour. The average shell length was 26.77 mm with and minimum length of 18.0 mm and a maximum length of 37.0 mm. Additionally, the field survey found evidence of recruitment within the Wilder impoundment. Nearly all DWM were found in water depths of 8 to 20 feet using scuba gear. Snorkeling the near shore areas during the survey was ineffective.

338. While no individual DWM were found in the area subject to frequent water level management during the survey, the time spent moving in response to relatively rapid changes in water level that occur under current operations may affect DWM.

339. Under the Applicant's proposal of IEO with flexible operations there is an increase in persistent habitat by stabilizing and reducing impoundment fluctuations and providing multiple consecutive day period at IEO each month during the DWM active period from April 1 through October 15 (>3 days) (see Table 8 and Table 18). Periods of IEO are intended to facilitate successful breeding and support other life cycle requirements.

340. Additionally, the Applicant's proposal includes a component to protect DWM overwintering habitat. The pre-winter habitat protection operation is intended to create overwintering habitat that is protected from potential water drawdowns that could expose mussels. As discussed in finding 313, mussel activity drops when water temperatures drop below 15°C. The Applicant is proposing to lower the water level at the Project to an elevation at or above the low limit of flexible operation impoundment range and maintain it at the elevation for a limited period of time (estimated at 10 to 21 days) during which water temperature is consistently dropping from 15°C to 10°C. This will likely occur in late October to early November.

Dragonfly and Damselfly

341. 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.

342. Of those seven odonate species, five were located within the Wilder project affected area. These include *Gomphus abbreviates, Gomphus quadricolor, Ophiogomphus rupinsulensis, Stylurus amnicola,* and *Stylurus scudderi*. These species were observed at multiple transects within the Wilder riverine or impoundment reaches.

343. Odonates spend one or more years in a larval stage within the water. The adult lifestage then exits 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.

344. 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, the individual has limited ability to climb the riverbank or vegetation in response to threats.

345. From previous 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 21st to July 31st. Observation of adults has occurred as late as September 20th.

346. Most species observed in the odonate study were the species Gomphus vastus (focal species) and Stylurus spiniceps. A total of 754 observations were made of odonates or their exuviae.

347. For the odonate study, surveys were conducted between 07:00 and 20:00 hours. 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.

348. Within the Wilder project affected area, a total of 231 odonate observations were made. Of these, 227 were exuvia and four were observed in the teneral or eclosion phase. The distance from the waterline for the four emergence phase individuals was either 14 inches or 204 inches. For the exuvia observations, they ranged from 0 inches to 201 inches with an average of 29 inches above the waterline. It should be noted that some exuviae could have been located at lower water elevations and subsequently inundated or swept from the bank when water levels rose.

349. It should also be acknowledged that the elevation of the waterline was subject to change during the study as water levels fluctuated. Therefore, some vertically measured exuviae could have been further from the waterline or closer to the waterline when eclosion took place.

Cobblestone and Puritan Tiger Beetles

350. Puritan tiger beetle *(Cicindela puritana*) is listed as federally threatened and is listed as threatened 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.

351. Cobblestone tiger beetle (*Cicindela marginipennis*) is listed as threatened in both New Hampshire and Vermont. Cobblestone tiger beetle (CTB) have been located within 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.

352. GRH conducted a study with a focus on CTB because of more recent confirmations of the species in the project affected areas. The focus was on the adult stages of CTB given the challenge of correct identification of larval burrows.

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

354. Within the Wilder project affected area, five study sites were located based on previously recorded observations, and in areas where habitat typical of CTB is located. All sites were located within the Wilder riverine section and were located near the Mascoma River, Johnston Island, Burnaps Island, Sumner Falls, and Hart Island.

355. CTB were identified at three of the five study sites. Those sites are Johnston Island, Burnaps Island, and Hart Island. At all three study sites mating behavior was noted. At each of the study sites where CTB were identified, it was estimated that there were 0.44 acres, 1.19 acres, and 1.75 acres of habitat available.

356. The minimum and maximum habitat elevation was measured at each study site. Additionally, GRH used a model developed as part of the relicensing to estimate the maximum modeled water surface elevation that might occur at each CTB site. This can be performed under the proposed operations (finding 113) and under IEO conditions (findings 64 and 65) for a series of years (2009, 2015, 2016, 2017) in limited months. In this case, the months analyzed are June and August of each year when it is anticipated that CTB will be most active.

357. The tables below are limited to specific nodes (locations of transects where water surface elevation was estimated) where CTB were located within the reach below the Wilder Project. This nodal information was provided in the study. The tables indicate the difference between the average maximum daily water surface elevation and the daily minimum water surface elevation. Table 24 is representative of the proposed operations and Table 25 is representative of the Project not altering flows and strictly passing inflow into the Project.

Table 24. Difference between the average maximum daily water surface elevation and the daily minimum water surface elevation for specific locations where cobblestone tiger beetles were located in the Wilder Project area. Values are based on the modeled proposed operations for different water years and months of interest. The months in the table below are limited to those time frames when cobblestone tiger beetles are anticipated to be active.

Year	Month	Johnston Island Node 839	Burnaps Island Node 807	Hart Island Node 752
2009	June	1.4	1.5	1.6
	Aug	1.4	1.6	1.6
2015	June	1.5	1.6	1.5
	Aug	1.0	1.3	1.5
2016	June	0.7	0.9	1.1
	Aug	0.9	1.1	1.4
2017	June	1.2	1.4	1.4
	Aug	0.8	1.1	1.7

Table 25. Difference between the average maximum daily water surface elevation and the daily minimum water surface elevation for specific locations where cobblestone tiger beetles were located in the Wilder Project area. Values are based on the modeled operations, if the Wilder Project did not alter flows (inflow equals outflow), for different water years and months of interest. The months in the table below are limited to those time frames when cobblestone tiger beetles are anticipated to be active.

Year	Month	Johnston Island Node 839	Burnaps Island Node 807	Hart Island Node 752
2009	June	1.3	1.4	1.5
	Aug	1.3	1.4	1.4
2015	June	1.6	1.6	1.5
	Aug	0.9	1.1	1.3
2016	June	0.7	0.9	0.9
	Aug	0.7	0.9	1.0
2017	June	1.2	1.3	1.3
	Aug	0.5	0.6	0.8

Fowler's Toad

358. 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 habitat requires a mix of both wetland pools and bare soils. Its optimal habitat may benefit from the occasional shoreline disturbance to keep the areas unvegetated and so that the floodplains may provide small pools for breeding.

359. 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.

360. Fifteen study sites were identified. However, through the course of the study, some sites were determined to be outside of the project affected area or unsuitable habitat for Fowler's toad.

361. 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.

362. For the standard call survey, each site was visited three times with approximately two weeks between each visit. At each site, the surveyors spent three minutes listening and recording calls after sunset. For acoustic monitoring collection, 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 on an SD card for later retrieval and analysis.

363. Of the fifteen sites, five were in the Wilder riverine reach. Three sites used the standard call method and two employed acoustic monitoring. No calls were heard within any of the Wilder riverine sites during the study.

Northeastern bulrush

364. Northeastern bulrush (*Scirpus ancistrochaetus*) is federally listed as endangered and is also classified as endangered 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.

365. It was determined that there is no suitable habitat for the Northeastern bulrush in the Wilder project affected area.

Shortnose Sturgeon

366. Shortnose sturgeon (*Acipenser brevirostrum*) 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 4 feet and can live up to 30 years or more, and do not reach reproductive maturity until they are 10 to 12 years old.

367. The historic range of 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 Turners Falls dam was built in 1905, as the falls were not believed to be passable by sturgeon to access the upstream reaches. In recent years shortnose sturgeon have been documented below Bellows Falls Project. However, no individuals have been observed in the Wilder Project affected areas.

368. The National Marine Fisheries Service (NMFS) is the federal agency responsible for research and prescribing conservation and management needs for the endangered shortnose sturgeon. 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 needed to protect them.

M. Recreation

369. The Wilder Project area encompasses 123 acres of land. Fifty-nine acres are available to outdoor public recreation, 10 acres are currently licensed to Dartmouth College, and 11 acres abut other parcels a short distance upstream and downstream on both the Vermont or New Hampshire sides. The remaining 43 acres are associated with the dam and generation facilities. Several 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

370. The Applicant undertook a recreation 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 opportunities, in-person surveys for individuals utilizing recreational areas, a questionnaire mailed to residents in the region, and an estimate of future use and capacity at recreational locations. Where applicable, the study distinguished between two seasons: the peak season representing May 1 through October 15, and the off-peak season for the remainder of the year.

371. The Applicant identified several recreational facilities within the Wilder Project area. These include Hartford Picnic Area at Kilowatt Park (North), Wilder Dam (Olcott Falls) Boat Launch at Kilowatt Park (South), Wilder Dam Portage and Picnic Area, Lebanon Picnic Area Vista and Hiking Trails, Wilder Dam Fish Ladder and Angler Parking, Sumner Falls, Connecticut River Paddlers' Trail Campsites, and Gilman Island/Titcomb Cabin.

372. Of those facilities listed above, the Applicant owns lands at the following recreational locations: Hartford Picnic Area at Kilowatt Park (North), Wilder Dam (Olcott Falls) Boat Launch at Kilowatt Park (South), Wilder Dam Portage and Picnic Area, Lebanon (Wilder Dam) Picnic Area Vista and Hiking Trails, Wilder Dam Fish Ladder and Angler Parking.

373. There is one Connecticut River Paddlers' Trail Campsite located in the Wilder Project area at Gilman Island/Titcomb Cabin. The Applicant owns the island and leases the land to Dartmouth College. The cabin is run by the Ledyard Canoe Club of Dartmouth College and rented by the club to interested groups.

374. The current Wilder dam portage trail is roughly 0.2 miles long, with the first portion running along a grassy bank next to a highway, over a gravel roadway to a set of stairs, and then to the gravel beach area for launch.

375. The recreational facilities owned by the Applicant and other recreational facilities located in the Project area receive relatively equal use. The summary of estimated visitations between April 2014 and April 2015 was 119,093 at the Project recreation sites and 115,307 at other public recreations sites in the study.

376. Of the Project recreational facilities, the greatest estimated use occurred at Hartford Park (Kilowatt Park South), and nearly half as many visits occurred at the Wilder Picnic area (Kilowatt Park North) during peak season use. The two highest used non-Project owned recreational facilities included Wilsons's (Fullington) Landing, and Sumner Falls during the peak season.

377. 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 0.5, the maximum number of hours spent was 12, with the average number of hours spent being 2.9. The activity that had the longest duration was bicycling/mountain biking, followed by hunting, and then by fishing from either boat or ice fishing. All other activities were reported as having a duration of 4 hours or less.

378. The onsite interviews allowed the Applicant to estimate the distribution of recreational activities for those who were onsite. The most common activity reported was canoeing/kayaking-flatwater with 30 percent of respondents. This was followed by picnicking/family gathering and fishing from shore both of which received 19 percent of the respondents.

379. From individuals who were interviewed on site, there were similar responses in the percentage of primary activities reported when visiting the Connecticut River. These include Canoeing/kayaking- flat water (21.9%), fishing from shore (15.2%), and tied were fishing from boat or ice fishing and walking/hiking (11.7%).

380. When onsite visitors completed the survey, they were asked how scenic the recreational area was and how safe the area felt. The responses are provided in Table 26.

Table 26. Responses from onsite interviewees on various Wilder project area recreational area based on scenic quality and feelings of safety.

Scenic Quality			Safety Ratings Wilder study area			Safety Ratings Wilder Project		
Number of responses	**Rating**	**Reference values**	**Number of responses**	**Rating**	**Reference values**	**Number of responses**	**Rating**	**Reference values**
127	9	Extremely appealing	182	9	Extremely safe	17	9	Extremely safe
29	8		12	8		0	8	
64	7	Appealing	28	7	Safe	5	7	Safe
5	6		1	6		0	6	
25	5	Average	5	5	Neither safe nor unsafe	1	5	Neither safe nor unsafe
1	4		0	4		0	4	
1	3	Unappealing	1	3	Unsafe	1	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

381. For scenic quality, one participant noted it was unappealing due to the exposed gravel across the river, but did note that once the leaves are out, it provides a wilderness feel. Another participant who noted that the Project site felt unsafe due to vandalism and security concerns, also noted that closing the gate helped.

382. When respondents noted in the questionnaire that they felt safe, there were still often comments about how safety could be improved at recreational sites. Some of these related to recognizing 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.

383. Individuals were also asked about their level of satisfaction with the number of public recreational areas, the types of public recreation areas and the location of public recreation areas in the Wilder impoundment and downstream of the facility.

384. Individual responses indicated that 57 percent and 53 percent were extremely to moderately satisfied, 42 percent and 41 percent were neutral, and 2 percent and 4 percent were slightly to not satisfied with the number of public recreation areas in the Wilder impoundment and downstream, respectively.

385. Regarding the satisfaction with the type of public recreation areas 60 percent, 36 percent, and 4 percent indicated being extremely to moderately satisfied, neutral, or slightly to not satisfied with the type of recreation sites in the impoundment where 55 percent, 34 percent and 7 percent indicated being extremely to moderately satisfied, neutral, or slightly to not satisfied with the type of recreation sites in the downstream reach.

386. As for the satisfaction with the location of the public recreation areas 54 percent, 38 percent, and 6 percent indicated being extremely to moderately satisfied, neutral, or slightly to not satisfied with the location of public recreation areas in the Wilder impoundment whereas 49 percent, 44 percent, and 9 percent indicated being extremely to moderately satisfied, neutral, or slightly to not satisfied with the location of public recreation areas in the downstream reach.

387. When onsite via interview, participants were asked about their satisfaction with the recreational facilities and most reported being satisfied with the current existing facilities. Opportunities for improvements were noted and common suggestions included removing trash and adding additional boat ramps. Responses suggesting adding bathrooms and improving road conditions were also common.

388. Specific to Applicant-owned properties, two individuals noted dissatisfaction with the facilities. One was the Wilder picnic area (Kilowatt Park North) and the concern related to “drugs/trash/syringes.” Another response was related to Hartford Park (Kilowatt Park South), noting issues with the boat launch being too flat resulting in getting wet when getting a boat on and off the boat trailer.

389. Regional mail survey respondents were also asked if they had visited any of the recreational facilities offered, and if not, to explain why. Common reasons cited included distance, lack of familiarity, and a lack of interest in recreational activities related to or near water.

390. The regional mail survey respondents also offered recommendations on specific types of facilities needed at the Wilder area sites. Some recommendations for the Wilder Project included boating facilities (access, parking, dock, launch), in addition to trashcans, picnic areas, campsites and river access.

391. The Applicant reviewed the recreational facilities for adequate parking, in addition to reviewing adequacy for future use. The recreational facilities were generally found to be adequate except for the facilities listed below.

392. The Ompompanoosuc launch, while providing a number of parking locations at one time, has a layout that can make it challenging should a poorly parked vehicle with trailer park incorrectly. The Lebanon picnic area vista and hiking trails are popular, but the Applicant uses the adjacent parking lot for various purposes, which can discourage use for parking. The Wilder Dam canoe portage put-in is also used by the Applicant, specifically for debris

which can remove parking opportunities. Both the Two Rivers Park and Ottauquechee Boat Launch can have challenging road conditions particularly during wet times of year. The Cornish boat landing is convenient and sometimes requires individuals to park along N.H route 12. While adequate for canoe launching, the boat ramp is too steep for motorboat launching.

393. There were several comments submitted to the FERC record related to recreational facilities for the Wilder Hydroelectric Project. Some of those include opening a foot bridge across the dam to allow crossing between Vermont and New Hampshire, conserving project owned land that is under FERC jurisdiction, funding a river cruise, and funding for various purposes outside of the Project boundary.

Boating

394. 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)).

395. A State may adopt subcategories of a designated use and set the appropriate criteria to reflect the varying needs of such subcategories of the uses.9 However, a State is not required to adopt subcategories of designated uses and selects the level of specificity it desires for identifying designated uses and 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 Act10. The Department has not adopted any subcategories of the boating designated use.

396. 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 its characteristics and hydrology.

397. There are many types of boaters who utilize the Connecticut River for recreation. This includes motorboaters, scullers, canoeing and kayakers. Of those there are through boaters who travel longer distances on the Connecticut with boats that contain gear typically used for overnight trips. Additionally, there is a group of users that primarily utilize the river for boating for day outings. Another group consists of 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.

398. From the survey done within the Wilder study area of onsite interviews, 30 percent of respondents were there for flatwater boating, 4 percent were at the river for motorboating, while 2 percent were there for whitewater canoeing or kayaking activities. For those who responded to the regional mail survey, which included all Connecticut River hydroelectric

[9] 40 C.F.R. § 131.10 Designation of uses
[10] 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

projects, those percentages were 74 percent, 22 percent, and 10 percent respectively. Several mail in respondents selected multiple activities, so the total percentage far exceeded 100 percent (Table 27).

399. The primary activity that individuals identified when participating in the onsite interviews was flat water canoeing/kayaking at 21.9 percent and whitewater canoeing/kayaking at 1.6 percent. For those who responded to the regional mail survey, which includes all Connecticut River hydroelectric projects, those values were 21.2 percent and 0 percent respectively (Table 27).

Table 27. Primary activity reported by onsite interviewees and main survey respondents as a percentage of all various activities in the Project area. Mail survey resident responses are not Project specific.

Activity type	Wilder interviewees	Mail survey resident respondents
Canoeing/Kayaking- flat water	21.9%	21.2%
Canoeing/Kayaking- white water	1.6%	0%
Motorboating	2.7%	2.4%
Sculling	1.6%	0%
Multiday float trip	0.8%	0%

400. Through-paddling for both day trips and longer trips is a popular activity, particularly along the Connecticut River Paddlers' Trail which provides over fifty-five camping destinations with over 150 access locations.

401. 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.

402. The Applicant conducted a whitewater boating recreation study (Study 30) as part of the relicensing process. In the Wilder Project area, Sumner Falls is an area known for white water boating opportunities and is located roughly 9 miles downstream from the Project.

403. Sumner Falls drops in elevation roughly seven feet over roughly a quarter of a mile. This creates different features for boating at different flows. These features are known as the main wave, washing machine, and sign wave.

404. As part of the study, the Applicant provided various flows from the facility for boaters to evaluate. Boaters who participated in the study were volunteers using different boat types and consisted of various skill levels. All skill levels were self-designated. Due to the inherent nature of whitewater boating, the boat type and skill level play a large part in an individual's preference for the type of experience any one boater is looking for.

405. The study took place over the course of two days in 2014. Participants were asked to complete two types of surveys, a single flow survey and a comparison flow survey. Not all participants boated all flows for various reasons (safety concerns, energy retention, ability to stay for the duration of the study). Of the sixteen participants, a minimum of thirteen completed the survey for each flow. The flow comparison survey was not provided to participants until multiple flows had been boated.

406. In the surveys, the participants were asked to rate each flow on various characteristics including navigability, whitewater challenge, safety, and aesthetics. Additionally, the participants were asked to indicate their preferred whitewater boating flow and access. Lastly, participants were asked to indicate how likely they would be to return to Sumner Falls, if there were a scheduled release at a certain flow.

407. There were four target flows as part of the study. Additionally, there were 5 estimated flows at the site. This is due to a rain event that occurred in tributary watersheds, specifically the Mascoma and Ottauquechee rivers. This rain event contributed to higher flows than anticipated during the study.

Table 28. Whitewater paddling study flows at Sumner Falls for targeted and estimated flows given localized rain events.

Date	Flow No.	Target Flows as measured at West Lebanon gage (cfs)	Estimated flows at Sumner Falls using West Lebanon, Ottauquechee, and Mascoma Gages (cfs)
6/28/2014	1	3,000-3,500	4,700
	2	5,000	6,700
	3	n/a	3,750
6/29/2014	4	7,500-8,000	7,800
	5	11,000-11,500	13,000

408. Generally, participants rated lower flows as less challenging, according to the whitewater class ratings, and higher flows received higher ratings. There was also a wide range of responses, which is likely due to the wide range of experience levels and types of crafts. Each participant rated the likely skill level required to successfully boat Sumner Falls (Table 29).

Table 29. Participants rated suggested skill level required to successfully boat Sumner Falls.

Skill Level Required	3,700 (cfs)	4,700 (cfs)	6,750 (cfs)	7,800 (cfs)	13,000 (cfs)
Novice	5	2	1		
Beginner	7	12	10	7	4
Intermediate	1	1	4	8	9
Advanced			1	1	1
Expert			1		1

409. The types of watercrafts used by the participants varied and included canoes, catarafts, kayaks of various types, squirt boats, and stand-up paddleboards. The following table presents the average scores of different watercraft types, given a characteristic of interest. Kayaks being the majority are presented in Table 30, while the other craft types are combined in Table 31. Values are rated from 1 to 7, with 1 being totally unacceptable, 4 being marginal, and 7 being totally acceptable. The total number of participants who rated that flow is denoted by 'n.'

Table 30. Whitewater flow characteristics by flow from participants using various types of kayaks. Ratings are from 1 to 7 with 1 being totally unacceptable and 7 being totally acceptable at Sumner Falls.

Characteristic	3,750 cfs n=10	4,700 cfs n=11	6,700 cfs n=15	7,800 cfs n=10	13,000 cfs n=11
Bootability	5.5	6.5	6.4	6.7	6.7
Technical Rapids	4.5	5.2	5.3	5.5	6
Powerful Hydraulics	4.3	4.3	5.2	5	5.9
Playboating Areas	5.2	6	5.3	5.2	6.2
Overall Whitewater challenge	4.6	4.8	5.4	5.5	5.9
Safety	6.6	6.9	6.4	6.1	6.4
Hazards present	5.4	5.9	5.9	5.4	6
Aesthetics	6.2	6.7	6.3	6.5	6.2
Overall rating	5.4	6.5	5.8	5.8	6.5

Table 31. Whitewater flow characteristics by flow from participants using watercrafts other than kayaks (e.g. canoe, cataraft, stand up paddle board, and squirt boat). Ratings are from 1 to 7 with 1 being totally unacceptable and 7 being totally acceptable at Sumner Falls.

Characteristic	3,750 cfs n=3	4,700 cfs n=4	6,700 cfs n=4	7,800 cfs n=4	13,000 cfs n=4
Bootability	6.3	6.5	6.8	6.9	7.0
Technical Rapids	4.3	4.8	5.8	5.8	6.3
Powerful Hydraulics	4.3	5.8	6.0	5.8	7.0
Playboating Areas	5.0	6.5	6.3	5.5	5.8
Overall Whitewater challenge	4.0	5.5	5.7	6.0	6.8
Safety	5.7	6.3	6.5	6.3	6.0
Hazards present	6.0	6.0	6.1	6.5	5.8
Aesthetics	7.0	6.3	6.5	6.8	7.0
Overall rating	5.7	6.0	6.3	6.4	7.0

410. The minimum reported characteristics for all flows and all watercrafts was 4.0 on average. This was provided in the "overall whitewater challenge" category for crafts other than kayaks at a flow of 3,750 cfs. This generally indicates that for any watercraft and at any of these flows, marginal or better characteristics are provided at Sumner Falls. While the overall rating increases with increasing flow, this is not the case in all circumstances, particularly among the kayaker user group. In Table 32, participants were asked to rate their flow preference for "about the same; this was close to the best flow."

Table 32. The preference of participants by watercraft types for the preferred or near preferred flow at Sumner Falls. The number indicates the number of respondents.

Boat types and flow preference of "About the same; this was close to the best flow"	3,750 cfs	4,700 cfs	6,700 cfs	7,800 cfs	13,000 cfs
Kayak	3	2	4	4	7
Canoe				1	1
Cataraft			1		1
Stand-up Paddleboard			1	1	

411. The above table highlights the complexities associated with flow preferences and whitewater sports. The craft type and experience level of any given individual will change the experience for each user.

412. The results from the whitewater boating study indicate that there is a wide range of flows that may be appropriate for Sumner Falls. In a follow up discussion, participants noted that Sumner Falls is complex and diverse enough to accommodate a number of skill levels and craft types at different flows, which would likely result in a positive experience. This is supported by the generally high overall ratings presented in Table 30 and Table 31. The closeout discussion also noted that this is a whitewater site that is good for beginners, as there are diverse courses to take at different flows with a deep pool to swim out if needed.

413. There were two preferred flows for surfing that emerged from the whitewater boating study. The first is somewhere between 4,700 cfs and 6,700 cfs. At these flows, 'main wave' emerges and becomes surfable, and participants indicated they would prefer slightly more than 4,700 cfs and less than 6,700 cfs.

414. The other flow that emerged from the study was the highest flow of 13,000 cfs. Although participants noted that the flow range between 4,700 cfs and 6,700 cfs was enjoyable, some felt it was less interesting, and therefore the highest flow was preferred.

415. Stakeholders noted concerns by through paddlers regarding peaking operations. Under current operations, flows drastically change, typically without warning or ramping. These abrupt flow changes can make the river unnavigable. Additionally, there are concerns that proposed operations would result in fewer opportunities for boaters at Sumner Falls.

416. Although no flatwater specific study was conducted, it is assumed that flatwater paddlers require relatively stable flows of a suitable magnitude to avoid stranding. Comments provided to the Department suggested that a flow of approximately 2,500 cfs would be adequate for boating the Connecticut River.

417. Other sources suggest that an average depth of four to eight inches supports boating through river system[11]. Another source of data is provided in the FERC record from studies that were conducted as part of the relicensing.

[11] Whittaker, D., B. Shelby, W. Jackson, R. Beschta. 1993. Instream Flows for Recreation: A handbook on

418. As part of study 7 (aquatic habitat) mapping was conducted in the project vicinity, both within the impoundment and riverine reach. The report not only includes the days and times of habitat mapping via boat but also includes the flows as recorded at the USGS West Lebanon gage.

419. On August 5, 2013, flows ranged from approximately 900 cfs to 5,000 cfs. On August 17, 2013, flows were estimated to be 1,470 cfs. On August 18, 2013, a flow of approximately 1,420 cfs was estimated to occur during the exercise. Because the mapping occurred using a boat it is assumed that the Connecticut River was boatable while these flows occurred.

420. The Applicant provided information to allow the anticipated flows downstream of the Project to be analyzed (see findings 110-115 and Table 9). The outputs from this model can be used to compare current operations to the proposed flex operations for comparison for both flatwater and whitewater flows.

421. The data output was filtered to avoid winter months and overnight hours, which led to a timeline of using two months, June and August, from the hours between 6:00 a.m. to 8:00 p.m. It is anticipated that the travel time from the Wilder Project to Sumner falls is approximately two hours. Therefore, the data was adjusted to account for the two hour travel time when considering the hours from 6:00 a.m. to 8:00 p.m. Three metrics were calculated to look at both flatwater and whitewater. The number of flatwater hours was calculated as the number of hours flows are above 2,500 cfs, 1,500 cfs and 900 cfs. These values were supported by American Whitewater, a literature review, and portions of the FERC record. The number of white-water hours was calculated as the number of hours flows are above 13,000 cfs (finding 414) and flows are between 4,700 and 6,700 cfs (finding 413).

422. Table 33 presents the data for each of the four years representing different water years (dry to high). The values represent the number of hours where there were specific instances of downstream flows as measured at the Wilder Project. These flows were not prorated to the Sumner Falls recreation site. Because prorations are an equal proportional change, it would not change the difference in the number of occasions between current operations and proposed operations.

Concepts and Research Methods. U.S. Department of Interior National Parks Service Rivers and Trails Conservation Program.

Table 33. Number of hours where flows are within a certain range as indicated by the various water years as modeled by the Applicant. The timeframe of interest includes modeled estimates for Jun 1-30 and August 1-31 from the hours of 6am to 8pm, after accounting for travel time from the Project to Sumner Falls.

	2009	2015	2016	2017
Current operations				
Flows above 13,000	0	0	0	0
Flows between 4,700-6,700	32	116	58	63
Flows above 2,500	593	508	309	308
Flows above 1,500	605	524	563	561
Flows above 900	636	549	793	793
Proposed operations				
Flows above 13,000	0	0	0	0
Flows between 4,700-6,700	175	65	103	115
Flows above 2,500	750	606	507	507
Flows above 1,500	793	790	707	707
Flows above 900	793	793	793	793

N. Debris

423. A hydraulic trashrake is used at the Project. The rake can be driven on top of the dam following a set of tracks. The trashrake can then be placed in front of each unit to pull river debris out of the river. This operation is done manually. Once the debris is removed, it is placed into a trailer for removal. The Applicant has also noted that debris is stored in various locations around the facility, typically recreational parking locations, to be dewatered and sorted.

424. The sluiceway between Unit 3 and the fish ladder entrance is also opened to pass river debris. It was unclear from the Application what types of debris can be associated with this flushing or under what circumstances either methodology is employed.

O. Aesthetics

425. 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)).

426. The Project impoundment extends roughly 45 miles upstream. The land adjacent to the impoundment is characterized by villages, farmlands, country roads, and mountainous terrain. The Project area is visible from a number of locations including recreational locations owned by the Applicant and others.

427. There is little information related to the aesthetics of the Wilder Project waters. For example, although there were questions related to aesthetics in the recreational needs and assessment study, individuals more often referenced the area’s cleanliness, vegetation, or vandalism.

428. Additional comments included muddy shorelines, which was noted by the Applicant to occur more often at the confluence with tributaries when flood profile operations need to be conducted. This type of occurrence can also occur during peaking operations. The Project does not contain a bypassed reach, meaning all flow being used for generation are then directly discharged to the Connecticut River.

III. Analysis

429. 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 Vermont Water Quality Standards. 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.

430. Continued operation of the Project may lead to violations of Standards. 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 Vermont Water Quality Standards.

431. 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 Vermont Water Quality Standards (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 Vermont Water Quality Standards.

A. Water Chemistry

432. 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 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 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)).

433. The Applicant conducted a water chemistry study in the years 2012 and 2015. For details on the methodology, see findings 148-148. The Applicant was operating the Project as currently licensed.

434. No occurrences of dissolved oxygen falling below the Vermont Water Quality Standard criteria of no less than 6 mg/L and 70 percent saturation were documented at any time during the course of the study within the vicinity of the Project. See findings 151, 154-157 and Table 10.

435. 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 later summer and early fall when the highest temperatures were observed. There were no violations of the temperature criteria of the VWQS during the study. See findings 151-153.

436. 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 dissolved oxygen and buffer changes in temperature relative to current operations. The following table (Table 34) shows the difference between the proposed operations and current operations for the downstream flow metrics calculated in Table 6 (findings 82-85) and Table 9 (finding 110-115).

Table 34. Difference in estimated downstream metrics for proposed operations and current operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Average Minimum downstream flow	Mean daily amplitude	Flashiness
2009			
February	2021	-2805	-0.14
June	2205	-4186	-0.09
August	2726	-4628	-0.09
November	2761	-4598	-0.07
2016			
February	2980	-204	-0.02
June	1284	-1878	-0.02
August	801	-2428	-0.09
November	2031	-1966	-0.11
2017			
February	2912	-162	-0.02
June	1272	-1841	-0.08
August	796	-2532	-0.12
November	1907	-1810	-0.05
2015			
February	1418	-3671	-0.29
June	2740	-3524	-0.06
August	1227	-5279	-0.22
November	2079	-4865	-0.24

437. Table 34 indicates that overall, 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 Applicants proposal to operate the facility in an IEO mode along with flexible and transition operations modes (condition B).

B. Aquatic Biota

438. "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 Wilder Project area. These include fully aquatic species, like fish, who spend their entire life cycles in the water, and organisms who do not such as turtles, beaver, and frogs.

439. The Applicant studied the potential for impingement and entrainment of resident fish species at the Project (see findings 169-180).

440. Adult American eels were the only species with a high overall entrainment potential. The following species had high to medium overall entrainment potential: bluegill juveniles, golden shiner juveniles, spottail shiner juveniles and adults, 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.

441. The amount of time that the Applicant is expected to operate at maximum hydraulic capacity, which under current operations generally occurs on a near daily basis and for multiple hours, would occur less frequently and for reduced durations. This will reduce through rack velocities and lower the overall potential for fish to be entrained in the turbines.

442. This is supported by the reduction in the mean daily amplitude estimated for the proposed vs. current operations (Table 34). In all estimated years and months, it is estimated that there will be a decrease in the maximum observed downstream flows. 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

443. The Applicant conducted studies specific to upstream fish passage as part of the Project relicensing (findings 182-193). This included collecting information specific to American eel, as well as collecting information on fish currently utilizing the upstream fish passage.

444. Efforts to observe congregating American eels below the Wilder Project over several days did not result in any sightings during the study (findings 183-184). However, American eels have been observed upstream of the Project and in the fish passage window. It is likely their numbers at the Project will increase once effective upstream eel passage is constructed at hydroelectric projects downstream on the Connecticut River.

445. The Applicant also reviewed footage from operations of the fish ladder. Three of the four targeted diadromous species were observed with the number of individuals totaling 55 (Table 14). The duration in which the target diadromous fish moved past the facility varied from the current upstream passage dates. Resident species were also observed in the fish

ladder, although not the target species. When the upstream passage is open, it allows for motivated resident species to move upstream as needed (Table 14).

446. In addition to the period in which fish moved through the facility it should also be noted that under current operations opening the Wilder fish ladder is contingent on passage of Atlantic salmon passing the bellows falls dam. During the period of 1987-2024 the ladder operated 45 percent of those years.

447. The Applicant has committed to a fish passage settlement agreement that includes an upstream fish passage effectiveness study by PIT tagging individuals (findings116, 125, 126) to assure the installation of safe, timely and effective fish passage measures. This Certification is conditioned to incorporate the Applicant's proposal to implement and adhere to the fish passage settlement agreement (condition E).

Downstream

448. The Applicant conducted two studies to understand downstream passage of American eels at the Project. The first included estimates of turbine mortality and effective passage (timely), and the second study investigated American eel migration cues specific to the Connecticut River (findings 196-218).

449. Estimates of turbine mortality were high at the Wilder Project, with a survival estimate of 62% through turbine 2 and higher survival estimate for turbine 3 of 93.5%, based on an estimate from an analogous turbine. This follows similar studies where American eel survival is higher for Francis type turbines than Kaplan type turbines (findings 208-210, Table 15).

450. In the second component of the study, the majority of American eels that passed the Wilder Project utilized the turbines in lieu of the trash/ice sluice, which is considered the downstream passage route. Additionally, five out of 50 fish did not approach or pass the Project (Table 16).

451. Any fish that spends longer than eight hours wandering or searching for downstream passage is considered to highlight a potential passage issue. Of the 45 American eel that passed the Project, eight were observed exhibiting this behavior for longer than eight hours (finding 216).

452. The studies at the Wilder Project indicate that there are issues with safe, timely, and effective passage of American eels. The Applicant has proposed to implement and adhere to the fish passage settlement agreement which includes investigating and modifying downstream passage facilities as needed. This process will take place in consultation with applicable resources 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

453. 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

454. The habitat-flow study and the results indicate that there is no single flow that optimizes available habitat within the riverine reaches of the Wilder Project (findings 225-237). Additionally, there is no minimum and maximum flow that optimizes remaining available habitat for immobile and mobile species (findings 238-240). This is not surprising given the complexity of the riverine section below the Project and the number of fish species of interest with varying life histories and habitat needs for depth, velocity, and substrate.

455. While there is no single set of flows that will optimize habitat for all species, there are observable trends across species and life stages (findings 238-242). The smaller the magnitude of change between the minimum and maximum flow, the greater the amount of suitable habitat that will remain available.

456. 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 in flow to and from flexible operations more gradual. These measures are consistent with the findings of the habitat-flow study described above.

457. By establishing IEO as the base operating mode, minimum downstream flows are expected to increase relative to current operations when downstream flows are generally maintained around 700 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 and above 1,800 cfs, maximum discharge is limited to 2.5 times inflow. Together, the higher minimum flow associated with IEO operations and the maximum generation flow restrictions associated with flexible operations will achieve what the habitat-flow study showed was needed to protect aquatic habitat for the diverse community of species present in the Connecticut River, to reduce the magnitude of change between the baseflow and generating flow.

458. As described above, specific elements of the proposed operation 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 Wilder Project under the Applicant's proposal. The following table (Table 35) shows the difference in downstream flow regime between the proposed operations and current operations as represented by change in mean daily amplitude calculated in Table 6 (findings 82-85) and in Table 9 (findings 115 and 116).

Table 35. 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 wettest (2009) to driest (2015).

Target Month and Year	Change in mean daily amplitude
2009	
February	-2805
June	-4186
August	-4626
November	-4654
2016	
February	-204
June	-1878
August	-2428
November	-1966
2017	
February	-162
June	-1841
August	-2532
November	-1810
2015	
February	-3671
June	-3524
August	-5279
November	-5031

459. Another way to consider the effects from proposed operations is to calculate difference in downstream mean daily amplitude compared to the Project operating in a 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.

460. The following table (Table 36) shows the difference between the estimates of IEO and proposed operations for the downstream changes in mean daily amplitude as calculated in Table 3 (findings 64-70) and in Table 9 (findings 115 and 116).

Table 36. 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 wettest (2009) to driest (2015).

Target Month and Year	Change in mean daily amplitude
2009	
February	4086
June	508
August	458
November	1664
2016	
February	777
June	324
August	333
November	2220
2017	
February	804
June	324
August	367
November	2220
2015	
February	2397
June	66
August	289
November	1856

461. There is an expected increase in the daily average magnitude of flows downstream of the Project relative to IEO conditions. 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. 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).

462. For mobile species, or those species that move to find suitable habitat, the frequency of those movements can come at an energetic cost (finding 239) or increased predation risk. For immobile species, these flow changes can involve a loss of suitable habitat and potential mortality if they become stranded. Decreasing the frequency of flow fluctuations reduces this energetic cost and is more protective of aquatic habitat.

463. Another goal of the Applicant's operating proposal is to reduce the frequency of sub-daily changes in discharge from the dam. Under current operations, flow can fluctuate from the minimum flow to generation flow 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 immobile lifestages such as spawning and incubation or fry stages, the Applicant is proposing to operate in flexible operations 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 immobile species and lifestages who lose much of the available habitat under flow fluctuations. 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.

464. Analysis supports the expectation that the proposed operations will decrease the frequency of fluctuations downstream of the Wilder Project. The following table (Table 37) shows the difference between the proposed operations and current operations for the downstream changes in flashiness as calculated in Table 6 (findings 82-85) and in Table 9 (findings 110-115). The measure of flashiness does not have units and instead is used as a comparative measure.

Table 37. Difference in estimated downstream flashiness metric for proposed operations and current operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Flashiness
2009	
February	-0.14
June	-0.09
August	-0.09
November	-0.07
2016	
February	-0.02
June	-0.02
August	-0.09
November	-0.11
2017	
February	-0.02
June	-0.08
August	-0.12
November	-0.05
2015	
February	-0.29
June	-0.06
August	-0.22
November	-0.24

465. In all cases, outside of one month where there was no change, the comparison shows a decrease in the flashiness of flows downstream of the Wilder Project.

Flashiness can also be compared to flashiness if the Project were operating in a strict IEO. This would remove any Project related influence on downstream flow as the Applicant would only be passing what was available from inflow (Table *38*).

Table 38. Difference in estimated downstream flashiness metric for inflow equals outflow operations and proposed operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Flashiness
2009	
February	-0.10
June	-0.01
August	-0.01
November	-0.03
2016	
February	-0.01
June	-0.01
August	-0.01
November	-0.02
2017	
February	-0.01
June	-0.01
August	-0.02
November	-0.04
2015	
February	-0.07
June	0.00
August	-0.02
November	-0.05

466. As estimated using the HEC-RAS model, there is little difference in the flashiness of downstream flow below the Wilder Project between IEO mode and the Applicant's proposal.

467. 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, finding 240 identified that the rate of change can impact available habitat due to stranding. Further, 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 106-107).

468. The Applicant's proposal will reduce the magnitude of change in flow downstream, limit the duration of deviations from IEO and 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

469. 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 fluctuations within the Wilder impoundment. The following table (Table 39) shows the difference between the proposed operations and current operations for the impoundment metrics calculated in Table 5 (findings 80 and 81) and in Table 8 (finding 114).

Table 39. Difference in estimated impoundment metrics for proposed operations and current operations. For specific seasons and water years from wettest (2009) to driest (2015).

Target Month and Year	Percent time at target SWE	Mean daily change in impoundment
2009		
Feb	-54.9	1.10
Jun	-91.3	1.27
Aug	-82.0	1.42
Nov	-79.2	1.42
2016		
Feb	-64.9	0.85
Jun	-95.8	1.07
Aug	-76.0	1.05
Nov	-58.3	0.76
2017		
Feb	-56.2	0.66
Jun	-87.2	1.18
Aug	-64.0	0.85
Nov	-70.6	1.03
2015		
Feb	-65.0	0.86
Jun	-95.8	1.08
Aug	-75.5	1.08
Nov	-59.0	0.73

470. Table 33 shows that for all scenarios under the proposed operating regime, the mean daily change in impoundment fluctuations will decrease. Additionally, the amount of time spent at the target surface water level increases in all months and years. 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 0 foot change in elevation. There would be limited to no measurable differences between estimated IEO operations and the Applicant's proposal.

471. 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 108). This is expected to decrease the rate at which water levels change after a drawdown.

472. Maintenance activities, in particular those that require a drawdown, have the potential to impact water quality standards 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 99).

473. The Applicants 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.

Stream Processes and Physical Habitat Structure

474. 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 § 29A-102 (43)).

475. 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, § 29A-102 (34)).

476. Stream processes, including erosion, are a naturally occurring and ongoing process in river systems, particularly in response to change working 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 the 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 the 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 than what would be expected in an equilibrium state where the sediment and hydrologic regimes were in balance.

477. 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.

478. The data collected in study 1-3 analyzed historic erosion from aerial photos and conducted an on the ground two-year study measuring bank movement. While there was noteworthy bank movement within the Wilder impoundment after the impoundment level was increased in the 1950s, this was, in part, likely due to the increased impoundment height being captured by the photos.

479. The two-year field study observed erosion in both the Wilder impoundment and downstream of the facility in the Wilder 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.

480. A supplemental analysis of erosion utilized sediment sampling and HEC-RAS modeling and allowed for a more direct assessment of Project effects (finding 268- 271). For the Wilder Project area at high flows, generally higher than the hydraulic capacity of the Project, there may be occasions when those flows remove sediment from the toe of the slope below the water surface. Areas that are potentially affected by operational flows are limited 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. Using the HEC-RAS model developed by the Applicant, additional analysis can take place by reviewing the nodal data throughout the impoundment. This can provide data on the difference between the minimum and maximum surface water elevation changes under an IEO mode and under the proposed Project operations (Table 18, Table 19 and findings 272-276).

481. Using the methods described above, the calculated differences in estimated magnitudes between proposed operations and IEO mode are provided in Table 40. The data indicate that the maximum change in water surface elevation between proposed operations and IEO is 0.4 feet, with the minimum difference being 0.0 feet.

482. The nodes closest to the dam (lower nodal numbers) are affected by Project operations, whereas those furthest from the dam (higher nodal numbers) are not. 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 magnitude of water surface elevation changes occurring in the upper impoundment are not a result of Wilder Project operations but are instead a result of constrictions in the river channel and inflow coming into the impoundment from upstream.

Table 40. The table includes the calculated difference in estimated change in water surface elevation between proposed operations and inflow equals outflow mode. Each node represents a transect from the Wilder 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 920	Node 970	Node 1020	Node 1070	Node 1120	Node 1170	Node 1120	Node 1251
2009	Feb	0.4	0.3	0.3	0.2	0.2	0.1	0.0	0.0
	June	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Aug	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Nov	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.0
2015	Feb	0.2	0.2	0.2	0.2	0.2	0.1	0.0	0.0
	June	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Aug	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Nov	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0
2016	Feb	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0
	June	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Aug	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
	Nov	0.3	0.3	0.2	0.2	0.2	0.2	0.0	0.0
2017	Feb	0.3	0.3	0.3	0.2	0.2	0.1	0.0	0.0
	June	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	Aug	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
	Nov	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.0

483. The upper Wilder impoundment will continue to experience an altered flow regime primarily due to the operation of the Fifteen Miles Falls Project, which is outside the scope of this Certification. The Application includes measures to reduce impoundment fluctuations by operating in an IEO mode along with flexible and transition operations. 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 (condition B) to incorporate the Applicant's proposal to operate the facility in an IEO mode along with flexible and transition operations.

Protection and Support of Life Cycle Functions

484. The Applicant conducted a study in 2015 that investigated the effects of current operations on spring spawning fish within the Project area including in backwaters, near islands, and near the mouths of tributaries (findings 277-294). The overall study took an appropriate

approach. Specifically, there were times when it was likely that spawning beds could not be observed due to deeper and turbid waters and a number of species spawn in shallower waters. 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, those heights did not vary.

485. Numerous nests were observed and assessed in the study. The following table (Table 41) 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 41. Estimates of the average number of days the 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 Wilder 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	Wilder Backwater	Wilder Backwater	Wilder Islands	Wilder Tributaries	Wilder Islands
1992 Driest year	45%	64%	61%	41%	54%
1989	33%	50%	34%	22%	50%
1994 Average Year	53%	33%	40%	11%	39%
2007	42%	43%	35%	20%	48%
1990 Wettest Year	62%	37%	32%	19%	45%

486. The above table indicates that even in the wettest years under current operations, it is expected that nests will become dewatered in the spring. The nest dewatering events affect the life cycle functions of spring fish spawners within the Wilder impoundment. In systems that do not have artificial regulation some low degree of nest dewatering can still occur, however not likely to the degree that occurs in waters with water level fluctuation. The focus of this Certification is on water levels affected by Project operations and their associated impacts.

487. The proposed operations were developed to protect 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 May through June, to limit effects on spring migrants and resident spawning species.

488. Analysis of the effects of the Applicant's proposal on impoundment water levels (Table 39) shows that for the month of June, which is most representative of spring conditions, the time at which the Wilder impoundment will remain within 0.5 feet of the target surface water elevation increases by a minimum of 87 percent and a maximum of 95.8 percent of the time. The magnitude of the impoundment fluctuations will also decrease by 1.15 feet on average across all water years in June.

489. Similarly, Table 18 and Table 19 (with a focus only on June) indicates that changes in water surface elevation throughout the impoundment will vary, with the greatest magnitude changing in the upper portions of the impoundment. However, as noted in Table 40 (finding 480-482), the Wilder Project operations are not contributing water surface elevation changes at those locations and it is more likely caused by incoming flow from peaking operations upstream.

490. In the study specific to sea lamprey spawning, the potential for nest dewatering were noted in part because sea lamprey prefer areas of shallow faster water in gravel and cobble substrates (finding 95-104). The study and subsequent modeling indicated that under current operations in a variety of water year types, it is expected that nests will become dewatered (finding 300 and 301). The nest dewatering events affect the life cycle functions of sea lamprey spawning activities within the Wilder riverine reach.

491. Analysis on the effects of the Applicant's proposed operations on downstream flows shows that in June, which is representative of the time of year we may expect to see sea lamprey spawning, there is a decrease in the flashiness of the system (Table 37). Additionally, the data anticipates a decrease in the magnitude of flow fluctuations in all modeled years downstream of the facility (Table 35) relative to current operations.

492. The proposed operations will be protective of spring spawning resident species and sea lamprey species. 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

493. 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 fluctuations as described in findings 100-104. These operations will create a more stable environment for wetlands and wildlife in the next license term (Table 39).

494. 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 typically emerge, the Applicant will be permitted to fluctuate water levels less frequently, and therefore wetlands and wildlife will experience less hydrologic alteration.

495. 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

496. The studies conducted by the Applicant concluded that there were no occurrences of either Fowler's toad, shortnose sturgeon, nor Northeastern bulrush within the Project area, so they are not further discussed as part of this Certification.

Northern Long-eared Bat

497. 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 3-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).

498. 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.

Jessup's Milk Vetch

499. Jessup's Milk Vetch (*Astragalus robbinsii var. jesupii*) is listed as endangered at both the state and federal levels. This plant species requires high flows with a relatively low occurrence level to aid in the continued survival and reproduction of the species. In discussions with experts, it was thought that flows on the magnitude of 40,000 to 60,000 cfs would be appropriate for the maintenance of this species (finding 323). This equates to roughly 11.8 to 17.75 cubic feet per second per square mile.

500. These flows are well outside of the hydraulic capacity of the Project (finding 34). Additionally, these flows are within flood profile operations (finding 76) that require impoundment drawdowns for flood protection.

501. The magnitude of these flows can also be compared to what would be expected to occur during estimated natural conditions provided in Table 1. The highest estimated average flow for estimated natural conditions is closer to the 4 to 5 csm, not 11 to18 csm as suggested that would be needed for the protection of Jessup's Milk Vetch.

502. Given the limitations of the Project facilities and the lack of regular high flow events required in the spring, specific mitigation measures are impractical.

Dwarf wedgemussel

503. Dwarf wedgemussel (*Alasmidonta heterodon*) is state and federally listed as endangered. Known occurrences of dwarf wedgemussel occur within the Wilder impoundment and within the riverine reach downstream of the dam.

504. There are a number of opportunities to decrease the risk associated with Project operations for the protection of DWM habitat. These include reducing the magnitude of flow fluctuations downstream of the Project to increase available habitat. (finding 334). This also

includes reducing the fluctuations within the impoundment to limit dewatering. (finding 335). Reducing the dewatering of mussels within the impoundment, particularly during the winter season would limit potential for mussels to freeze (finding 327).

505. The Applicant's proposal reduces the frequency and magnitude of flow fluctuations downstream by operating in an IEO mode, along with flexible and transition operations. The Application also specifically includes lowering the impoundment level before the winter to facilitate successful overwintering of the DWM.

506. 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).

Dragonfly and Damselfly

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

508. Of those seven odonates, five were located within the Wilder project affected area. These include *Gomphus abbreviates, Gomphus quadricolor, Ophiogomphus rupinsulensis, Stylurus amnicola, and Stylurus scudderi*. All these species were observed at multiple transects within the Wilder riverine or impoundment reaches.

509. Within the Wilder project affected area, a total of 231 odonate observations were made. Of those, 227 were exuvia and four were observed within the teneral or eclosure phase. The distance from the waterline for the four emergence phase individuals was either 14 inches or 204 inches. For the exuviae observations, they ranged from 0 inches to 201 inches with an average of 29 inches above the waterline. However, the waterline was subject to change due to water level fluctuations during the study period.

510. 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. These operations are intended to create periods of stable water level for odonate larvae to complete the eclosion process.

511. 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

512. Puritan tiger beetles (*Cicindela puritana*) are state and federally listed as threatened, while cobblestone tiger beetles (*Cicindela marginipennis*) are state-listed as threatened. CTB were located within the Project area at three locations: Johnston Island, Burnaps Island, and Hart Island (findings 350- 356).

513. Limiting the frequency and magnitude of flow fluctuations at the sites where CTB are located will benefit the species by avoiding inundation and facilitating successful

reproduction. Using a model developed by the Applicant, the difference between water surface elevation at those locations relative to if the Applicant strictly operated in an IEO mode can be evaluated.

514. The table below (Table 42) is the difference in water surface elevation changes at selected nodes within the riverine reach of the Wilder Project where CTB were located. The table is the difference between Table 24 and Table 25 which represents different modeled operating modes (findings 356 and 357).

Table 42. The difference in estimated water surface elevation changes between two operating modes (inflow equals outflow or proposed operations) at three locations within the Wilder Project area where Cobblestone Tiger Beetles were located.

Year	Month	Johnston Island Node 839	Burnaps Island Node 807	Hart Island Node 752
2009	June	0.1	0.1	0.1
	Aug	0.1	0.1	0.3
2015	June	0.0	0.0	0.0
	Aug	0.2	0.2	0.2
2016	June	0.0	-0.1	0.2
	Aug	0.2	0.3	0.4
2017	June	0.1	0.1	0.1
	Aug	0.4	0.5	0.9

515. In nearly all modeled cases, the difference between average daily elevation change is minimal as simulated through different types of water years for the active months of the CTB.

516. 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 not be met. This goal involves maintaining multiple consecutive day periods, numbering 3 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.

517. The proposed operations will protect the reproduction of 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).

G. Recreation

518. The Vermont Water Quality Standards 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

519. 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 recreational facilities, and the types of uses enjoyed. Lastly, the study addressed the current capacity of the recreational facilities and their future adequacy (findings 369-393).

520. Comments provided in the 2014-2015 recreational surveys relating to recreational use were also submitted to the FERC record (finding 393).

521. The recreational surveys documented that most individuals rated the recreational facilities as scenically average to extremely appealing, and safe to extremely safe (Table 26). While most respondents provided high rankings for the recreational facilities, some still offered suggestions for improvements, including bathrooms and trash facilities.

522. Additional proposals from the FERC record include funding recreational activities such as river cruises or funding for projects. These activities are outside the scope of the water quality certification, which is limited to water quality related impacts of the activity. Another specific request, to reopen the foot bridge across the Wilder dam, is also outside the scope of the water quality certification. Additionally, the Applicant has indicated that the footbridge existed at the former dam (Olcott Falls) and regardless is a dam safety issue that must be addressed with FERC.

523. The existing recreation facilities provide public access to public waters. The Applicant also proposes specific enhancements to recreation facilities at the Project (finding 130). The Applicant also proposes to maintain and enhance various recreational areas as needed and develop a recreational management plan after license issuance (finding 130).

524. This Certification is conditioned to incorporate the Applicant's proposal to enhance and maintain specific recreational facilities and develop a recreational 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

525. 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.

526. The Applicant's proposal to operate in an IEO mode with flexible and transition operations will limit impoundment and downstream flow fluctuation and create a more stable impoundment with higher downstream flows. Additionally, 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 information for the Project. These operational changes will support recreational boating in both the impoundment and downstream reach below the Project.

527. The Department heard concerns about the ability to use the Connecticut River for two types of boating, flatwater and whitewater paddlers. These users made up approximately 21.9-21.2 percent, and 1.6-0 percent of recreational survey respondents (findings 394-401, Table 27).

528. The Applicant conducted a whitewater specific study at Sumner Falls, in the riverine reach below the Wilder Project (findings 402-415, and Table 28-Table 32).

529. There were a wide variety of whitewater boaters with differing boat types and experience levels. It was generally concluded that the features at Sumner Falls allowed various flows to be acceptable, particularly to use as training opportunities and for use of various sport crafts.

530. From the whitewater study, the preferred flows for whitewater boating at Sumner Falls were between 4,700 cfs and 6,700 cfs, but also at flows of 13,000 cfs and potentially higher. The highest flow observed of 13,000 cfs is a magnitude that is beyond the maximum generating capacity of the Project. It was able to occur during the study because the watersheds between the Project and Sumner Falls received significant rainfall augmenting flow from the Project.

531. Concerns raised by whitewater boaters include that the preferred flows will occur less frequently under the proposed operations, the preferred flows will occur less predictably under the proposed operations, and the preferred flows will occur at times that are inconvenient for boaters (i.e. not weekends or holidays).

532. Table 33 estimated the number of hours available for boating from the HEC-RAS model developed by the Applicant for a series of water years from dry to wet and for representative months. Except for 2015, there are estimated to be more boatable hours of flows between 4,700-6,300 cfs under the proposed operations than current operations. Additionally, there is nothing in the Applicant's proposal that would limit flexible operations from occurring on pre-scheduled weekend days.

533. The objective of the proposed operations are to reduce the flashiness, frequency, and magnitude of Project discharges. Therefore the data indicates that under the proposed operations flows of 5,000 cfs (one unit maximum capacity) or greater, 7,500 cfs (one unit at maximum capacity and one unit at half of maximum capacity) or greater, or 10,000 cfs (maximum capacity) or greater occur less frequently than current operations, but more often than inflow equals outflow only operations. As a result in some years during daytime hours, due to reduced hydrologic alteration there will be fewer occasions when discharge out of the project provides those flows at Sumner Falls.

534. In addition to the number of hours available for whitewater, Table 33 also estimated the number of hours available for flatwater boating from the HEC-RAS model. The values assessed were 900 cfs, 1,500 cfs, and 2,500 cfs. In all modeled years at all modeled flatwater flows there is either the same number or an increase in the number of hours available under the proposed operations relative to current operations.

535. Additionally, analyses on an estimated IEO regime can be used to evaluate how different proposed operations would be to those that would be expected without an influence from the

Project, or strict IEO. Table 36 and Table 38 indicate that the proposed operations are a small change relative to the hydrology of the system if Project operations did not influence changes in the Connecticut River.

536. Proposed operations will provide a level of water quality compatible with good quality boating. 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

537. The Applicant described to some degree how the Project-related debris is disposed. Some is flushed downstream via the sluiceway between Unit 3 and the fish ladder. Other debris is pulled up with a hydraulic rake, left to be dewatered, and sorted (findings 423-424). The information presented in the Application does not include enough specificity as to how debris is managed. This Certification is conditioned (condition I) to assure that debris disposal is consistent with applicable regulations (finding 11).

I. Aesthetics

538. 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)).

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

540. The Applicant is proposing to operate in an IEO mode along with flexible and transition operations. These types of operations will decrease the frequency at which the impoundment is lowered and the extent to which the impoundment is lowered (Table 39 and Table 40).

541. 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.

542. The hydrologic change associated with the proposed operations will be limited to small change 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 along with flexible and transition operations (condition B).

J. Antidegradation

543. Pursuant to the Anti-Degradation Policy set forth in the Standards (§ 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)).

544. 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.

545. 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.

546. 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)).

547. 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)).

548. 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 waters affected by the Project. The principal impacts of the Project are in the reaches of the Connecticut River affected by the Project and consist 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 Wilder 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.

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

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

551. 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)).

552. 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; canoeing/kayaking- whitewater; motorboating; sculling; multi-day float trips; and aesthetics.

553. 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, canoeing/kayaking- whitewater, 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 inflow equal to outflow mode by maintaining a target water 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 maintain the existing uses identified in finding 548.

554. The Secretary finds that the operation of the Project, as conditioned by this Certification, will comply with the Vermont Water Quality Standards 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 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 431 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 384.5 feet (+/- 0.5 feet), except when lowered during DWM pre-winter habitat protection (See below). Outflows shall be adjusted based on calculated inflow at least on 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 outflows operations are permitted to be suspended during operation modes included in finding 98 within the Certification.

Flexible Operations: At the discretion of the Applicant, Project operations may deviate from IEO operations to a mode using storage to generate, 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 between 384.5 and 383.0 feet. The maximum discharge during flexible operations will be based on the calculated inflow at the hour in which the flexible operations occur. When the calculated flow 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 which the flexible operations begin.

Table 1. The monthly allocation of hours for flexible operations at the Wilder 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 to a flexible operation event. Transition operations include requirements for up-ramping, down-ramping and refill. Table 2 below specifies the applicability of transition operations for various Project operations.

Up-ramping: Up-ramping is required for scheduled flexible operation events. During up-ramping flow will begin to increase over the hour preceding to the flexible operations event hours. The up-ramping rate for the Project shall be the lesser of flow from 1 of 2 larger units (approximately 5,000 cfs) or halfway between IEO flow and the flexible operations flow.

Down-ramping: Down-ramping shall occur after a flexible operations event where flow is decreased until the flow is equal to inflow at the dam. Decreases in flow shall occur on an hourly basis as a percentage of previous hours flow. The first hour after a flexible operation event, flows shall be no greater than approximately 70% of the flexible operations flow. Each successive hour flow will be approximately 70% of the previous hour.

Refill: The impoundment shall be restored to the target water level elevation of 384.5 feet within 48-hour period subsequent to completion of post-flexible operation down ramping. 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% 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 384.5 feet. The 48-hour period includes any temporary interruptions during the refill period.

Table 2: Operation modes of the Wilder 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

Dwarf Wedgemussel Pre-Winter Habitat Operations: The water surface elevation as measured at the dam, shall be lowered to an elevation at or above the low limit of the flexible operation range of the impoundment and maintained for a limited period of time when water temperatures are consistently dropping from 15°C to 10°C, typically occurring in late-October to early- November. Once water temperature is consistently below 10°C the water surface elevation can be returned to the target elevation of 384.5 feet and the elevation range above the lower limit can be utilized for flexible operations. The water surface elevation shall remain above the DWM pre-winter habitat protection elevation throughout the winter period until March 1st unless inflows required Project to flood profile operations.

See findings 91-115, 453- 492 and 518- 536 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304 & § 29A-306 (b)(3)(B) & § 306 (d)(3).

C. Minimum Base Flows. Minimum base flows are required to be maintained below the Project at all times. The seasonal minimum base flows for the project are 2,000 cfs from April 1 through May 31; 1,100 cfs from June 1 through September 30; and 1,500 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 91-115, 453- 492 and 518- 536 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304 & § 29A-306 (b)(3)(B) & § 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 Operation, and Transition Operation. 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 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 431 for a statement of necessity. 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 § 29A-304 & § 29A-306(b).

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 117-129 and findings 443-452[12] (Appendix A). 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 submitted 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 the 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 evaluation, as appropriate.

As required by the Agreement, the required fish passage operational periods are as follows for the Project. The upstream fish passage measures shall be operated April 1 - July 15 upon issuance of the FERC license.[13] American eel passage shall be provided from May 1 to November 15 upon completion of the implementation of enhancements as set forth in the Agreement. The downstream fish passage shall be operated from August 1 – December 1 upon completion of the implementation of enhancements as set forth in the Agreement.

See finding 117-129 and 484-492 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 3-inch diameter breast height or greater in the project boundary between April 1st and October 31st to avoid any roost disruption of the Northern long-eared bat, except when necessary to protect public safety or respond to emergency

[12] Great River Hydro, LLC Settlement Agreement for Fish Passage; Vernon, Bellows Falls, and Wilder Hydroelectric Projects dated August 2, 2022. See Appendix A

[13] The April 1 start date is to accommodate early spring spawners such as walleye and white suckers only. The fish ladder at 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.

conditions. In 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 finding 316, 318, and 497 for a statement of necessity. 10 V.S.A. § 5403.

G. Recreation.

In accordance with the Applicant's proposal. The Applicant shall improve the upstream portage and install a floating dock, stairs, and a boat slide. For the downstream portage, GRH shall provide trail improvements, stairs, and a boat slide. 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 recreation measures summarized above and in findings 91- 133. 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 finding 91-133, and 518-536 for a statement of necessity. 10 V.S.A. § 1421, 10 V.S.A. § 1258 & Vt. Code R. 12 030 026 §29A- 306(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 that 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 be restricted access. In such instances where access is restricted due to public safety issues, the Applicant shall notify the Department.

See finding 91- 133 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 423-424 and 537 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 92, 99, 305, 431, 472and 473for 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 429 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104.

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

See findings 2 and 431 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104(b).

M. Modification of Certification. The conditions of this Certification may be altered or amended by the Department to assure compliance with the Vermont Water Quality Standards and to respond to any changes in classification of management objectives for 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 and 429-431 for a statement of necessity. 10 V.S.A § 1258 & Vt. Code R. 12 0330 026 § 29A-104(a)(c).

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 
Digitally signed by Peter LaFlamme
DN: cn=Peter LaFlamme, o=VTDEC, ou=Watershed Management Division, email=pete.laflamme@vermont.gov, c=US
Date: 2025.04.16 09:50:25 -04'00'

Peter LaFlamme, Director
Watershed Management Division

Wilder 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

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VERNON, BELLOWS FALLS, AND WILDER HYDROELECTRIC PROJECTS

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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: _____

Name: Scott D. Hall

Title: President & CEO

United States Fish and Wildlife Service

By: _____

Name: _____

Title: _____

New Hampshire Fish and Game Department

By: _____

Name: Scott R. Mason

Title: Director, New Hampshire Fish and Game

Vermont Department of Fish and Wildlife

By: _____

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: Christopher A. Herrick

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: o Design consultation initiated 2/1 of License Year 10 and completed by 12/31 in License Year 10 o Complete construction NLT 7/15 in License Year 11 o Operate measure NLT 7/16 in License Year 11 • If additional studies are required: o Study design consultation initiated NLT 2/15 in License Year 10 and completed NLT 1/1 in License Year 11 o Initiate design consultation in February of License Year 11 and complete design consultation by 12/31 in License Year 11 o Complete construction of permanent upstream eel passage measures NLT 7/15 in License Year 12 o 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 12/21 Y6				
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 12/21 Y6*				
3.4.2.1 Design Consultation and Final Design on Upstream ladder passage measures					Initiate Y6	Complete NLT 7/15 Y5			
3.4.3.1 Design Consultation and Final Design - shad related ladder passage measures					Initiate 1/1 Y6	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 6/6 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 6/6 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 12/21 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 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 12/21 Y3					
3.4.1 Design Consultation and Final Design on Downstream passage measures				Initiate NLT 7/1 Y3	complete NLT 12/21 Y6				
3.4.1. Construction of Shad/Eel Downstream measures						Initiate Y5	complete NLT 12/21 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 12/21 Y8
3.4.3 Design improvements to public viewing and counting windows					complete NLT 12/21 Y6				
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 12/21 Y6*				
3.5.2.1 Design and Complete Ladder Hydraulic Study for eels/lamprey if needed						Initiate NLT 7/16 Y5	complete NLT 12/21 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 12/21 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 12/21 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 12/21 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 - 7/16					
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 12/21 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 12/21 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 [illegible] 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 6/1*	*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*				
3.5.2.3 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 Y12*					
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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