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Connecticut River Conservancy

April 11, 2025

Daniel Demers
Water Quality Certification Program Supervisor
NH Department of Environmental Services
29 Hazen Drive
Concord, NH 03302

Re: Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855), and Vernon (FERC No. 1904) New Hampshire Draft § 401 Water Quality Certifications

Dear Mr. Demers:

The Connecticut River Conservancy ("CRC"), American Rivers ("AR"), American Whitewater ("AW"), and Appalachian Mountain Club ("AMC") respectfully submit these comments to state in the strongest possible terms that the § 401 Water Quality Certification ("WQC" or "Certification") for the Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855), and Vernon (FERC No. 1904) hydroelectric projects owned by Great River Hydro, LLC ("GRH") should be denied without prejudice because a substantial amount of the information critical to assessing compliance with Water Quality Standards (WQS) has not been developed and was not considered.

The Connecticut River is one of New Hampshire's most important public and natural resources. The areas affected by these three projects span approximately two-thirds of New Hampshire's length and impact river use and ecology in 15 towns. The Federal Energy Regulatory Commission ("FERC") relicensing and § 401 Water Quality Certifications must

assure compliance with Water Quality Standards ("WQS") and water-quality-related requirements of state law for the next 30-50 years.

The draft Certification fails to comply with State of New Hampshire ("NH") WQS and reveals critical shortcomings resulting from GRH's failure or outright refusal to provide adequate information and plans. The Draft Water Quality Certification for these Projects offers little meaningful evaluation of how the proposed operational changes would affect NHWQS over the course of the license. Rather than presenting a thorough independent analysis, the draft WQC document largely echoes GRH's application to NHDES[1] and relies on broad, unsupported conclusions that WQS will be attained. At a minimum, these shortcomings compel denial of certification without prejudice such that GRH and the New Hampshire Department of Environmental Services ("NHDES") can fully address these critical deficiencies in a timely manner, as outlined below.

As an environmental organization dedicated to the protection and restoration of the Connecticut River and its tributaries, CRC is deeply concerned about the lack of specificity and appropriate conditions outlined in the draft WQC. The draft WQC fails to provide enforceable appropriate conditions to address the adverse impacts the GRH projects will have on water quality and recreation. Furthermore, proposed operational changes were not considered during the relicensing study process, and only limited modeling was done to consider future environmental impacts. Therefore, important data are lacking for sound decision-making, particularly in the context of climate change. The NHDES's draft WQC does not ensure that the continued presence and operation of the three projects will comply with the NH WQS assimilative capacity [2].

Since 1952, CRC has worked to protect and restore the Connecticut River and its tributaries. CRC represents thousands of members across NH, VT, MA, and CT, who are invested in the health and protection of the Connecticut River and its watershed. As the only nonprofit organization dedicated to protecting the entire Connecticut River ecosystem, our comments consider the localized impacts of the three hydroelectric projects, as well as the

[1] FERC Accession Number 20201207-5219.
[2] Env-Wq 1702.03, page 2.

watershed-wide implications of the failure of NHDES to properly condition the § 401 certifications.

American Rivers works to protect wild rivers, restore damaged rivers, and conserve clean water for people and nature. Since 1973, American Rivers has protected and restored more than 150,000 miles of rivers through educational and advocacy efforts, on-the-ground projects, and an annual America's Most Endangered Rivers campaign. Annually, American Rivers engages in more than 20 hydropower relicensing across the country. American Rivers has regional programs across the country including in the Northeast, and more than 100,000 supporters, members, and volunteers nationwide. American Rivers' staff and volunteers work to enhance river flows and increase river connectivity to benefit biodiversity, protect floodplains and wetlands, and restore rivers providing climate change refugia. Members of American Rivers enjoy and are sustained by the resources of the Connecticut River including for angling, boating, swimming, hiking, and wildlife viewing.

American Whitewater is a national non-profit 501(c)(3) river conservation and recreation organization founded in 1954. With approximately 7,000 members and 85 affiliate clubs, representing tens of thousands of whitewater paddlers across the nation, American Whitewater's mission is to protect and restore our nation's whitewater resources and to enhance opportunities to enjoy them safely. American Whitewater members are primarily conservation-oriented kayakers and canoeists, many of whom live and/or engage in recreational boating in the New England region within easy proximity of the Connecticut River. American Whitewater has long been involved with the FERC licensed hydropower projects in Vermont, including hydropower projects located on the Connecticut, Green, Missisquoi, Mad, and Wells rivers.

Since 1876, the Appalachian Mountain Club has promoted the protection, enjoyment, and understanding of the mountains, forests, waters, and trails of the Appalachian region. AMC is the largest conservation and recreation organization in the Northeast with more than 90,000 members, supporters, and advocates, many of whom visit the lands and waters upstream and downstream of the projects for recreation.

The current § 401 certification process is the first opportunity since 1979 to address the projects' impacts on water quality and evaluate their compliance with NH WQS. It will be the only opportunity to do so for the next 30-50 years. As such it is an extremely important

opportunity to ensure that this public trust resource[3] is maintained and protected, inclusive of all designated uses and criteria, under the preferred proposed operating conditions. The 30–50-year licensing cycle compels gathering as much information as needed for the enormous task of correcting conditions that resulted in impacts to water quality and fluvial since 1979, as well as to plan appropriately for the protection of water quality and access to the River to protect designated uses for the next 30-50 years. The draft § 401 WQCs fail to meet the burden of proof to determine that discharges[4] will comply with state WQS. GRH has not provided sufficient information to establish if the projects will comply with NH WQS; on this basis alone NHDES must decline to issue a WQC at this time.

The draft § 401 WQCs cannot ensure that the operating conditions of the projects will comply with NH WQS and the protections afforded to a NH State Designated River[5]. CRC has significant concerns regarding the currently known and potential future adverse impacts the projects have on water quality, including water quality criteria like temperature, pH, dissolved oxygen ("DO"), benthic deposits and nuisance/invasive species. In addition, CRC notes the deficiency of information regarding WQS including designated uses such as wildlife habitat, recreation, and aquatic life integrity, as well as antidegradation standards designed to protect the existing beneficial uses and to minimize degradation of the State's surface waters. The draft § 401 WQCs lack comprehensive details regarding recreation, river access, and monitoring, which limits the ability of NH to meaningfully enforce WQS and precludes the public from providing meaningful commentary.

CRC has commented over the years on many of the issues pertaining to project operations and NH water quality as part of FERC proceedings, most recently in comments on the

[3] NH Public Trust Doctrine, see: https://www.lmac.des.nh.gov/sites/g/files/ehbemt671/files/documents/2022-10/public-trust-doctrine-and-nh-lakes.pdf.

[4] Env-Wq 1702.17, page 3

[5] See: The Rivers Management and Protection Act of 1988 (RSA 483:1) which states, "If conflicts arise in the attempt to protect all valued characteristics within a river or stream, priority shall be given to those characteristics that are necessary to meet state water quality standards." AND "It is the intent of the legislature that the New Hampshire rivers management and protection program shall complement and reinforce existing state and federal water quality laws, and that in-stream flows are maintained along protected rivers, or segments thereof, in a manner that will enhance or not diminish the enjoyment of outstanding river characteristics pursuant to RSA 483:1."

entire Final License Application[6]. CRC also presented comments to the State of Vermont on GRH's § 401 certification application[7] and draft § 401 WQC[8] for the Wilder, Bellows Falls, and Vernon projects. On January 31, 2025, CRC submitted comments to the State of New Hampshire[9] regarding GRH's § 401 certification application for the three dams, urging that NHDES deny water quality certification due to the material lack of information in the application. We have incorporated earlier communications by reference within, and explicitly as comments to be considered and addressed through this formal comment period. We encourage NHDES to review all previous comments.

CRC supports, joins, and in order to avoid repetition, incorporates by reference the comments of American Whitewater, Appalachian Mountain Club, and American Rivers addressing the effects of Wilder, Bellows Falls, and Vernon hydroelectric projects operated by GRH on recreational opportunities and other local and regional concerns related to the Connecticut River.

Summary

The Connecticut River ("River") is a public resource. GRH's use and manipulation of, and profit from, this public resource impedes public access to and use of the River and impacts natural hydrologic, hydraulic, and ecological processes, but the River remains a public resource. Public access and designated uses must be maintained - the issuance of a federal license or § 401 WQC does not transfer ownership of the River to Great River Hydro. Both these documents allow and in fact require co-existence and-co-extensive use of the River with the public.

Through outright lack of data as well as vague and contradictory statements, GRH neglects to demonstrate how their project proposals meet NH WQS. NHDES' subsequent lack of

[6] Accession Number 20240522-5202, Comments of Connecticut River Conservancy on Great River Hydro, LLC's amended final license applications re the Bellows Falls Hydro Project, et al. under P-1855, et al.
[7] CRC Comments to VT DEC on GRH § 401 application are available here: https://www.ctriver.org/post/hydro-401-comments-vermont.
[8] CRC Comments to VT DEC on the § 401 draft WQC are available here: https://www.ctriver.org/hydropower.
[9] CRC Comments to NHDES on GRH § 401 application are available here: https://dee7f4e9-992f-409a-8b16-c767c6b5c598.usrfiles.com/ugd/dee7f4_cb966dd5637a4be8a6724c66ea5c1bf6.pdf.

clear and enforceable conditions in the draft § 401 WQC fails to meet the WQS because it fails to:

1. Improve shoreline undercutting and erosion; model impacts of change in flows and monitor for impacts of peak flows under new inflow equals outflow ("IEO") and flexible ("flex") operations; and manage sediment transport, including the protection of aquatic habitat and limiting the release of legacy nutrients;
2. Protect rare, threatened, endangered or otherwise protected species of concern such as shortnose sturgeon, dwarf wedge mussels, tiger beetles, and protected plants under proposed operational changes;
3. Protect water quality, aquatic habitats, and species in the face of increased flooding and subsequent drawdowns;
4. Provide for appropriate and equitable access to the River for designated recreational uses;
5. Reduce impacts to water quality and aquatic habitat by managing aquatic invasive species;
6. Install fish passage upgrades in a timely manner;
7. Provide financial assurances regarding the funding of eventual decommissioning;
8. Provide real time public data on flows for recreational access, improve education about and access to fish passage, communicate about recreational access areas, and provide regular reports regarding ecological concerns.

Clean Water Act § 401Certification

The Clean Water Act ("CWA") § 401 water quality certification process is a critical regulatory mechanism that empowers states to protect their water resources[10]. While the certification can include conditions necessary to ensure compliance, states have full authority to deny certification if the project fails to meet the state's WQS or poses significant risks to water resources.

[10] 33 U.S.C. § 1341(a)(1).

NH WQS are designed to "establish water quality standards for the state's surface water uses as set forth in RSA 485-A:8, I, II, III and V. These standards are intended to protect public health and welfare, enhance the quality of water and serve the purposes of the federal Clean Water Act, 33 U.S.C. 1251 et seq., and RSA 485-A. These standards provide for the protection and propagation of fish, shellfish, and wildlife, and provide for such uses as recreational activities in and on the surface waters, public water supplies, agricultural and industrial uses, and navigation in accord with RSA 485-A:8, I and II"[11].

Designated uses identified by the state, including aquatic life integrity and wildlife, fish and shellfish consumption, potential drinking water supply, and recreation (primary contact and secondary contact recreation)[12], must be protected and restored. To maintain a water body's uses, New Hampshire has established specific criteria for water quality, including limits to temperature, pH, and dissolved oxygen, among concentrations for other specific pollutants[13]. These standards are crucial for maintaining the ecological health of water bodies, protecting fish and wildlife habitats, and ensuring the water is safe for recreational activities, in short, supporting the designated uses for the River. Furthermore, NH WQS include an antidegradation policy, which is "designed to preserve and protect the existing beneficial uses and to minimize degradation of the State's surface waters"[14]. All hydrologic modifications, such as dam construction and water withdrawals, fall under the antidegradation rules.[15]

Water quality certification requires that the GRH Projects, which are subject to relicensing under FERC, comply with NH's WQS.[16] Because the GRH Projects seek renewed federal licenses that may last for the next half-century[17], this § 401 certification process will have effects on the health of the River for decades. Moreover, given the significant modifications the GRH Projects will continue to impose on the natural flow and ecological dynamics of the Connecticut River (even under their proposed preferred alternative operating conditions), CRC is

[11] Env-Wq 1701.01, page 1.
[12] R-WD-24-23, page 10.
[13] Env-Wq 1703, page 5.
[14] R-WD-24-23, page 10.
[15] Env-Wq 1708.02, page 33.
[16] 33 U.S.C. § 1341.
[17] 16 U.S.C. § 808(e) ("any license issued by the [Federal Power Commission] under this section shall be for a term which the [Federal Power Commission] determines to be in the public interest but not less than 30 years, nor more than 50 years, from the date on which the license is issued").

concerned about whether and how the designated uses for the River will be protected under these conditions, particularly in the face of increasing climate disruption.

Comments on Section E. Certification Conditions

The conditions in the draft § 401 WQCs will not protect water quality. They cannot because of the lack of fundamental information needed to assure WQS compliance in NH. We address those conditions below as organized in the draft § 401 WQCs:

E-1. Compliance with Surface Water Quality Standards:

The § 401 WQC process requires NH to protect water resources and ensure that those who are utilizing state waters through a federal permit are in compliance with EPA-approved WQS. Certifications issued by NH typically contain conditions designed to ensure compliance, however, the state has both the authority[18] and the responsibility to deny certification if the project fails to meet NH WQS or does not provide adequate information for NHDES staff to determine whether and how it will do so.

The NH WQS (Chapter Env-Wq 1700) are "intended to protect public health and welfare, enhance the quality of water and serve the purposes of the federal Clean Water Act, 33 U.S.C. 1251 et seq., and RSA 485-A"[19] and apply to "all surface waters" and anyone who "undertakes hydrologic modifications"[20]. Designated uses of all water bodies include recreation, fish and shellfish consumption, aquatic life integrity, wildlife, and potential drinking water supply[21]. In order to evaluate whether these uses are being supported, specific criteria are established under Env-Wq 1703. These include limits to temperature, pH, dissolved oxygen, nutrients, and other specific pollutants, as well as standards for benthic deposits, community integrity, and other physical, chemical, and biological aspects of water quality[22]. The Connecticut River and tributaries affected by GRH project operations are classified as Class B waters in NH. All waters in NH, regardless of class, must be maintained and restored to meet the existing and designated

[18] RSA 485-A.
[19] Env-Wq 1701.01, page 1.
[20] Env-Wq 1701.01, page 1.
[21] Env-Wq 1702.16, page 3.
[22] Env-Wq 1703.03, page 5.

uses, shall have adequate flow to protect existing and designated uses, and be able to support fish, wildlife, and recreation. The § 401 water quality certification process is critical to upholding the CWA obligations of the state, and to supporting and protecting water quality and designated uses of the River.

Importantly, NH WQS criteria are designed to ensure criteria are met in comparison to naturally occurring conditions, defined by Env-Wq 1702.27 as "conditions which exist in the absence of human influences"[23]. GRH has proposed significant modifications to project operations and repeats throughout their § 401 applications and draft § 401 WQCs that the preferred alternative operation of IEO/Flex will provide better environmental protection and maintain or improve water quality in comparison to the prior peaking operations. While CRC supports this preferred alternative operation model, little to no analysis has been done to substantiate the claim that water quality will be maintained or improved. The Connecticut River will still be undergoing significant hydrological modifications as a result of the presence and operation of the GRH projects, as well as additional modifications as a result in the change in operations, and these impacts must be considered in respect to "conditions which exist in the absence of humans influences"[24] not in comparison to what has been happening under past hydroelectric operations. The draft § 401 WQCs lack comprehensive evidence that designated uses and antidegradation will be supported and water quality criteria achieved under future operating conditions.

Additionally, the Connecticut River itself is also a designated river under the River Management and Protection Program[25]. As such, it is a river that has "been recognized by the state legislature and the governor for their important natural resources, historical significance, and their contribution to our quality of life"[26]. Likewise, the Ashuelot, Cold, and Mascoma Rivers are impacted by project operations and are also designated rivers under NH statute. This designation mandates additional scrutiny in how the rivers are utilized and impacted to ensure that management decisions continue to "maintain and enhance the natural, scenic, recreational

[23] Env-Wq 1702.27, page 4.
[24] Env-Wq 1702.27, page 4.
[25] RSA 483.
[26] See: https://www.des.nh.gov/tabbed-content/designated-rivers and NH Statute Chapter 483.

and community values of the river"[27]. Not only has NHDES required insufficient scrutiny of how WQS are to be met, it declines to require the maintenance and enhancement of these designated rivers under state law.

The GRH projects seek renewed federal licenses, and if granted, these licenses will last up to 50 years, impacting the health of the River for decades to come. Due to the inadequate, outdated, vague, and contradictory terms in the GRH draft §401 WQCs, CRC is not confident that the WQS and designated uses for the River will be protected, particularly in the face of increasing climate change impacts.

NHDES must take their responsibility for the protection and improvement of NH's waters seriously, and ensure that the projects comply with NH WQS, as GRH does not provide adequate assurance that they will do so. Proper modeling leading up to the draft §401 WQCs was not conducted or required, thus there are no conditions in the draft §401 WQCs that can meet WQS. Denial of the §401 WQCs is necessary until proper modeling and analysis can be done .

E-2. Proposed Modifications to the Project:

We support the condition that the applicant "shall consult with NHDES, NH Fish and Game Department (NHFGD), US Fish and Wildlife Service (USFWS) and FERC and receive prior written approval from NHDES regarding any proposed modifications to the Project"[28]. This is necessary to ensure that any "proposed modifications that could have a significant or material effect on discharges to surface waters from the Project"[29] are compliant with NH WQS. This information must be made publicly available so all parties are aware of proposed modifications and given the opportunity to comment.

E-3. Compliance Inspections:

[27] NH RSA 483:7-a.
[28] New Hampshire Department of Environmental Services. Draft Water Quality Certification. In the matter of: Wilder hydroelectric Project (FERC No. 1892). Issued March 21, 2025. Page 16. *This footnote will be referred to as *Draft WQCs: Wilder, Bellows Falls, and Vernon* and unless otherwise stated, will encompasses the draft WQCs for Wilder, Bellow's Falls and Vernon, since the language and conditions are essentially identical.
[29] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-2.

We support the need for compliance conditions, but request that "*reasonable times*"[30] be defined in a more precise manner.

E-4. Submittal of Information:

We support the 5-day timeframe in which information from a written request must be provided, and request that this information be made available to the public.

E-5. Transfer of Certification:

If a Transfer of Certification occurs, there need to be additional steps other than simply providing contact information. This is to ensure the new owners uphold NH WQS and understand the conditions required in the § 401 WQC. NHDES must establish a reasonable timeline in which they and FERC are notified and provided contact information if a Transfer of Certification is to occur.

E-6. Flow / Impoundment Management:

We are in support of the change in flow management from peaking to Inflow equals Outflow (IEO) w ith flexible peaking operations. This change, however, addresses only some of the River's water quality issues. And while this change is a step in the right direction, it is also expected to have short and long-term impacts, which have not been adequately studied. There has not been sufficient information provided for NHDES to establish proper conditions to address bank erosion and stabilization, sediment transport, potential release of legacy nutrients, changes in equilibrium, and climate change. Thus, the § 401 WQC must be denied.

Surface water elevation changes resulting from peaking project operations at the Wilder, Bellows Falls, and Vernon hydro facilities have caused and contributed to bank erosion throughout the project areas. The impoundments have experienced unnatural, unpredictable, and rapid surface water elevation fluctuations for over 40 years, which has led to extreme bank undercutting and extensive shoreline erosion in excess to natural erosional processes. GRH has

[30] Draft WQCs: Wilder, Bellows Falls, and Vernon, Section E-3.

not acknowledged the contribution of operations to erosion but asserts that the change from peaking to IEO/flex will mitigate erosion. The focus of discussion that defined the parameters in the agreement defining the operational change was on protecting aquatic life. While the preferred operation might reduce some impacts from erosion, the instability of banks within the impoundments, the interruption of natural erosion, transport, and aggradation processes, and the unnatural surface water elevation changes will continue or may be exacerbated under IEO/flex operations.

Issues regarding erosion throughout the project areas related to dam operations, has been observed and reported on for years, but remains unaddressed. In their Exhibit E for Wilder, for instance, GRH states that over 40 percent of the banks in the Project impoundment are unstable"[31]. GRH also admits that "…The lack of a clear correlation between Project related WSE fluctuations and erosion occurrence in impounded reaches would continue to exist under Great River Hydro's proposal"[32]. Their lack of understanding underscores the need for all three WQCs to be denied.

These unnatural sediment depositional conditions within impoundments, behind the dams, and particularly at tributary confluences negatively impact designated uses of habitat and recreation and also violate NH Env WQS 1703.08[33] which explicitly *prohibits benthic deposits that do not occur naturally* [emphasis added]. As these deposits occur and are enhanced directly as a result of the presence and operation of the hydro facilities, they are clearly a violation of water quality standards. Because the river will continue to be controlled, it is unclear that these benthic deposits will be minimized or eliminated under proposed operations.

The preferred operation of IEO/flex is expected to change sediment movement dynamics concurrent with the new flow regime, and while this may provide better habitat in some areas, no data or predictive models have been provided to understand these impacts and where it is likely that increase sediment transport versus deposition will occur. It is unclear if increased upstream sediment moved from riverine reaches will just continue to be trapped behind the downstream dam, increasing the proportion of soft bottom substrates in impoundments and further degrading

[31] Draft WQCs: Wilder, Bellows Falls, and Vernon, C-14.
[32] Draft WQCs: Wilder, Bellows Falls, and Vernon, C-15.
[33] Env-Wq 1703.08, page 7.

habitat from what would be naturally found. Certification must be denied as there are no data provided, nor any data-driven assessments undertaken or anticipated that would verify that habitat is not degraded or eliminated by shifting sediment transport dynamics under the proposed operations.

The WQC should have been denied, due to lack of detailed information. In addition, at a minimum, if and when the §401 certifications are to be issued, NH DES must require a condition to monitor and assess in real time over the life of the license the effect of proposed project operational flows on riverbank erosion and sediment transport and related effects on habitat quality and biota supported, water chemistry, nutrient transport, and recreation. This condition must also include an improvement or mitigation plan if project operations are found to exacerbate or cause erosion with negative effects on designated uses and water quality criteria. All data must be publicly accessible. This is the only way to ensure that WQSs are being met over the course of the license.

CRC welcomes the operational change and many of the anticipated benefits of this modification, however, that change alone is not enough to protect water quality. The change in operations, and thus the managed flow of the river, will shift sediment transport dynamics, with anticipated higher flows and more consistent velocities increasing sediment movement, while dam presence continues to impede natural downstream transport and deposition patterns. This operational change was not considered during the study phase of the relicensing, therefore no analysis has been completed to model the effects of the change in river management on important hydraulic and hydrologic processes. From this standpoint, GRH's application and draft § 401 WQCs fail to demonstrate that operations will comply with NH WQS.

Interaction of Peaking Operations at Wilder Impoundment:

The §401 certification must require third-party monitoring and reporting to assess ongoing changes to erosion, bank stability, and sediment deposition in the Wilder impoundment resulting from project operation changes interacting with upstream peaking flows from 15 Mile Falls facilities.

It is critical to understand how these flows will interact with the new operational regime at Wilder. Operations at Wilder that will have an effect on riverbank erosion and sediment transport dynamics were not been adequately addressed within the §401 WQC application, meaning that there is currently no evidence that the Project will comply with NH WQS: NH Env-Wq 1703.01 (Water Use Classifications; Designated Uses), 1703.03 (General Water Quality Criteria), 1703.08 (Benthic Deposits), 1703.14 (Nutrients), and 1703.19 (Biological and Aquatic Community Integrity).

Current erosion dynamics are enhanced at the upper end of the Wilder impoundments, due to the nature of peaking operations on the range of water surface elevation ("SWE") changes both near and far from the dams. This dynamic has resulted in extremely exacerbated bank erosion in particular sections of the impoundment. The numerous filings from the town and community members of Lyme and Orford NH demonstrate that this is a significant and continuing concern for NH residents in this section of the Wilder impoundment. The loam and sand bank composition in this section of the River is particularly susceptible to erosional forces, of which Project operations have been a significant cause and contributor.

Project operational changes could further intensify ongoing erosion in the impoundment area due to the interaction with peaking flows arriving from the upstream Fifteen Mile Falls projects. The applicant has stated that "[w]hile the impoundment upstream of Wilder dam extends upstream to Haverhill, New Hampshire, and Newbury, Vermont, WSE fluctuations in the upper impoundment are more significantly impacted by inflows from upstream"[34], demonstrating clear knowledge that upstream inflows impact erosion in an area that is already prone to it. This negatively affects private landowner properties, aquatic and riparian habitat availability and integrity, and recreation opportunities. Given that the influence of upstream peaking flows on erosion will continue, it is critical to understand how these flows will interact with the preferred operational regime, specifically in regard to erosional forces in the Wilder reservoir.

There is no analysis regarding this in the applications or draft § 401 WQCs and it directly impacts water quality in this section of the River. GRH should have been required to model this as a part of the application, and should be required, as a condition in the § 401 WQC, to

[34] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-8.

undertake a multi-decade assessment and evaluation of the flow regulation change impact on erosion and sediment transport and deposition in the Wilder impoundment over the course of the next license to ensure that it does not continue to violate NH WQS.

Flooding and Drawdowns:

The § 401 WQCs must include provisions to protect water quality, aquatic life and prevent impacts on designated uses resulting from project operations in response to predicted increases in flooding and drawdown events.

GRH failed to address the impacts of project operations on flooding and drawdowns within the Project areas. In July of 2023[35] and 2024[36] parts of the Connecticut River watershed experienced catastrophic rainfall and flood events, impacting the River far beyond where and when the rain occurred. These types of events are expected to become more common during the next license term as a result of increasing frequency and intensity of localized storm events under climate change[37]. The extensive 2023 flooding resulted in structural failure of the stanchion flashboard at the Bellows Falls dam, requiring a drawdown of the impoundment to repair the spillway[38]. Even though the drawdown did not happen instantaneously, the reduction of surface water elevation far below what occurs during peaking operations resulted in the stranding and death of numerous organisms and the dewatering of important habitat, particularly in shallower backwater areas.

Drawdowns interfere with the designated uses of recreation, aquatic life integrity, wildlife, and potential water supply, and directly violate Env-Wq 1703.01(d) [39]. With the expectation that the need for them will increase, GRH must find a solution to limit the impact of these events on the River, designated uses, and water quality criteria. NH § 401 WQC must ensure that sensitive locations and developmental time periods are protected by limiting the

[35] DR-4740-NH: https://www.fema.gov/disaster/4740
[36] DR-4812-NH: https://www.fema.gov/disaster/4812
[37] See: https://sciencecouncil.noaa.gov/wp-content/uploads/2022/07/FINAL-SoS-Fact-Sheet-How-Changing-Climate-Affects-Extreme-Events-04.14.2021-1.pdf.
[38] See: https://www.reformer.com/bellows-falls-dam-impoundment-to-be-drawn-down-this-week/article_5a815402-2a3b-11ee-801d-cb5c0f578527.html
[39] Env-Wq 1703.01(d), page 5.

extent and timing of drawdowns both in terms of how long it takes to lower and refill the impoundment, how long the drawdown persists, and when during the year it may occur.

E-7. Flow / Impoundment – Notification and Reporting:

CRC supports the Notification and Reporting condition and requests one minor amendment: NHDES should require a timeframe by when the deviation needs to be corrected rather than leaving it up to the Applicant to inform appropriate agencies regarding how long they think it will take to correct the deviation and for operations to comply with Condition E-6.

E-8. Operations Compliance Monitoring Plan (OCMP):

Condition E-8 states that the applicant shall prepare the OCMP within 180 days of license issuance[40], but details outlined in the OCMP are important to review prior to issuing the license. Therefore, a monitoring plan should be developed prior to the issuance of the license. Additionally, draft § 401 WQCs condition that the OCMP be kept up to date by the Applicant so that it reflects current operation of the Project[41], but "up to date" is arbitrary. We recommend requiring consistent and regular review to ensure that the OCMP remains up to date throughout the project license.

Furthermore, E-8e requires a freshwater mussel protection plan, but only in association with drawdowns or flashboard failure, or required maintenance. Protection plans should be comprehensive and include monitoring under all operational conditions. All other endangered species[42] like cobblestone tiger beetle, northern long-eared bat, and shortnose sturgeon require protection and management plans. A detailed monitoring plan for all endangered, threatened, and protected species that are impacted by these projects should be required by GRH as a condition in the § 401 WQCs. NHDES and GRH must consult with relevant agencies like NHFGD, Vermont Fish and Wildlife Department ("VTFWD, USFWS"), and National Oceanic and

[40] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-8.
[41] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-8.
[42] See Endangered and Threatened Wildlife of NH: https://www.wildlife.nh.gov/wildlife-and-habitat/nongame-and-endangered-species/endangered-and-threatened-wildlife-nh

Atmospheric Administration ("NOAA") Fisheries during the development and implementation of these plans. Section 7(a)(2) of the Endangered Species Act requires Federal agencies, like FERC, to consult with the U.S. Fish and Wildlife Service to ensure that actions they fund, authorize, permit, or otherwise carry out will not jeopardize the continued existence of any listed species or adversely modify or destroy designated critical habitats[43].

E-9. Fish Passage and Protection:

To uphold NH WQS and support designated uses, fish passage improvements must be expedited and designed for all species. Additionally, fish passage monitoring capability must be improved and financially supported by GRH to ensure that passages are effective and improving rather than impeding fish passage and population recovery.

CRC has commented repeatedly[44] that the length of time in which fish passage improvements will occur, and the continued harm to migratory fish populations, is unacceptable and unlawful. Species such as sea lamprey, American eel, shortnose sturgeon, and American shad will continue to be negatively impacted by inadequate or ineffective passage facilities until proposed upgrades are completed. Fish passage designs need to be inclusive to all relevant species, as to not harm or hinder passage of a specific species while helping another. Migratory fish in the project areas are prevented from accessing appropriate habitat by a lack of safe, timely, and effective passage, leading to a diminished community composition, structure, and function in comparison to the natural condition is a direct violation of Env-Wq 1703.19[45]. Expedited fish passage improvements should be rectified in the shortest possible time to comply with state law.

Lastly, the construction of the new turbine within the Bellows Falls dam was not considered when addressing passage and habitat concerns through the bypassed reach. The "fish friendly" turbine will facilitate passage of species downstream into the bypassed reach that would not be apt to enter the reach without it, particularly eel, a fact that GRH acknowledges by

[43] 16 U.S.C. 1531-1544.
[44] Accession Number 20220901-5247. CRC, AMC, AW comments on Great River Hydro Fish Passage Settlement Agreement.; Accession Number 20240522-5202, pages 43-53.
[45] Env-Wq 1703.19, page 9.

specifically proposing a turbine designed to pass fish with decreased injury and mortality in comparison to traditional turbines. Passage of fish into the bypassed reach requires the concurrent facilitation of fish ability to get out of the reach, and access to appropriate habitat and food while there. The Fish Passage Settlement agreement occurred prior to the proposal to include a minimum flow turbine in the dam. Thus, the effects of the turbine on flow, habitat, fish movements, and other aquatic life integrity concerns in the bypassed reach were not considered when these agreements were made. The financial responsibility to remove the salmon dam must be required of GRH as a condition of the § 401 WQC and must occur **before** construction of upstream and downstream passage improvements. Removing the salmon dam prior to establishing new passages will help account for changing attraction flow patterns after removal and to accommodate the presence of more diverse fish in the bypassed reach as a result of the installation of the minimum flow turbine.

The bypassed reach is listed as impaired for aquatic life integrity[46] and this impairment is a direct result of hydropower infrastructure and operations disrupting physical attributes and flow regimes within this reach. NH Env-Wq 1703.01(b) requires that "All surface waters shall be restored to meet the water quality criteria for their designated classification including existing and designated uses, and to maintain the chemical, physical, and biological integrity of surface waters"[47]. GRH projects will be in violation of NH WQS regarding habitat, aquatic life integrity, and recreation without the salmon dam removal at Bellows Falls and an expedited timeframe for passage improvements at all three projects.

Shortnose Sturgeon:

Within the draft § 401 WQCs, considerations for NH state and federally listed endangered Shortnose Sturgeon (*Acipenser brevirostrum*) are absent[48]; quite literally, the term "sturgeon" does not appear once in the draft 401 WQCs or in the 2022 "Settlement Agreement

[46] NH 2020/2022 Watershed Report Card: https://www4.des.state.nh.us/onestoppub/SWQA/010801070501_2020.pdf.
[47] Env-Wq 1703.01, page 5.
[48] Env-Wq 1704 (c), page 29: *Where new information that was not considered in the development of the criteria becomes available.*

on Fish Passage"[49]. Both GRH and NHDES neglect to acknowledge their presence and the recent evidence which confirms their existence in the reaches between the Turners Falls dam, Vermon and Bellows Falls dams[50]. On this basis alone, the § 401 WQCs should be denied.

Prompted by anecdotal community reports and two verified sightings, CRC conducted environmental DNA ("eDNA") sampling in June and July 2024 to investigate the shortnose sturgeon's potential presence. Results received in August 2024, which were sent to both NHFGD and FERC[51], confirmed positive detections of shortnose sturgeon eDNA at four locations: three between the Turners Falls and Vernon dams, and one between the Vernon and Bellows Falls dams. These positive "hits" indicate the presence of shortnose sturgeon in these river segments, extending their documented habitat upstream of the Turners Falls dam. CRC conducted a second round of water sampling in September 2024. Analysis of these samples resulted in a positive hit at one location within the Turners Falls impoundment, in addition to the four previous locations.

Shortnose sturgeon are benthic species that require both upstream and downstream movement to complete their life cycle[52], therefore fish passage considerations must include consideration of this species. NHFGD, NH Natural Heritage Bureau, NOAA, USFWS should use most up to date, comprehensive data regarding larval, young-of-the-year ("YOY"), and juvenile shortnose sturgeon movement to establish appropriate trash rack bar spacing, approach velocities, and bottom bypasses, specifically for movement downstream. This is not to diminish the need to address upstream passage improvements as well.

NHFGD has the authority to designate "critical habitat" under state law[53] and they should do so for shortnose sturgeon spawning, feeding, and overwintering grounds. If NHFGD does not have adequate information to characterize this habitat, it must be acquired though prompt analysis. This can include an understanding of substrate characteristics and flow conditions over said substrate during timeframes appropriate to each developmental or behavioral life stage. The

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[49] FERC Accession Number 20220803-5124.
[50] FERC Accession 20241220-5026 CRC shortnose sturgeon eDNA results; FERC Accession 20241223-5058 CRC comments on shortnose sturgeon presence.
[51] CRC letter to Debbie-Anne Reese, Acting Secretary, FERC, Oct. 16, 2024, "Re: evidence of presence of shortnose sturgeon in NH, VT, and MA waters impacted by the Bellows Falls (FERC No. 1855), Vernon (FERC No. 1904), Northfield Mountain (FERC No. 2485), and Turners Falls (FERC No. 1889) Projects," Oct. 16, 2024, FERC Accession No. 202410165224.
[52] See: https://www.wildlife.nh.gov/fishing-new-hampshire/fish-species-nh/shortnose-sturgeon.
[53] RSA 212-A:9.

most vulnerable life stages are thought to be juveniles or younger, and these life stages require access to cobble, gravel, and sandier areas[54], making them susceptible to unnatural and/or excessive fine sediment deposition that can be facilitated and/or exacerbated by dams and river manipulation. These factors must be considered and underscore the need to monitor and understand changes in hydrogeomorphology, erosion, and sediment transport and deposition under changing flow operating conditions in real time.

It is unknown whether consultation under section 7(a)(2) of the Endangered Species Act ("ESA")[55] has been completed, leaving significant questions as to the extent of relicensing impacts on shortnose sturgeon. The Connecticut River Migratory Fish Restoration Cooperative also stated in November 2024 a need for more information to be collected in a timely manner "to determine whether hydropower project operations, or other activities, may affect shortnose sturgeon above Turners Falls Dam." Additionally, Micah Kieffer, a research fishery biologist with the U.S. Fish and Wildlife Service agrees that,"[t]here is enough compelling evidence right now to indicate the need for further investigation by experts"[56].

More data are needed, but in order to certify compliance with NH WQS, NHDES must undertake its own analysis of impacts to ensure the protection of this endangered species as well as those mentioned earlier. NHDES is obligated to consult with NHFGD and NH Natural Heritage Bureau in their analysis. Furthermore, without a formal consult and finding from NOAA Fisheries, as to whether these Projects are likely to adversely affect shortnose sturgeon, any statement regarding the sufficiency of the "Settlement Agreement on Fish Passage" is premature and cannot serve as a justification to grant a § 401 WQC. Moreover, Env-Wq 1708.07 (a) states that the applicant shall provide all information necessary to identify all existing uses, including the "Presence of a specialized use of the waterbody, such as a spawning area or as a habitat for a federally- or state-listed threatened or endangered species"[57]. In the draft § 401 WQCs GRH did not provide this information in regard to shortnose sturgeon, and NHDES did not include any conditions addressing needed protection of or even consideration of this state listed endangered species, thus directly violating NH WQS.

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[54] See: https://www.wildlife.nh.gov/fishing-new-hampshire/fish-species-nh/shortnose-sturgeon.
[55] 16 U.S.C. 1531-1544.
[56] See: https://www.commonsnews.org/issue/765/765CTRiver_dams.
[57] Env-Wq 1708.07, page 34.

NH WQS require that designated uses, such as habitat for fish, be protected[58]. As EPA guidance notes, "[s]pecies that are in the water body and which are consistent with the designated use (i.e., not aberrational) must be protected, even if not prevalent in number or importance. Nor can activity be allowed which would render the species unfit for maintaining the use."[59] As such, because the the Connecticut River is a Class B water, habitat for fish, including shortnose sturgeon, shall be "enhanced, maintained and protected"[60]. NHDES must impose more definitive conditions to protect, restore, and enhance shortnose sturgeon and their habitat between Vernon and Bellows Falls, as well as facilitate sturgeon passage at these projects in a timely manner.

E-10. Invasive Plant Species Management Plan (IPSMP):

The § 401 WQC should require monitoring, prevention, management, and education regarding nuisance species with the project areas that may be directly or indirectly spread or enhanced by project operations. We support the condition that GRH must be required to address the prevention and management of invasive aquatic plant species as a condition of the § 401 WQC. Env-Wq 1702.32 defines nuisance species as those that interfere with a designated use of the surface waters[61]. This condition does not address nuisance species that are not aquatic plants, like cyanobacteria[62] or animals that may be facilitated by project operations. We recommend that the condition be broadened to include nuisance species like animals and other aquatic species that interfere with designated uses.

In particular the spread of aquatic invasive plant species can negatively impact recreation, aquatic community composition and function, habitat suitability, oxygen concentrations, and in some circumstances can have negative human health impacts. Therefore, the existence of these species is both directly and indirectly interfering with all designated uses for NH surface waters. For example, dense unmanaged mats of water chestnut (*Trapa natans*)

[58] Env-Wq 1702.16, page 3.
[59] 44 Question and Answer on Antidegradation policy 3, available at https://www.epa.gov/sites/default/files/201810/documents/questions-answers-antidegradation.pdf.
[60] 314 CMR 4.01(3).
[61] Env-Wq 1702.32 , page 4.
[62] Env-Wq 1903.17, page 8.

can prevent motor and paddle boat use where it thrives, outcompete native species for light, nutrients, and substrate, and cause hypoxic conditions when large quantities decompose. Cyanobacteria, while a natural component of surface waters, can proliferate in slack or backwater areas created by impoundments. Cyanobacteria algal blooms can pollute drinking water sources and cause illnesses in humans exposed to cyanotoxins, clearly meeting the definition of "nuisance species" at certain times. Changes in water flow, and increases in temperature and nutrients, all conditions associated with hydropower generation, can contribute to the exacerbation of these and other nuisance species. Env-Wq 1703.03(C)(1)d[63] mandates that all surface waters be free of substances that result in the dominance of nuisance species.

There are growing concerns about the Connecticut River strain of hydrilla, which has been detected in multiple lakes in the states of Connecticut and Massachusetts, suggesting transport by boaters. The extremely detrimental effects of hydrilla led the NH Exotic Aquatic Weeds and Species Committee (of which CRC is a member) to invite a presentation from the US Army Corps of Engineers regarding the current trials underway to determine a best management strategy[64]. It is critical that hydrilla does not continue to spread northwards. There are also two (known) active infestations of water chestnut within the project areas, although there may be others. The Hinsdale NH setbacks have an estimated 120 acres of water chestnut which are currently surveyed and managed mostly by volunteer hand pullers. Albee's Cove in Rockingham VT/Walpole NH has a smaller affected area and is similarly managed. Additionally, Eurasian milfoil is found throughout the Project areas. These and other nuisance species are currently and will continue to negatively impact designated uses of recreation, fish consumption, aquatic life integrity, and drinking water.

Increasing education about the presence of nuisance species, how to prevent transport and spread of them, and monitoring for future spread is critically important. GRH, through management of water resources and recreational facilities can directly protect NH water quality by contributing to these efforts and has a responsibility to do so by virtue of using our public waters for profit. In this condition NHDES should require financial contribution from GRH for annual detection surveys for extremely aggressive nuisance species like hydrilla, and continue to

[63] 1703.03(C)(1)d, page 6.
[64] See: https://www.nae.usace.army.mil/Missions/Projects-Topics/Connecticut-River-Hydrilla/.

coordinate with resources agencies, the Northeast Aquatic Nuisance Species Panel, and other relevant stakeholders. Additionally, GRH should be required to provide boat cleaning CD3 type units to prevent the spread of nuisance species and display signage educating visitors about nuisance species prevention and particular species of concern at all boat launches in the project areas as defined by the Exhibit G maps[65].

It is also necessary to support efforts to eliminate currently known infestations that will have an opportunity to multiply in size under the more stable higher surface water elevation anticipated in each impoundment as a result of the operational change. In the draft WQCs, GRH states "the more stable WSE at the dams will likely result in an expansion of deep and shallow marsh species and SAV [(submerged aquatic vegetation)]. Because many invasives have the ability to respond rapidly, the transition to more stable water levels may allow invasives to expand… such as Phragmites, purple loosestrife, brittle naiad, [Eurasian] water-milfoil, and others" [66]. As stated in Env-Wq 1703.03 "All surface waters shall be free from substances in kind or quantity that result in the dominance of nuisance species"[67] The draft condition as written lacks adequate invasive species management plans to address potential increases in invasive species spread due to the stabilized water levels proposed in the new and preferred project operations. Without active management and monitoring, the conditions will likely favor the rapid expansion of these invasive plants, threatening native biodiversity. We urge NHDES to require GRH to implement a robust invasive species management plan, including regular monitoring, removal protocols, and collaboration with local conservation groups.

There needs to be comprehensive consideration of prevention and management of nuisance species throughout the project areas to ensure project operations do not contribute to the spread of nuisance species as defined by the state. If project operations contribute to the growth of nuisance species, they will not comply with NH WQS. Currently, the proposal does not adequately indicate how GRH will uphold NH WQS relevant to nuisance species. Because there is no evidence provided as to how project operations will protect water quality in regard to nuisance species, the certification must be denied or amended with more robust conditions.

[65] FERC Accession Number 20201207-5219
[66] Draft WQCs: Wilder, Bellows Falls, and Vernon, C-17.
[67] Env-Wq 1703.03 (c), page 6.

E-11. Water Quality Improvement Plan (WQIP):

NHDES states that "With this Certification and conditions, NHDES certifies that the proposed operations of the Project will comply with New Hampshire Surface Water Quality Standards"[68]. To reiterate, GRH's Project applications and subsequent draft § 401 WQCs fail to include adequate information and plans on essentially every aspect of project operations and impacts. Without proper analysis, modeling, and data it is impossible to know that the GRH Projects will comply with NH WQS. As noted repeatedly throughout these comments, the GRH Projects already violate NH WQS in terms of criteria and designated uses.

The stimulus of a WQIP ensues only after a violation has occurred, yet, NH DES has not provided any conditions in this draft WQC for monitoring in order to know when a violation occurs. In conflicting statements, NHDES declares that GHR's Projects comply with NH WQS, but how can they certify compliance today on the basis of an after-the-fact plan? For NHDES to make an informed decision on whether water quality is improving, a WQIP must be required as a condition of this certification.

As written, the 120 day timeframe to submit a WQIP to NHDES is too lengthy. In Condition E-4, NHDES requires that the Applicant provide requested information within 5 days of their request. This creates contradictory conditions and requires further investigation of what a fair and adequate timeframe is. Nonetheless, if the Projects are causing or contributing to a violation of WQS, the violation needs to be rectified immediately. After NHDES approves a WQIP, the applicant has five years to implement the plan in an effort to achieve the purpose of the WQIP[69]. However, five years is too long to execute a plan that may have little to no success while impeding water quality and designated uses. Therefore, a shortened timeframe is needed.

E-11e(ii) allows the applicant to stop the implementation of the WQIP after NHDES has determined that the purpose of the WQIP is achieved[70]. Due to the many potential risks to WQS

[68] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-11.
[69] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-11.
[70] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-12.

from the GRH Projects, the § 401 WQC should require ongoing water quality monitoring throughout the duration of the license - not only when triggered by violations.

E-12. Water Quality Monitoring and Reporting Plan (DO, Temperature, and pH):

A Water Quality Monitoring and Reporting Plan is required when there is a violation of Surface Water Quality Standards "at a magnitude, duration, and frequency that contributes to an impaired designated use related to DO, pH, or temperature"[71]. In this condition NHDES, neglects to address designated uses that are impaired by Project operations which are not related to DO, pH, or temperature, but rather other water quality criteria outlined in Env-Wq 1703.03[72].

NH water quality criteria include standards for more than dissolved oxygen ("DO"), Temperature, and pH[73]. Other criteria include nutrients like phosphorus and nitrogen, bacteria, benthic deposits, turbidity, Biological and Aquatic Community Integrity, and Cyanotoxins, to name a few. Furthermore, Condition E-11c includes a broader list of potentially impacted parameters, and begs the question as to why these same criteria are not included in this condition. If there is a violation, all designated water quality criteria must be monitored and reported out. Only monitoring the three above-mentioned criteria is both confusing and insufficient.

Condition E-12 requires that the "Applicant shall include in the WQIP, a water quality monitoring and reporting plan […] to determine if additional changes in Project operation or the WQIP are necessary to comply with Surface Water Quality Standards"[74]. It is important for the Applicant to research this finding, but it is pertinent that independent agencies, like NHDES, NHFGD, and USFWS also conclude if changes in project operation are necessary or if the WQIP is in compliance with WQS and make final determination.

Similar to our comment in Condition E-11, a water quality monitoring and reporting plan is only triggered *after* a water quality violation occurs. A water quality monitoring and reporting plan must be required prior to certification so that NHDES can make an educated decision to

[71] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-12.
[72] Env-Wq 1703.03, page 5.
[73] Env-Wq 1703.03, page 5.
[74] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-12.

grant or deny the § 401 WQC. As it stands, NHDES does not have adequate data to make that determination.

According to New Hampshire's *2020/2022 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology*, data requirement, data must be no more than five years old to be valid for assessing water quality and potential impacts[75]. To make informed decisions about environmental conditions and mitigation requirements, up-to-date data is essential. GRH should be responsible for regularly monitoring the physical and chemical conditions within their project areas and it is of the utmost importance that all water quality data, chemical and biological, collected by GRH be accessible to the public. The water quality data GRH submitted in their application relies on data from 2012 and 2015, which are both outdated, not statistically robust, and do not accurately reflect the current state of the river. On this basis, the § 401 WQS should be denied.

E-13. Modification to Certification:

We support NHDES's right to make modifications to the certificate to protect water quality if WQS are being violated but ask that any proposed modifications be publicly available to allow for public review and input. Furthermore, we request that "significant or material effect on discharges to surface waters from the Project"[76] be more adequately defined, as the terms "*significant*" and "*material effect*" may be subject to varying interpretation.

The Draft WQC Does Not Adequately Address Recreation, Decommissioning, and Has Unfairly Limited Public Participation

Several concerns are not addressed in the draft § 401 WQCs, but should be considered and incorporated as conditions, including recreation and public access, and the creation of a decommissioning funding mechanism. In addition, the opportunity for public engagement in this process has been severely limited.

[75] NH R-WD-20-20, page 72.
[76] Draft WQCs: Wilder, Bellows Falls, and Vernon, E-13.

Recreation and Public Access:

The draft § 401 WQC does not include a condition for recreation and public use and access. Under NH WQS[77], recreation is a designated use for all public waters in NH that must be protected and upheld. The absence of this condition and lack of detail, specificity, and planning for supporting recreation uses of the River in the draft § 401 means that NHDES cannot determine if the facilities will be in compliance with this NH WQS. While GRH states they will manage, maintain, and enhance recreational facilities, we believe that more emphasis should be placed on improving access and safety for recreation.

Protection of water quality for recreation is of paramount concern in NH WQS, being specifically addressed in Env-Wq 1703.01 and 1703.03 as a requirement that all surface waters must be able to be recreated in and on. NH communities bordering the Connecticut River are similarly concerned about the ability to safely and easily access the River for recreational purposes. Swimming, which is a designated use, is not mentioned at all in these draft § 401 WQC. Public access is directly needed to implement designated recreational uses like fishing, swimming, and boating. Prior to certification, NHDES should require a Recreation and Public Access Plan from GRH with specific and enforceable requirements and which includes consultation with recreation stakeholders. GRH should also be required to provide real time flows in more accessible ways, such as real time updates to a website and smartphone app, both for recreationists' planning purposes and for public safety.

The draft § 401 WQC does not demonstrate that proposed operations protect and do not interfere[78] with recreation opportunities and access for the River. At best, the draft § 401 WQC indicates that the current status quo regarding recreation will be maintained for the next 30-50 years, but there is no guarantee that this minimum will occur as it is currently presented. "Under the Great River Hydro proposal, Great River Hydro will also continue to operate and maintain the existing Project recreation facilities throughout the term of the new licenses and continue to permit state and local entities to operate recreational facilities that provide access to Project lands

[77] Env-Wq 1702.16 (a).
[78] Env-Wq 1703.03 (c) (1d), page 6.

and waters for recreational boating, fishing, picnicking, and environmental education. Great River Hydro proposes to incorporate into its respective Projects three canoe campsites, currently non-Project recreation areas on Great River Hydro fee-owned land"[79]. Importantly, there are also indirect effects impacting recreation such as: altered substrate providing insufficient habitat to support desirable game fish populations and their prey, proliferation of nuisance species decreasing swimming and boating opportunities, eroded banks diminishing safe access to and from the River.

GRH recycles the same language for each project, indicating that it will continue to "manage, maintain, and enhance as demand and use requires the various recreation areas and facilities associated with the three projects"[80], but it is manifestly unclear how they intend to do so. There is simply no detail to ensure that recreational opportunities will be supported and improved by project operations, necessitating certification denial.

Financial Assurances and Plans for Decommissioning:

The § 401 WQCs must include a mandated decommissioning plan and financial assurances for dam removal and river restoration for when the projects have reached the end of their useful life and are ready for retirement. Without these measures water quality will continue to be degraded long after hydropower has ceased operating. NH taxpayers should not bear the financial responsibility for decommissioning and restoring the River in order to be in compliance with NH WQS. Financial assurances are necessary now to fully decommission and remove these projects and restore the Connecticut River to a natural flow regime to protect existing and designated uses when the projects are retired.

NHDES Unreasonably Limited Public Process and Input

RSA 485-A:12 requires that NHDES must "provide a reasonable opportunity for public comment"[81]. With only three weeks for public comment, it was unreasonable that NHDES gave

[79] Draft WQCs: Wilder, Bellows Falls, and Vernon, C-13.
[80] Draft WQCs: Wilder, Bellows Falls, and Vernon, C-1.
[81] RSA 485-A:12, III-a(b).

the public such a brief comment period to address all three Projects. Similarly, the fact that NHDES failed to hold any public meetings regarding the § 401 WQCs is unacceptable given that these projects span decades and have a significant impact on water quality and designated uses for the Connecticut River. While public meetings are not required by law in NH, they promote public engagement, allow for questions and discourse, provide opportunities to share in-person testimony, and bolster transparent information sharing. Furthermore, the draft § 401 WQCs were structurally inadequate, in terms of content, clarity, and specificity, making it challenging to accurately provide informed feedback and ultimately for NHDES to enforce. Moreover, the delayed release of the draft § 401 WQCs resulted in a shortened timeframe, leaving NHDES with insufficient time to effectively understand, respond, and potentially incorporate conditions in the final § 401 WQCs. CRC understands the resource constraints facing NHDES, but the process and quality of the draft WQCs do not reflect well on NHDES and its role as protector of the State's waters and the public commenting process required by law.

The § 401 certification processes for these three Projects warrant extensive public input. The Connecticut River is one of New Hampshire's most important public and natural resources. The areas affected by these projects span approximately two-thirds of New Hampshire's length and is adjacent to several population centers including Lyme, Hanover, Lebanon, Claremont, Charlestown, Walpole, and Hinsdale. These § 401 processes will shape and protect the uses and quality of this public resource for the next 40 to 50 years. The three projects seeking certification are each a major project posing numerous complex ecological, biological, hydrological, geological, recreation, and social issues. The uses protected by the NH WQS and with which NHDES is asked to certify compliance include: swimming, fishing, fish consumption, wading, boating, surfing, and other recreation in and on the water – all public uses. Compounding matters is that GRH largely avoided providing any meaningful information regarding public uses and water quality.

An undertaking of this magnitude and sound public policy demand a high level of public input. Nonetheless, NHDES did the opposite and provided a public process for these three § 401 certification processes was wholly inadequate, unworkable, and hollow. NHDES published its notices for public comment for these three Projects simultaneously at 3:15 on Friday afternoon, March 21, 2025, and set a deadline for comments on all three draft certifications of 4:00 p.m. on

Friday, April 11. Including weekends, the public was given slightly less than three weeks to address a vast array of critical issues for area public resource spanning two-thirds of New Hampshire's length and reaching out for the next 40 to 50 years. Further, NHDES will only accept written comments. NHDES affirmatively chose to not hold any public hearing. There was no pre-application or informational hearing, or any other public process.

Most concerning, and most telling of this hollow public process, is the fact that NHDES has given itself the impossible task of reviewing public input, addressing the comments, incorporating material comments into the certifications, and issuing the three final certifications in a mere five business days. This task is even more impossible because of the draft certifications' multiple and severe gaps and defects – problems that simply cannot be meaningfully addressed, much less remedied, in five days. The end result is that the only information (or lack of information) meaningfully considered by NHDES was the information provided by GRH regarding one of New Hampshire's most important *public* resources – a resource owned by the public and that is not GRH's private property.

NHDES' failure to provide a reasonable opportunity for public comment is also highlighted by Vermont's robust public engagement process in its parallel § 401 certification processes. The NH and VT certification processes ran simultaneously and on the same timeline. NHDES and VTDEC closely coordinated their efforts. Despite the fact that the Connecticut River is almost entirely in New Hampshire, the VT DEC provided numerous opportunities for public engagement, including:

- Three public informational meetings, one in a location near each of the three Projects, Brattleboro, Hartford, and Bellows Falls held on August 6, 7, and 8.
- Issued a draft certification for the Wilder Project on December 23, 2024, provided a 30-day comment period, and held a public hearing in White River Junction on January 16, 2025.
- Issued a draft certification for the Bellows Falls Project on January 22, 2025, provided a 30-day comment period, and held a public hearing in Bellows Falls on February 12, 2025.

- Issued a draft certification for the Vernon Project on February 13, 2025, provided a 30-day comment period, and held a public hearing in Brattleboro on March 5, 2025.
- Encouraged public comment and input outside of formal comment periods.
- Engaged in substantial public outreach efforts and assured a fully transparent process. See Great River Hydropower 401 Water Quality Certification Application | Department of Environmental Conservation

FERC's relicensing processes that triggered these § 401 certification processes further demonstrate NHDES's failure to provide a reasonable opportunity for public comment. This FERC process has been on going for the last 13 years. And while the § 401 process has a one-year limitation, it is important to note that New Hampshire (like Vermont) has been actively engaged in the FERC process. Indeed, the draft certifications are almost entirely based on portions of GRH's 2020 final amended application to FERC and a 2020 MOU regarding flows that NHDES was a party to. Clearly, NHDES knew what was coming, had virtually all of the information provided by GRH's actual § 401 application years prior to the application, and had ample time to prepare and engage the public.

Simply put, NHDES has not provided a reasonable opportunity for public comment. NH RSA 485-A:12; 40 C.F.R. § 121.7(c)(4). NHDES now has two choices. It could continue in its effort to unreasonably limit and effectively preclude meaningful public comment. Or, NHDES can acknowledge the critical and severe gaps preventing certification and deny certification without prejudice until such time that GRH provides the information requisite to certification and the public has had a reasonable opportunity to comment.

Conclusion

In conclusion, these draft § 401 certifications do not ensure that the continued presence and operation of the GRH Projects will comply with New Hampshire Water Quality Standards. The Connecticut River Conservancy, American Rivers, American Whitewater, and Appalachian Mountain Club respectfully requests that NHDES deny the § 401 certification or include

significantly more robust conditions in the final § 401 certification for the GRH Hydroelectric Projects that adequately address the aforementioned concerns.

Thank you for your consideration of our comments in this important § 401 certification process. Should you have any questions about our comments, or require further information, please do not hesitate to reach out to me, Marilla Harris-Vincent, River Steward for New Hampshire, at mharrisvincent@ctriver.org.

Sincerely,

/s/ Marilla Harris-Vincent
River Steward for New Hampshire
Connecticut River Conservancy

/s/ Rebecca Todd
Executive Director
Connecticut River Conservancy

/s/ Andrew Fisk
Northeast Regional Director
American Rivers

/s/ Bob Nasdor
Northeast Stewardship & Legal Director
American Whitewater

/s/ Mark Zakutansky
Director of Conservation Policy Engagement
Appalachian Mountain Club

Water Quality Certification Program
Attn: Daniel Demers
NHDES Watershed Management Bureau
P.O. Box 95
Concord, NH 03301-0095

RE: Draft New Hampshire 401 Water Quality Certificates
Wilder Hydroelectric Project # WQC 2025-FERC-003
Bellows Falls Hydroelectric Project # WQC 2025-FERC-004
Vernon Hydroelectric Project # WQC 2025-FERC-005

April 11, 2025

Dear Mr. Demers,

On behalf of the Connecticut River Conservancy (CRC), Princeton Hydro LLC (Princeton Hydro) provides the following comments on the above-mentioned draft Water Quality Certificates (QWCs)[1].

Introduction

There is insufficient information to allow the "NHDES . . . [to] determine that discharges from the Project[s] will comply with surface water quality standards specified under RSA 485-A:8 and NH Code of Administrative Rul Env-Wq 1700"[2]; At minimum, information needed to assess the Projects' compliance with WQS includes:

- Analysis, modeling, or proposed monitoring measures to determine if the high quantity of unstable riverbanks will stabilize following the change to operations.
- Modeling and assessment of the impacts of the new flow regime and how a new equilibrium might trigger consequential impacts such as the initiation of sediment migration and if this could release nutrient laden sediment, triggering harmful algal blooms (HABs); and if the IEO operation, including the Flexible Operations[3] will have a material benefit to the stability of the riverbanks.

[1] Vernon, Bellows Falls, and Wilder Hydroelectric Projects; all three drafts are reviewed in this letter and will be submitted for each of the individual applications.
[2] NHDES, Public Notices for the Wilder, Bellows Falls, and Vernon Hydroelectric projects.
[3] Draft WQCs Wilder, Bellows Falls, Vernon, section E-6f

- The information required by the after-the-fact Water Quality Improvement Plan (WQIP)[4] must be developed prior to the issuance of the WQC instead,
- A robust, quantifiable, and repeatable baseline assessment of bank erosion and changes caused by the dams and the impacts of climate change have not been considered. As the FERC license will have a lifetime of 30 to 50-years, the impacts of higher intensity storms have not been evaluated in relation to the proposed flow regime.

None of this information was provided, requested or considered.

River Function and How they are Affected by Dams

The Connecticut River, as with all rivers over the eons, has evolved and reached relative equilibrium (before the construction of the dams) due to developing bankfull channel width relative to geomorphic characteristics, such as geology, climate, and land cover (i.e. vegetive cover). While rivers such as the Connecticut migrate laterally over time, the timescale is large (decades to hundreds of years), as meanders form and move about the floodplain floor. Channel stability and migration are muted by healthy vegetative cover on the riverbanks and floodplain through root systems that bind the soil together, and the roughness caused by the same, slowing the water velocities at the edges. Channel migration is usually induced by significant flooding events, by filling the channel to its bankfull elevation, where velocities are highest, and the rising and falling of the water surface that saturates the banks. These are the conditions that cause slope movement such as slides and slumps But, again, this description is of a free-flowing river with healthy riparian vegetation, with migration that occurs over decades to hundreds of years.

It is also noted that rivers also contain a variety of habitat types over short reaches, such pools (deeper areas of scour), riffles (i.e. rapids), and glides (usually downward slope from a riffle where water

[4] Draft WQCs: Wilder, Bellows Falls, and Vernon; Section E-11.

runs at a higher velocity than in the pools). This variety provides a diverse range of habitats, velocities, and substrates that increase the biodiversity if a river.

Construction of the three dams artificially elevated the water surface and saturated the portions of the riverbanks that were only subject to rare significant flooding events. As a result of the artificial elevation of the river, local water tables are increased and fluctuate as the water rises and falls. When there are changes in the water surface elevation, even subtly, as there has been because of peaking over the last at least 40 years plus, this repetitive saturation and desaturation of riverbanks cause instability to slopes that may have previously reached an equilibrium between channel migration and vegetative cover.

Rivers also move sediment from the far reaches of the watershed and pick up additional sediment as the system flows downstream; sourced from upland erosion mechanisms, and erosion and scour of the banks of the river channel itself. Rivers, such as the Connecticut, maintain the finer-grained sediment (clays, silts, and fine sands) portion of total sediment load[5] in suspension, while the coarser grained sands, gravels and cobbles are transported as bedload, running on the channel bottom. It is this bedload that provides the substrate for spawning of key species, such as for American shad, Sturgeon, and Atlantic Salmon. Dams constructed across the channel of a river interrupt the sediment transport process, capturing sediment through the increase in cross sectional area and reduced gradient that slows the velocity of flow, promoting the settlement of sediment above the dam; including clays, silts, and fine sands also containing phosphorus and nitrogen. As a result, the benthic substrate is covered fine-grained sediment, producing ecologically unsuitable areas of the river. Any changes in the flow regime, for example, when the operations of a dam increase water velocities in the impoundment by increasing discharges, will disrupt the fine-grained material and nutrients in deposited sediment, and can suddenly release this material in high concentrations into the water column. Sediment disturbance is also caused

[5] Total sediment load is a combination of suspended and bedload sediment.

by the changing of long-term flow regimes, for example with the proposed IEO operations, especially at the deltas of the impoundment where sediment that has settled because of sudden slowdowns in flow, in the current operations, for example, and with the change to the IEO operation leaves this sediment now subject to erosion from a more constant higher flow.

These current peaking operations have contributed to destabilized riverbanks since they were constructed in the mid-20th Century. Under this proposal, the change in operations will also change the flow regime increasing the velocity of flows potentially further destabilizing riverbanks without significant human intervention, such as slope stabilization efforts. It is impossible to know if the project "will comply" with the NH WQS without understanding the proportion of destabilized banks that will continue to fail in an accelerated manner or how the change in operations impacts water quality.

Climate Change Is Very Likely to Significantly Exacerbate Impacts on Operations

Climate change is causing more frequent and more severe storms that significantly increase the risk and severity of river flooding in New England. Since the late 1950s, the region has experienced a 60% increase in extreme precipitation events, driven by a warmer atmosphere capable of holding more moisture, which intensifies heavy rainfall during storms.[6] These changes have led to more frequent flash floods and prolonged inundation, particularly in areas with steep watersheds prone to rapid runoff. Recent studies predict that extreme precipitation events will increase by over 50% by the end of the century, further straining river systems and flood management infrastructure.[7]

Such increases in precipitation and resulting floods will further put strain on the three projects' riverbanks within their respective impoundments, accelerating the bank failures, including those sections

[6] Historic New England. "Flooding and Climate Change in New England." Published January 21, 2025. Based on the Fifth National Climate Assessment (2023).
[7] Njiiri, Kari. "Climate Change Will Cause More 'Extreme' Weather Events in New England." New Hampshire Public Radio, 22 Aug. 2024, www.nhpr.org/2024-08-22/climate-change-will-cause-more-extreme-weather-events-in-new-england. Accessed: April 7, 2025.

caused by the current operations. It will be vitally important for NH DES to understand the impacts of such future conditions by requiring modeling future flood scenarios based on the current available science on climate change induced rainfall over the life of the FERC licenses.[8]

Summary of Bank Stability Conditions of Each Impoundment

Wilder Hydroelectric Project

The current condition of this impoundment is described under section C-14 of the draft WQC, wherein it states that the impoundment flows across large floodplain, resulting in banks of less than 15 feet in height north of Piermont, NH. Banks are higher than 50 feet in the lower reach of the impoundment where the river encounters glacial surficial deposits. As stated above, NH DES admitted that "…slightly greater than 40 percent of the banks in the Wilder impoundment are unstable…", which includes eroding banks, loss of vegetation, or failing bank armor. This draft WQC admits that "[t]he amount of erosion in the Wilder impoundment appears to have increased through time "…although historical reviews are difficult because "…vegetated eroding and failing armored banks were likely not considered." One can conclude that the Wilder impoundment, likely contains much more than 40% failed riverbank, which is apparently increasing over time, as stated.

Bellows Falls Hydroelectric Project

For the Bellows Falls Hydroelectric Project draft WQC, the conditions of the riverbanks are included within section C-16. This impoundment comprises of "nearly 80 percent sand", with gravel and cobble along less than 15 percent of the banks, mostly in the locations of the banks that are over 50 feet in height, which comprises of about 10 percent of the banks. Bedrock only occurs on 4 percent of the banks.

[8] Bonnin, Geoffrey M., et al. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 2, Version 3.0: Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, 2006. Accessed: April 7, 2025.

According to the draft WQC for Bellows Falls the unstable banks include 40 percent of the riverbank, and the "amount of erosion…appears to have decreased through time…" because of reviewing historical mapping. Again, the draft WQC further states that "[h]istorical comparison is "challenging…" as "…vegetated eroding and failing armored banks were likely not considered." So, whether the instability is actually decreasing is unknown.

Vernon Hydroelectric Project

The Vernon dam impoundment riverbanks are comprised of 90% sand. Almost 60% of the banks are greater than 15 feet in height, with very little floodplain between Putney and Brattleboro, VT. Just over 10 percent of the riverbank is less than five (5) feet in height, due to the backwater impacts of the dam. As with the Bellows Falls impoundment, bank instability appears to have "decreased slightly", yet, again, as with the other two dams described above, comparing the historical mapping emphasizes the difficulty in making such comparisons because "…vegetated eroding and failing armored banks were likely not considered."

Proposed Flow Regime and Purported Benefits

The Draft WQCs' language includes modification of the flow management operations from what is termed "Peaking Operations", to an "inflow equals outflow" (IEO) wherein flow entering the impoundment are to equal flow being discharged downstream. The IEO operation is designed to reduce the frequent water surface elevation changes within the respective impoundments and provide flow closer to natural conditions within the riverine reaches of the Connecticut River. This change in operations is outlined in the Memorandum of Understanding (MOU) signed on December 1, 2020.[9] There are

[9] Memorandum of Understanding between Great River Hydro and the United States Fish and Wildlife Service, the New Hampshire Department of Environmental Services, the New Hampshire Fish and Game Department, the Vermont Department of Environmental Conservation, the Vermont Department of Fish and Wildlife, The Nature Conservancy, and the Connecticut River Conservancy; filed with Vernon Project FLA Exhibit B of Amended Final License Applications of Great River Hydro, LLC for Vernon Project, et. al. under P-1855 et. al. Accession Nos. 20201207-5219 (Public), executed on December 1, 2020

allowances for exceeding the IEO operations, albeit for limited periods of variance, for example due to extraordinary energy demands, maintenance, and flooding events, as well as continued flexible hours that allow for peaking flows.

The purported benefits, put forth by GRH, to changing operations to IEO, include consistent river levels and flows to improve water quality criteria related to ecological function, the modification may also create unintended consequences initiating sediment discharges and harmful algal blooms (HABs), for example. Regarding HABs, a change in flow regime from peaking to IEO operations leads to several questions regarding the change in state of sediment stability at tributary confluences and the upper reach of the impoundments, thermal stratifications, thermal conditions, nutrient concentrations, and available oxygen at depth. The current peaking operations likely provides mixing of thermal layers of the water body but can release nutrient laden sediment, but with the IEO operation, more consistently stable water surface elevations could lead to extended periods of higher water temperatures, anoxia at depth, and the triggering of harmful algal blooms (HABs) within the impoundments.[10] It will be vitally important to understand how the changes to the operations could trigger such blooms, and if there will be a measurable improvement to riverbank stability.

History of Riverbank Instability and Recognition of Impacts

Due to concerns regarding bank instability of the hydroelectric projects on the Connecticut River, as far back as the 1970s, the US Army Corps of Engineers completed a study in 1979, called the "Connecticut River Streambank Erosion Study".[11] While this study concluded that a significant portion of the instability was caused during major flood events, it also included compounding factors such as pool

[10] Harmful algal blooms consist of blue-green algae, also known as cyanobacteria, which release cyanotoxins that can negatively affect fish and terrestrial organisms, including humans who might ingest water containing these toxins.

[11] U.S. Army Corps of Engineers, 1979, Report on Connecticut River Streambank Erosion Study: Massachusetts, New Hampshire and Vermont: Department of the Army New England Division Corps of Engineers: Waltham, MA, 185 p.

fluctuations. In fact, **pool fluctuation was the second highest ranking of causative factors in the study** (emphasis added). The study stated that "…the storage and release of water for hydropower generation causes numerous fluctuations in river stage…[and]…[t]hese changes in stage, even though relatively small", causes flows from the river into the banks during the rising of water levels, and then water flowing out of the banks and into the river…" decreasing stability of the bank".[12] This failure mechanism includes "piping of riverbanks" where soil is transported by groundwater into the river. This is important, as even with the new IEO operations, "[t]here are no limitations on the number of Flexible Operations events per day or the duration of the event, other than those that indirect limitations..."[13] as described in section E-6f(iv) of each of the draft WQCs, that will continue to strain the toe of the slopes. The projected daily fluctuation during normal operations is expected to range by 12 inches[14], while "flexible operations", of which there is no limit as to the number or duration of these operations, as described above, allow for up to 18 inches of fluctuation in water surface elevation.[15] Based on our review of the draft WQCs and their references support materials, there is no modeling or literature reviews of the potential impacts to bank stability, even for these smaller water surface elevation fluctuations.

A subsequent 1982 study, also by the US Army Corps of Engineers, "[o]perating a reservoir in a peaking mode, that is, controlling releases to match peak energy demands, creates another level of impacts within the reservoir and downstream of the dam." [16]

[12] U.S. Army Corps of Engineers, 1979, page 62.
[13] Draft WQCs Wilder, Bellows Falls, Vernon, subsection E-6f.
[14] Draft Water Quality Certifications, Wilder (2025-FERC-003), Bellow Falls (2025-FERC-004), and Vernon (2025-FERC-005) Hydroelectric Projects, subsection E-6c of each.
[15] Draft Water Quality Certifications, Wilder (2025-FERC-003), Bellow Falls (2025-FERC-004), and Vernon (2025-FERC-005) Hydroelectric Projects, subsection E-6f. of each.
[16] Dames and Moore. 1981. An Assessment of Hydroelectric Pumped Storage. In National Hydroelectric Power Resources Study. Volume X. Prepared for the U.S. Army Engineer Institute for Water Resources, Fort Belvoir, Virginia. https://www.iwr.usace.army.mil/portals/70/docs/iwrreports/iwr019-000001-000517.pdf

Background and Prior FERC Studies Review by Princeton Hydro Addressing Erosion

Princeton Hydro was contracted by the CRC in 2016[17], 2017[18], and 2018[19] to provide a peer review of Studies 2 and 3 and the modeling efforts completed by GRH and their consultants. Specifically, there was concern by CRC, and concluded by Princeton Hydro that the actual causes of erosion, bank slumping, and the associated impacts to water quality and habitat were not adequately and accurately evaluated. Our focus at the time was on the Revised Study Plan (RSP) and Integrated Licensing Process (ISP) Study 2 and 3 (Riverbank Transect and Riverbank Erosion Studies). In our initial peer review of 2016, with the 18 recommendations made in the memorandum, we found that GRH only reviewed velocities of the river flows and would not concede that rapid fluctuations in water levels could lead to bank failure. Such a broad conclusion was not founded in accepted scientific standards, and as a result, we recommended that "…a better understanding of causation should be ascertained with a difference methodology such as statistical analysis of the data collected or a bank stability model that utilizes a wider variety of geotechnical and vegetative parameters, such as geotechnical strength, maximum rooting depth, and hydraulic gradient between ground water and river water levels."[20] And finally, we pointed out that the impacts of instability of the river banks within the impoundments as a result of loss of upland vegetation and sedimentation below the water surface, including riparian areas, shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat, all have direct and consequential impacts on many of the water quality parameters covered in the NH WQS.

[17] Memorandum referenced "FERC Re-Licensing Process for TransCanada Hydro Northeast Inc. Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies", prepared by Princeton Hydro, dated September 16, 2016.
[18] Memorandum referenced "FERC Re-Licensing Process for TransCanada Hydro Northeast Inc. Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies, Supplement to Final Study Report, dated February 4, 2017", prepared by Princeton Hydro, dated May 15, 2017.
[19] Memorandum referenced "FERC Re-Licensing Process for TransCanada Hydro Northeast Inc. Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies, Final Study Report, dated November 15, 2017", prepared by Princeton Hydro, dated March 6, 2018.
[20] Princeton Hydro, 2016, page 19.

Our last report of 2018, while recognizing the improvements to the GRH's evaluation of bank stability, including the incorporation of 2-dimensional sections (in HEC-RAS 1D, with specific sections modeled as 2D) found significant gaps. For instance, GRH did not evaluate the daily inundation of riverbanks that created conditions that left the lower riverbanks bare of vegetation and subject to submersion that would reduce the shear strength of the banks, thus causing the sloughing at the toe of the slope that was observed. In response to our concern about their oversimplification of the impacts of river flow velocities on the subject reach, they stated that "only 8 out of 21 sites show any potential for sediment entrainment[21]". We pointed out in our review that 8 out of 21 sites represents over 30% (actually, 38%), which can be extrapolated to mean that nearly 40% of the river channel within the Wilder, Vernon, and Vernon Hydroelectric Projects or 37 miles of river are subject to instabilities caused by these projects. We provided quoted text from FERC's Determination Letter, dated July 21, 2017, wherein they specifically requested that the study "…includes an analysis of estimate critical shear stress, near bank velocity, and the potential correlation of these factors with project operation at the 21 monitoring sites."[22]

Our recommendations and needs for improvements to the models remain valid and were supported by the 1979 and 1982 US Army Corps of Engineers studies. This and descriptions of more current[23] conditions of the riverbanks provided in the draft WQCs, cited above, indicate that project operations were a significant causation of bank erosion and instability under the current operating regime. And, while the Connecticut River Conservancy supports the change to IEO, as agreed, there are still unknowns and insufficient information, as stated throughout this document, to support the statement that these projects will comply with the NH WQS.

[21] Entrainment is defined as the process of water flows or currents capturing and transporting sediment because of exceeding a soil's shear strength or having a velocity to be able to suspend such sediment.
[22] Princeton Hydro, Memorandum, 2018, page 2
[23] Albeit the data provided is at least a decade old.

NH Water Quality Standards Implicated by Impacts

Env-Wq 1703.01 Water Use Classifications; Designated Uses.

The impoundments and riverine sections of the three projects are designated as Class B, considered the second highest water quality in the state, below Class A. The above-described impacts bear negatively on the "chemical, physical, and biological integrity"[24] of the Connecticut River due to the likely existing and likely to remain violations of the water quality criteria described below.

Env-Wq 1703.07 Dissolved Oxygen. The above-described impacts create conditions that resuspend nutrient laden sediment that could lower DO, creating unsupported conditions for aquatic life. The change to IEO operations has a high probability of further stratifying during the summer months in low flow conditions, inducting low DO or anoxic areas of the impoundments. This will impact aquatic organisms and may lead to fish kills.

Env-Wq 1703.08 Benthic Deposits. This is a key criterion in this regulation, as the river already contains large swaths of finer-grained sediment that will have a "…detrimental impact on the benthic community …" and is not "naturally occurring" due to the existing dams promoting the capture of fine-grained sediment. As illustrated in GRHs, ILP Study 7, most of the impounded reaches have lost their pool, riffle, run sequences and have a mono-substrate of sand/silt/clay covering 2,308.0 acres (76.2% of habitat), 2,450.9 acres (83.9% of habitat), and 2,273.1 acres (72.5%) of the impoundment for the Wilder, Bellows Falls, and Vernon impoundments, respectively.[25][26] This water quality standard is, by far, the most impacted and clearly violated criteria, now or in the future operations as IEO, as it negatively impacts spawning substrates, habitat, and contains nutrients that lead to impacts to the other criteria described

[24] NH WQS, subsection Env-Wq 1703.01(b)
[25] Great River Hydro, ILP Study 7, Aquatic Habitat Mapping Final Study Report, March 2, 2015, Tables 6-1 (Wilder), 6-2 (Bellows Falls), 6-2 (Vernon)
[26] The total areas of the fine-grained benthic deposits is equivalent to the area of over 8 times the area of Central Park in New York City.

herein. The change to IEO operations will not improve this condition, and in fact, may promote the resuspension and redistribution of sediment that will repeatedly smother much of the impoundment.

Env- Wq 1703.11 Turbidity. and Env-Wq 1703.14 Nutrients. These two criteria are grouped, as they are linked with the potential for fine-grained sediment resuspension to release legacy nutrients, as well as the continuing bank instability caused by the hydropower operations that would create turbid conditions releasing additional nutrients into the water column.

Env-Wq 1703.17 Cyanotoxins. Related to nutrients and dissolved oxygen (DO), if the sediment (see section Env-Wq 1703.08, above) is resuspended because of the change in flow management operations, this will release nutrients, particularly phosphorus, that could lead to harmful algal blooms (HABs), the source of cyanotoxins. The resuspension of sediment is likely to occur at tributary confluences within the impoundments and at the upper reaches of the impoundments, where the sediment are greatest and will be subject to resuspension due to the change to IEO operations. When additional nutrients are released to the system biological oxygen demand (BOD) increases creating reduced DO in the hypolimnion (lower layer in lake stratification), triggering the release of additional phosphorus in the anoxic condition. Additionally, in the lower and deeper reaches of the impoundment the change to IEO will lead to more stable stratification that can promote anoxia in the hypolimnion, releasing additional nutrients. What has been experienced specific to climate change are longer periods of dry, hot weather in the summers, followed by more intense storms and subsequent turbulence in the impoundments in between that breakup the stratification, further releasing phosphorus to the upper, sunlit section of the water column. This will further promote the potential for more frequent HABs. This criterial will impact on the recreational aspects of the NH WQS, and is not just a result of the existing operations or proposed IEO operations, but from the existence of the dams and creation slower waters creating the conditions for the occurrence of HABs.

Env-Wq 1703.19 Biological and Aquatic Community Integrity. Unnatural conditions within the impoundments caused by widespread fine-grained sediment covering the river channel bed, is not

conducive to supporting the native species normally encountered in free riverine systems with healthier substrates. Additionally, ongoing failure of the banks continuously deposits sediment in the nearshore, shallow water habitats, and upon emergent wetlands vegetation and invertebrates.

PART Env-Wq 1708 Antidegradation – There is just one mention of "antidegradation" in the draft WQCs, and it is included in future monitoring. There is no discussion of how the project will meet this criterion anywhere in the drafts.

Requisite Further Study, Modeling and Analysis

None of the above-described impacts were considered or at least addressed, in the draft WQCs. As also detailed above, these impacts must be considered to render a scientifically valid assessment of the Projects' compliance with WQS. At minimum, the following is needed for such assessments. Further study necessary includes the following.

- A true[27] 2-dimensional model, such as the HEC-Ras 2D[28] program must be used to establish baseline understanding for the entire impoundment and riverine reaches of all three (3) projects. This has been partially completed by GRH, although using a single flow value in each run does not reflect the transitory nature of water surface elevations and impacts on the riverbanks. The result of the model should be calibrated during operations. In this way the HEC-RAS model can be used to understand circulation patterns along the riverbanks that may affect water quality (backwater areas where HABs can develop) and flow velocities and directions that would determine the cause of a bank failure that may occur or predict where slope failures may occur based on observed flows corroborated with the model.
- Volumetric quantification of accumulated sediment and sediment sampling throughout the impoundments is a missing component of the data provided to date. Such data to be obtained would include physical and analytical characteristics of accumulated sediment, as well as

[27] As opposed to a HEC-RAS 1-D, quasi-2 dimensional model.
[28] USACE Hydraulic Engineering Center (HEC), River Analysis System (RAS).

determining the distribution of accumulated sediment and evidence of subsurface areas where erosion/bank failures may have contributed to a violation of the **Benthic Deposits**, water quality standard[29] , for example.

- Due to the advancement and cost efficiency of LiDAR technologies for use in the monitoring of rivers and bank stability, obtaining riverbank topographic data and vegetative cover is strongly recommended. Such data to be collected will be an initial baseline flyover via drone or helicopter survey to collect the above and below water surface slope conditions pre-change to IEO. Such data can be used to identify existing slope movements and vegetative covers. In subsequent years, say biannually, or after significant events such as flooding caused by tropical storms, nor'easters, or summer catastrophic storms such as have occurred over Vermont in the last two years, a flyover LiDAR (upland and bathymetry) survey must be conducted. Subsequent years can be precisely overlain over prior years to calculated changes in slope elevations. Especially following significant flooding, the impacts between regional storm events versus bank instability/erosion caused by operations can be distinguished. In consulting with remote sensing/survey firms who conduct such services, each survey, including analysis and reporting can be completed for less than $50,000 per impoundment in 2025 dollars, providing NH DES and the public with a more comprehensive, quantitative assessment of the stability of the riverbanks and the vegetative cover that adds to river stability. Such a cost would be comparable, if not less costly than ground surveying the limited number of river sections previously completed to determine the overall stability of slopes within the subject impoundment. The surveys conducted would then be overlain with the HEC-RAS 2-dimensional models to evaluate natural and operational flows and how they may be contributing to riverbank instability.

[29] NH WQS, Part Env-Wq 1703.08.

The following figures illustrate the usefulness of this technology and how it has been researched and developed for a situation such as for these impoundment reaches.

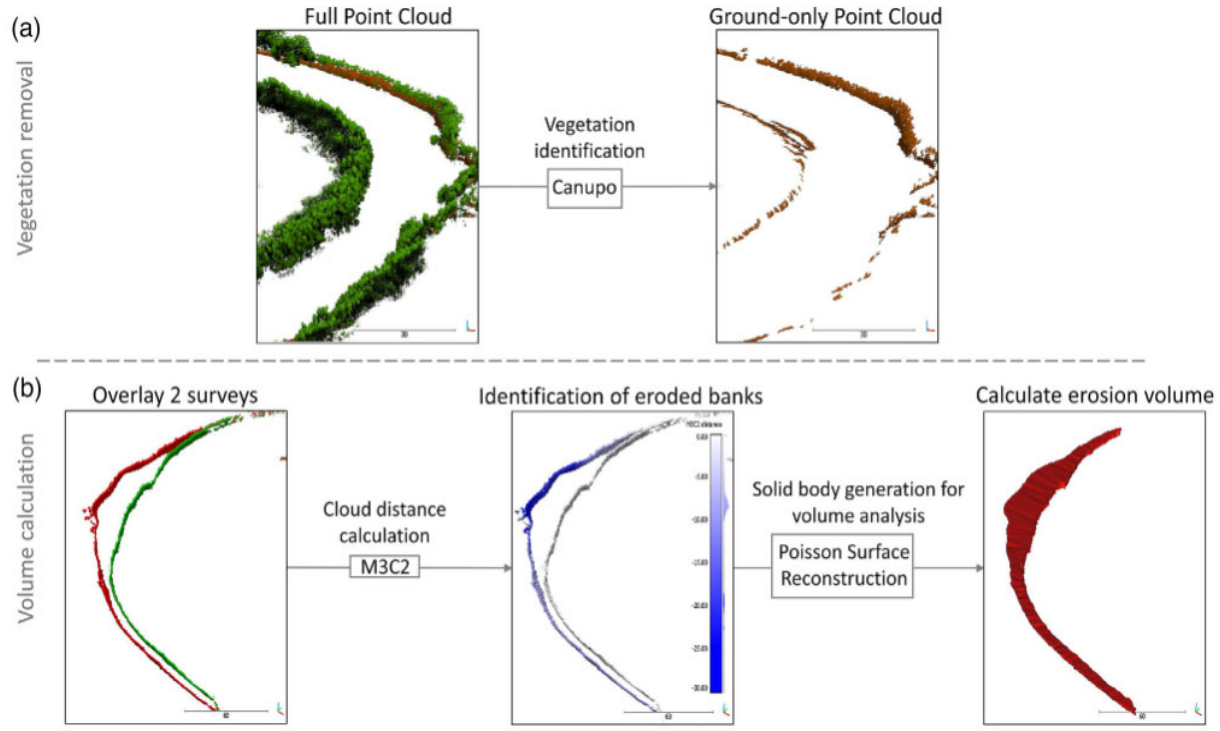

FIGURE 2 Schematic overview of the data processing workflow. Note that the bank segment shown in figure (a) (vegetation removal) differs from the bank segment shown in figure (b) (volume calculation) because areas with considerable bank erosion are generally near-vertical banks without vegetation cover—thus, different segments are best used to illustrate the two steps. [Color figure can be viewed at wileyonlinelibrary.com]

Figure 1 Illustration of the ability of the use of LiDAR to accurately assess vegetation cover and slope/volume changes of riverbanks.

Haddadchi, A., Bind, J., Hoyle, J., & Hicks, M. (2023). Quantifying the contribution of bank erosion to a suspended sediment budget using boat-mounted lidar and high-frequency suspended sediment monitoring. *Earth Surface Processes and Landforms*, 48(14), 2920–2938. https://doi.org/10.1002/esp.5667

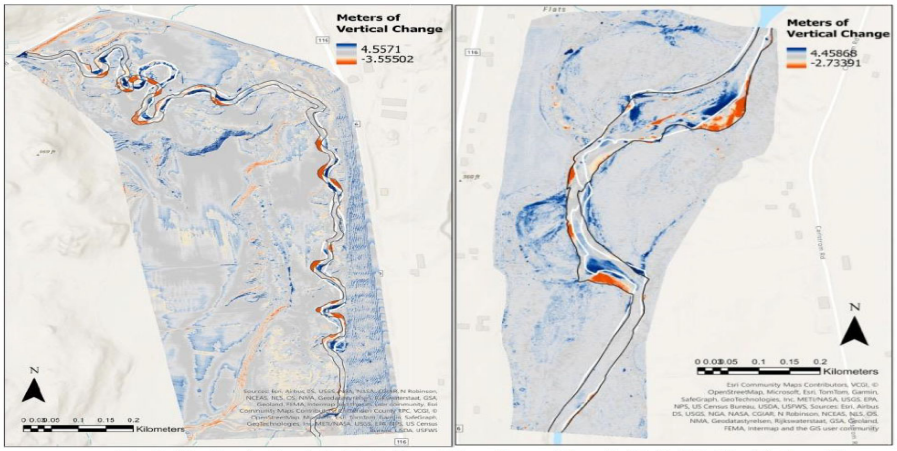

Fig 3. The Lewis Creek DoD (left) and New Haven River DoD (right). The black outline represents the 2023 stream channel boundary, and the white outline shows the older channel boundary. Polygons representing the extent of bank erosion were drawn in between the channel boundaries where the new channel was outside the older channel.

Figure 2 Another illustration of the ability of the use of LiDAR to accurately assess vegetation cover and slope/volume changes of riverbanks.
Flanzer, Zoe C., "Examining Variability in Streambank Erosion Rates in the Lake Champlain Basin, Vermont" (2024). *UVM College of Arts and Sciences College Honors Theses*. 129. https://scholarworks.uvm.edu/castheses/129

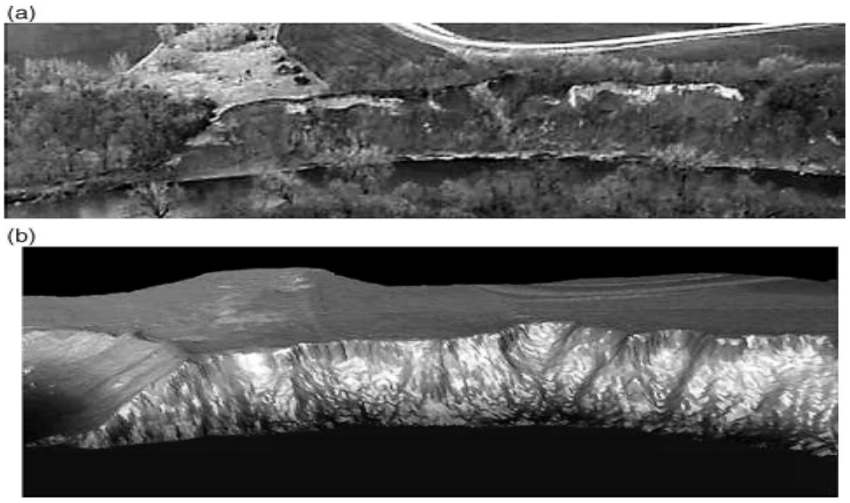

Fig. 2. (a) A severely eroded site along the Blue Earth River photographed at an oblique viewing angle from the air, and (b) rendered as a bare-earth elevation model from the LIDAR data. Vegetation was filtered and points gridded to a 1 m interval in the LIDAR image to create the model. Note gravel road passing through fallow field for scale in both figures.

Figure 3 The use of LiDAR from oblique angles to evaluate the overall stability and areas of failures on riverbanks.
Thoma, D. P., Gupta, S. C., Bauer, M. E., & Kirchoff, C. E. (2005). Airborne laser scanning for riverbank erosion assessment. *Remote Sensing of Environment, 95*(4), 493–501. https://doi.org/10.1016/j.rse.2005.01.012

Recommended Conditions

Compliance with WQS cannot be certified, absent the results of the above-described modelling and information. The information is likewise critical to developing information needed to formulate conditions assuring WQS compliance.

Based on current information, only an incomplete list of conditions that may be included in a revised certification based on the requisite information detailed in these comments can be formulated. Conditions that must be added, much of which must be completed prior to the issuance of the final WQCs are as follows:

1. Require baseline water quality modeling (prior to issuance of WQCs) and a monitoring plan to be developed **prior to the issuance of the WQCs**. Monitoring and sampling for the potential for these impoundment systems to initiate the development of Harmful Algal Blooms (HABs), including reference reach and impoundment sampling and analysis for the existence of cyanotoxins and their relevance to the impacts to the water quality standards for "Cyanotoxins"". Develop the water quality monitoring plan for the life of the Licenses to ensure that all water quality parameters can be met going forward, and the ability to enforce changes to operational processes or other conditions to protect water quality.
2. Complete a bathymetric survey that includes quantification of sediment, including volume, distribution, grain size and nutrient content. This would be **completed prior to the issuance of the WQCs** and used in the water quality modeling in 1, above, and the scour analysis under the HEC-RAS modeling recommendations.
3. Require a topographic survey, utilizing flown LiDAR at a scale that permits the identification of elevation slopes at an interval of two (2) feet, and using RTK GPS technology to allow for repeatable overlays of the terrain from survey to survey. The frequency of the survey should be conducted at intervals of a maximum of every two years, and following significant flooding

events, such as Nor'easters and tropical storms. The baseline survey **must be completed prior to the issuance of the WQCs**.

4. Require an updated HEC-RAS model that includes 2-dimension modeling in unsteady conditions of the entire reaches of all three projects, including the riverine sections to evaluate flow patterns, scour, and sediment transport during operational conditions in both the existing peaking operations and proposed IEO operations. This **must be completed prior to the issuance of the WQCs**, with subsequent calibration of the model during the change to IEO operations.

Conclusion

Thank you for the opportunity to review and provide our comments on the Draft 401 Water Quality Certificates for the Wilder, Bellows Falls, and Veron Hydroelectric Projects. The Drafts' conclusions that the Projects comply with WQS is scientifically unfounded. The information outlined above is requisite to assessing compliance.

Sincerely,

Geoffrey M. Goll, P.E.
President
Princeton Hydro, LLC

Enclosures:

- Memorandum referenced "FERC Re-Licensing Process for TransCanada Hydro Northeast Inc. Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies", prepared by Princeton Hydro, dated September 16, 2016.
- Memorandum referenced "FERC Re-Licensing Process for TransCanada Hydro Northeast Inc. Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies, Supplement to Final Study Report, dated 11/15/2017", prepared by Princeton Hydro, dated May 15, 2017.
- Memorandum referenced "FERC Re-Licensing Process for TransCanada Hydro Northeast Inc. Peer-Review of ILP Study 2 and Study 3 Riverbank Transect and Riverbank Erosion Studies, Final Study Report, dated February 4, 2017", prepared by Princeton Hydro, dated March 6, 2018.

Connecticut River Conservancy

Clean water. Healthy habitat. Resilient communities.

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31 Jan 2025

Daniel Demers
Water Quality Certification Program Supervisor
NH Department of Environmental Services
29 Hazen Drive
Concord, NH 03302

Re: Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855), and Vernon (FERC No. 1904) Relicensing and Clean Water Act §401 Certification Applications to the State of New Hampshire

Dear Mr. Demers,

The Connecticut River Conservancy ("CRC") respectfully submits these comments regarding the applications of Great River Hydro, LLC ("GRH") for New Hampshire Clean Water Act §401 Water Quality Certifications for the Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855), and Vernon (FERC No. 1904) hydroelectric projects (collectively, "the GRH projects").

Since 1952, CRC has worked to protect and restore the Connecticut River and its tributaries. CRC represents members across NH, VT, MA, and CT, who are invested in the health and protection of the Connecticut River and its watershed. As the only nonprofit organization focused on the entire Connecticut River, we are considering both local project effects and watershed-wide implications of potential §401 certification by the NH Department of Environmental Services ("DES").

CRC has commented over the years on many of the issues pertaining to project operations and NH water quality as part of the Federal Energy Regulatory Commission

("FERC") proceedings, most recently in comments on the entire Final License Application[1]. We have incorporated some of those earlier communications by reference within, but encourage DES to review all previous comments. CRC also recently submitted comments to the State of Vermont[2] regarding the §401 certification process under their jurisdiction and we encourage NH DES to review those comments as well.

The current §401 certification process is the first opportunity since 1979 to address the projects' impacts on water quality and evaluate their compliance with NH Water Quality Standards ("WQS"). It will be the only opportunity to do so for the next 40 years. As such it is an extremely important opportunity to ensure that the public trust is maintained and protected, inclusive of all designated uses and criteria, under the preferred operating conditions. GRH has not provided sufficient information to determine if the GRH projects will comply with NH WQS; on this basis alone NH DES must decline to issue a water quality certification.

GRH's applications do not ensure that the presence and preferred operating conditions of the projects will comply with the State of New Hampshire Water Quality Standards ("NH WQS"), the protections afforded a designated river, and other applicable state and federal regulations. CRC has significant concerns regarding the currently known and potential future adverse impacts the projects have on water quality, both in regard to the "typical" criteria addressed in the application (temperature, pH, oxygen), criteria such as benthic deposits and nuisance species which were not addressed in the application, as well as designated uses including habitat, recreation, and aquatic life integrity.

The applications lack comprehensive details regarding recreation, river access and monitoring which limits the ability of NH to meaningfully enforce WQS and prevents the public from providing meaningful commentary on the application. CRC reserves the right to amend these comments should additional information become available.

Compliance with NH Water Quality Standards

The §401 water quality certification process allows NH to protect water resources and ensure that those who are utilizing state waters through a federal permit are in compliance with EPA approved WQS. Certifications issued by NH typically contain conditions designed to

[1] Accession Number 20240522-5202, Comments of Connecticut River Conservancy on Great River Hydro, LLC's amended final license applications re the Bellows Falls Hydro Project, et al. under P-1855, et al.
[2] CRC Comments to VT DEC are available here: https://www.ctriver.org/post/hydro-401-comments-vermont

ensure compliance, however, the state has both the authority and the responsibility to deny certification if the project fails to meet NH WQS or does not provide adequate information for DES staff to determine whether it will do so. CRC contends that the GRH proposal is lacking throughout and will expand upon this in our comments below.

List of affected assessment units and current impairments[3] for the mainstem only:
NHRIV801030703-04 – Aquatic Life, Fish Consumption, no data to assess remainder
NHRIV801040205-06 – Fish Consumption, no data to assess remainder
NHLAK801040402-03 – Fish Consumption, insufficient data to assess remainder
NHRIV801040402-13 – Fish Consumption, no data to assess the remainder
NHRIV801060302-01 – Fish Consumption, Swimming, no data to assess remainder
NHRIV801060302-05 – Fish Consumption, Swimming, insufficient data to assess remainder
NHRIV801060305-12 – Fish Consumption, insufficient or no data to assess remainder
NHRIV801060702-12 – Aquatic Life, Fish Consumption, no data to assess remainder
NHIMP801060703-05 – Aquatic Life, Fish Consumption, no data to assess remainder
NHRIV801070501-10-01 – Aquatic Life, Fish Consumption, no data to assess remainder
NHRIV801070501-10-02 – Aquatic Life, Fish Consumption
NHRIV801070502-06 – Fish Consumption, no data to assess remainder
NHRIV801070505-10 - Aquatic Life, Fish Consumption, no data to assess remainder
NHIMP801070507-01 – Fish Consumption, no data to assess remainder
NHRIV802010501-05 – Aquatic Life, Fish Consumption

The NH WQS (CHAPTER Env-Wq 1700) are "intended to protect public health and welfare, enhance the quality of water and serve the purposes of the federal Clean Water Act, 33 U.S.C. 1251 et seq., and RSA 485-A. [4]" and apply to "all surface waters" and anyone who "undertakes hydrologic modifications[5]". Designated uses of all water bodies include recreation, fish and shellfish consumption, aquatic life integrity, wildlife, and potential drinking water supply. Contrary to GRH's application in which they state that only some designated uses apply to assessment units within the project area, all six designated uses defined in Env-Wq 1702.17

[3] Listing categorizations of 3-PNS, 4, and 5 from the 2024 watershed report cards
[4] Env Wq 1701.01
[5] Env Wq 1701.02

apply to all surface waters in the state of NH. In order to evaluate whether these uses are being supported, specific criteria are established under Env-Wq 1703. These include limits to temperature, pH, dissolved oxygen, nutrients, and other specific pollutants, as well as standards for benthic deposits, community integrity, and other physical, chemical, and biological aspects of water quality. The Connecticut River and tributaries affected by GRH project operations are classified as Class B waters in NH, and some criteria have class specific conditions. All waters in NH, regardless of class, must be maintained and restored to meet the existing and designated uses, shall have adequate flow to protect existing and designated uses, and be able to support fish, wildlife, and recreation[6]. The §401 water quality certification process is critical to upholding the CWA obligations of the state, and to supporting and protecting water quality and designated uses of the river.

Importantly, NH WQS criteria are designed to ensure criteria are met in comparison to naturally occurring conditions, defined by Env-Wq 1702.28 as "conditions which exist in the absence of human influences." GRH has proposed significant modifications to project operations (which CRC is in favor of) and repeats throughout their §401 applications that the preferred alternative operation of IEO/Flex will provide better environmental protection and maintain or improve water quality in comparison to the prior peaking operations. However, the Connecticut River will still be undergoing significant hydrological modifications as a result of the presence and operation of the GRH projects, as well as additional modifications as a result in the change in operations, and these impacts must be considered in respect to "conditions which exist in the absence of humans influences" not in comparison to what has been happening under past operations. To that end, the GRH application lacks comprehensive evidence that designated uses will be supported and water quality criteria achieved under future operating conditions; it is all speculative.

Additionally, the Connecticut River itself is also a designated river under the River Management and Protection Program. As such, it has "been recognized by the state legislature and the governor for their important natural resources, historical significance, and their contribution to our quality of life.[7]" The river is designated as a Rural; Rural-Community; or Community River throughout the project areas. The Ashuelot, Cold, and Mascoma Rivers are

[6] Env Wq 1703.01
[7] https://www.des.nh.gov/tabbed-content/designated-rivers and NH Statute Chapter 483

also impacted by project operations and are also designated rivers under NH statute. This designation mandates additional scrutiny in how the rivers are utilized and impacted to ensure that management decisions continue to "maintain and enhance the natural, scenic, recreational and community values of the river. [8]"

The GRH projects seek renewed federal licenses, which has triggered the §401 process. If renewed, those licenses will last for decades, meaning that this §401 certification process will have effects on the health of the river for decades as well. Due to the lacking, vague, or contradictory aspects of the GRH §401 application, CRC is not confident that the designated uses for the river will be protected, particularly in the face of increasing climate change impacts, without robust and comprehensive conditions attached or outright denial of the certification. DES must take their responsibility for the protection and improvement of NH's waters seriously, and ensure that the projects comply with NH WQS, as GRH does not provide adequate assurance that they will do so. The following details more specific aspects of our concerns.

Outdated or Inadequate Data Provided

According to the NH CALM (202020/2022 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology)[9], NH considers data collected within the last five years to be appropriate for assessing the condition and potential impairment of rivers within the state[10]. The GRH application refers to water quality studies completed in 2012 and 2015 in providing evidence that current operations do not violate NH WQS. These studies are beyond the data age restrictions that would be determined acceptable for accurately assessing support of designated uses. The same date age restrictions in the name of accurate assessment should be applied to the §401 water quality certification process. Additionally, these studies address current operations, not the preferred alternative proposed within the application.

Moreover, ILP Study 6, referred to by GRH in the application as assessing water quality focused on chemical parameters, and was not inclusive of physical and biological effects that are included in the NH WQS. Emphasis on pH, temperature, and dissolved oxygen, while critical components of NH WQS impacted by dam presence, minimizes the additional direct and indirect effects of hydro operations on aspects of water quality such as bank stability, habitat structure

[8] NH RSA 483:7-a
[9] Available at https://www.des.nh.gov/resource-center/publications?keys=SWQAcalm&purpose=&subcategory=
[10] 2020/2022 CALM section 3.1.10

and availability, and aquatic community composition that support designated uses. For example, it is well established that the impoundments created by dams are subject to increased temperature and decreased oxygen in the water column, but it is also well established that impoundments are characterized by increased deposition of fine sediments as a result of alterations to water flow. This in turn determines habitat and food availability for resident species. Thus, dam presence affects biological and aquatic community integrity by imposing controls on substrate and food availability for the entire trophic community through both benthos and water column alterations.

There is no dispute that the Connecticut River is an unnatural river system that is managed, and thus shaped, by the operations of numerous hydroelectric dams and projects. The fact that the assessment unit for the river north of Wilder Dam is classified as a lake (NHLAK801040402-03) is both a testament to how deeply the projects influence and impact the water, and an insult to New England's longest river, much of which is within the care of NH. In order to restore, maintain, and protect the designated uses of this public trust, DES must critically evaluate how preferred project operations will alter the chemical, physical, and biological components of the river *from its natural state [emphasis added]* and whether these alterations impede designated uses. CRC maintains that DES does not have adequate data to conduct a robust evaluation, and thus should deny the §401 certification until those data have been provided.

No Public Access to Data is Assured

GRH must be required to make publicly available in real time the data they are utilizing to determine compliance with WQS and the WQC, including flow, water chemistry, biological, and recreation access data.

It is clear from recently issued §401 certifications at other facilities that DES includes a standard condition that "The Applicant shall ensure that the discharges from the Project will maintain and protect Surface Water Quality Standards of surface waters that are affected by the Project, including the chemical, physical, and biological integrity of those surface waters[11]" and that "If NHDES determines that the Project is causing or contributing to a violation of Surface Water Quality Standards at a magnitude, duration, and frequency that contributes to an impaired

[11] Section E1 in both Errol and Watson WQC available at https://www.des.nh.gov/water/rivers-and-lakes/water-quality-certification

designated use, or is not protecting or maintaining an existing use, then NHDES shall notify the Applicant in writing, and the Applicant shall submit a [water quality improvement plan] to NHDES for approval.[12]"

Additionally, it is clear from the biannual 305b/303d listing process that NH DES does not have the capacity to truly evaluate the water quality conditions of all of the water bodies in our great state within a timeframe that accommodates the data age restrictions. The listed mainstem sections above include numerous designated use categories that cannot be evaluated due to lack of data. Thus, it appears incumbent upon the Applicant to self-report compliance, and yet it is only when DES determines that the WQS are not being upheld that the Applicant will be required to develop a plan to improve water quality and include in that plan "a schedule to conduct water quality monitoring within the Project boundary at least every five years to: 1) determine the effects of Project operation, both spatially and temporally (in terms of flow, impoundment elevation, and power generation) on water temperature, pH, and dissolved oxygen (i.e., dissolved oxygen concentration and dissolved oxygen percent saturation); 2) to compare results to Surface Water Quality Standards; and 3) to determine if additional changes in Project operation or the WQIP are necessary to comply with Surface Water Quality Standards.[13]" If GRH is already required to ensure that they are maintaining NH WQS, it stands to reason that these data (at least for temperature, pH, and oxygen, if not the full suite covering potential water quality impacts) will already exist. This public reporting should be a condition of the license and not a component of a water quality improvement plan once a violation has already occurred.

To that end, CRC also expects that flow, water chemistry, recreation reports, and biological data collected to show compliance with NH WQS should be regularly reported and that all data should be publicly accessible. Over the anticipated 40-year license, we can expect that the river will see substantial changes in conditions. These changes will result from the preferred operating change and other environmental improvements required as a result of this license, as well as ongoing climate change related impacts, and changing electricity demands, grids, policies and markets. The anticipated operational changes were not considered during the relicensing study process and were not included in any modeling to predict future environmental impacts. There is no assurance that NH WQS will be met as these changes occur. It is critical

[12] Errol WQC Section 11; Watson WQC Section 12
[13] Ibid.

that the impact on the environment under the preferred operations in the context of changing climate conditions is monitored and assessed in real time, not after the fact. The process to assess environmental impact must be transparent and accessible to the public.

NH DES should require publicly available data and analyses in the context of §401 certification including:

1. Expected and real-time ("live") data on flows released from the hydropower facilities, including continued access to historical actual discharge data,
2. Regular year-round monitoring and publicly available water chemistry data from impoundment, discharge, and riverine reaches including but not limited to dissolved oxygen, temperature, pH, conductivity, chlorophyll a, nitrogen, and phosphorus,
3. Regular monitoring and publicly available data of macroinvertebrate populations in various locations throughout the project areas, as macroinvertebrate surveys are an easy and powerful tool to assess ecosystem quality,
4. Annual reports on the benefit to and impact on ecological health and public recreation from project operations.

Application does not address the direct and indirect impacts of erosion on water quality

§401 certification must require a condition to monitor and assess in real time the effect of proposed project operations on riverbank erosion and sediment transport and related effects on habitat quality and biota supported, nutrient transport, and recreation**.** This condition must also include an improvement or mitigation plan if project operations are found to exacerbate or cause erosion with negative effects on designated uses and water quality criteria.

CRC and others have reiterated throughout the relicensing process the profound negative impacts of erosion within project areas on designated uses such as habitat and recreation as well as other specific water quality criteria. Surface water elevation changes resulting from peaking project operations at the Wilder, Bellows Falls, and Vernon hydro facilities have caused and contributed to bank erosion throughout the project areas. Multiple studies, most notably the US

Army Corps of Engineers 1979 report,[14] have confirmed these findings, which were validated by experts retained by CRC as part of the relicensing[15]. The impoundments have experienced unnatural, unpredictable, and rapid surface water elevation fluctuations for over 40 years, which has led to extreme bank undercutting and extensive shoreline erosion in excess to natural erosional processes. GRH has not acknowledged the contribution of operations to erosion but asserts that the change from peaking to inflow equals outflow with "flex" hours (IEO/flex) will mitigate erosion.). While the preferred operation will potentially address some impacts from erosion, the instability of banks within the impoundments, the interruption of natural erosion, transport, and aggradation processes, and the unnatural surface water elevation changes will continue or may be exacerbated under IEO/flex operations. CRC supports the operational change and many of the anticipated benefits of this change, however the change in operations, and thus the managed flow of the river, will almost certainly shift sediment transport dynamics, with anticipated higher flows and more consistent velocities increasing sediment movement, while dam presence continues to impede natural downstream transport and deposition patterns. This operational change was not considered during the study phase of the relicensing, therefore no analysis has been completed to model the effects of the change in river management on erosion, sediment transport, or hydrogeomorphology. The GRH application fails to demonstrate that operations will comply with NH WQS from this standpoint.

CRC is particularly concerned with three areas where river management, hydrogeomorphology, and NH WQS intersect: habitat impacts, unnatural depositional areas, and sediment mediated nutrient transport.

Habitat Impacts

Unobstructed, unmanaged rivers display a natural trend towards equilibrium between erosion, transport, and deposition of sediment. Erosive effects are balanced by upstream sediment transport and deposition. This natural process is interrupted by the presence of dams and hydro operations, with sediment trapped in upstream impoundments and downstream

[14] Simons, Daryl B. (1979) Connecticut River Streambank Erosion Study, Massachusetts, New Hampshire and Vermont. Technical Report: United States. Army. Corps of Engineers. New England Division. Available at https://hdl.handle.net/11681/44641

[15] Accession Number 20180423-5180 Comments from Connecticut River Conservancy (formerly CRWC) on Study Reports 2/3, 18 and 21

reaches depleted as a result. While this phenomenon is well known, it is also demonstrated within the relicensing studies. In particular, Study 7 results of bathymetry and habitat mapping indicate the dominance of fine-grained substrates within project impoundments in contrast to reaches classified as riverine.

This depositional wedge is particularly noticeable where the downstream edge of a riverine reach meets the upstream limit of the impoundment, causing a slowdown of water and deposition of particles. This overabundance of fine substrate within the impoundment versus dominance of larger grained particles and cobbles immediately downstream of the dams has implications for habitat availability and connectivity for both migratory and resident species, particularly those which require variety in substrate type to complete different life stages (e.g. sea lamprey require gravel and cobble in order to construct redds, but soft substrate for ammocoete habitat, similarly tessellated darters require hard substrate for breeding and egg laying, but softer substrates for the rest of their life) and the multiple species of freshwater mussels (including endangered and threatened species) which require a balance between available soft bottom substrate and not too much deposition (e.g. suffocation) to thrive. River management directly impacts habitat type and quality and must be considered as part of the §401 process.

The preferred operation of IEO/flex is expected to change sediment movement dynamics concurrent with the new flow regime. This may provide better habitat in some areas, yet no data or predictive models have been provided to understand these impacts and where it is likely that increase sediment transport versus deposition will occur. It is unclear if increased upstream sediment moved from riverine reaches will just continue to be trapped behind the downstream dam, increasing the proportion of soft bottom substrates in impoundments and further degrading habitat from what would be naturally found.

Certification must be denied as there are no data provided, nor any data-driven assessments undertaken or anticipated that would verify that habitat is not degraded or eliminated by shifting sediment transport dynamics under the proposed operations.

Unnatural Sediment Deposition

Project operation have caused unnatural sediment deposits in violation of NH Env WQS 1703.08 and will continue to do so. Under peaking operations, the Wilder, Bellows Falls, and

Vernon impoundments functioned more as lacustrine than riverine environments. As a result, tributary confluences have developed sediment wedges where the flowing tributary water rapidly slows and or halts upon meeting the mainstem, dropping particles of all sizes. This benthic deposit is clearly visible in the following google earth photographs of the mouth of the Cold River from September 2003 and October 2020 (Figure 1). CRC staff have walked on this bar at the mouth of the Cold River when it is elevated, and it is disconcerting to be above the water line yet standing in the center of the Connecticut River, on the bottom, not an island. Because this bar (and others like it at other tributary confluences) is not continuously inundated, it does not provide adequate or consistent habitat for species who might otherwise utilize the cobbles, pebbles, and sand dropped there. Just upstream, during our annual sea lamprey nest surveys, CRC staff have observed nests that were built in the sediment wedge at the mouth of the Saxtons River under higher water conditions. These nests could then be exposed or inundated, and thus potentially unviable, when flow management returns water levels either higher or lower than when the redds were constructed. Similarly, the buildup of sediment in tributary mouths inhibits recreation in both the tributaries and the mainstem. Under lower flow conditions the waterways become unnavigable to all but the shallowest canoes and kayaks. These unnatural sediment depositional conditions within impoundments, behind the dams, and particularly at tributary confluences negatively impact designated uses of habitat and recreation and also violate NH Env WQS 1703.08 which prohibits benthic deposits that do not occur naturally. As these deposits occur and are enhanced directly as a result of the presence and operation of the hydro facilities, they are clearly a violation of water quality standards. Because the river will continue to be managed, it is unclear that these benthic deposits will be minimized or eliminated under proposed operations.

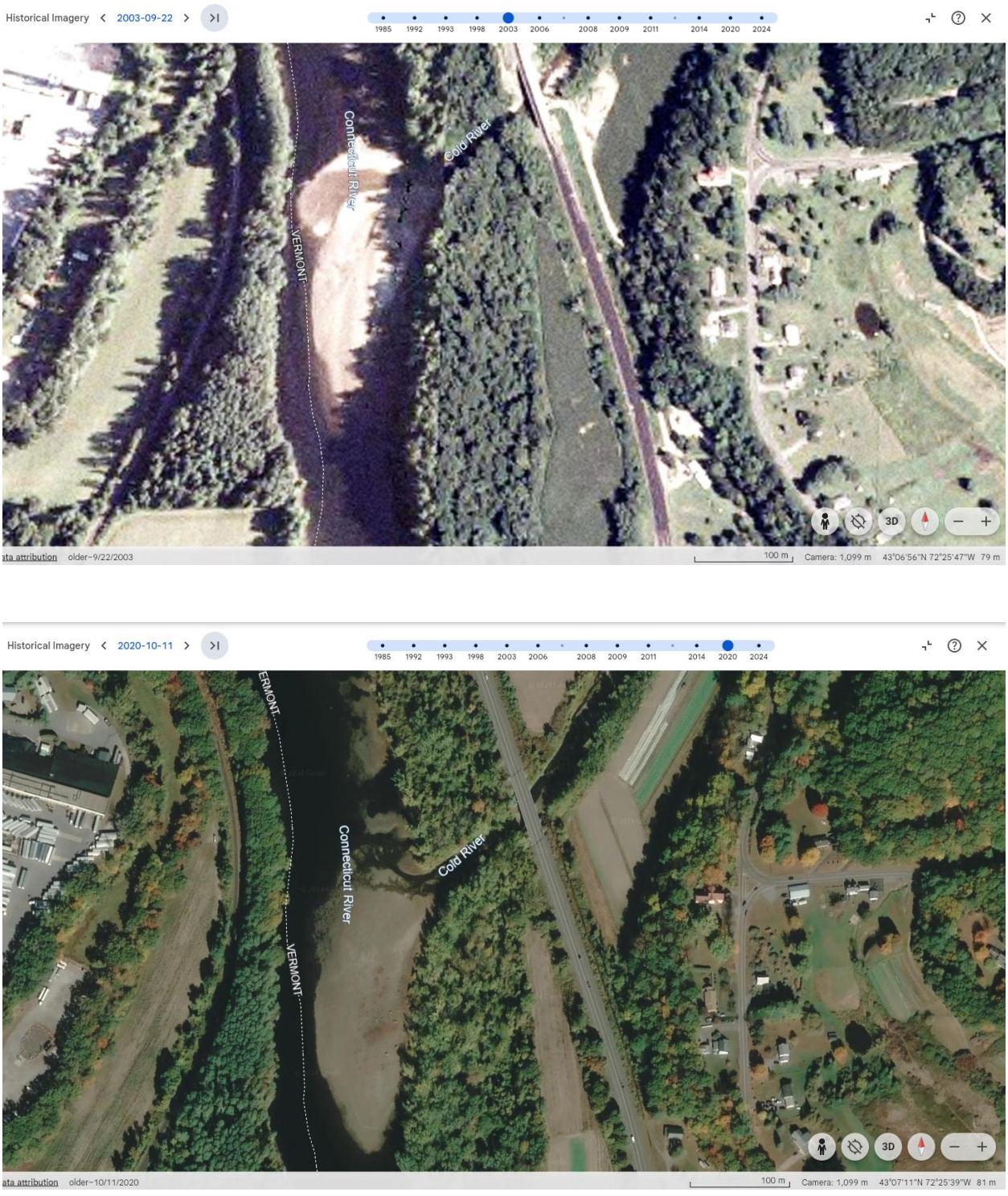

Figure 1. Google earth screenshots of the confluence of the Cold and Connecticut Rivers in NH under low water conditions showing the bar of sediment that has been deposited. The top photo is from 2003 and the bottom photo is from 2020.

Nutrient Loading Resulting from Sediment Movement

As noted above, continued operation of the hydro projects, even under the preferred alternative IEO/flex operations, will result in continued erosion and may result in increasing erosion of bank soil and unknown changes to in river sediment transport dynamics. Much of the land currently subject to erosion as a result of project operations, and which will continue to erode, are agricultural areas. GRH has not provided any data regarding the current sediment loads of phosphorus and/or nitrogen in the river and what that may mean for water column nutrient concentrations as a result of higher and more continuous flows under both climate change scenarios in combination with the preferred operating conditions. The agricultural lands bordering the river and its tributaries have a long history of phosphorus use[16], and there is almost certainly legacy phosphorus bound up in eroded sediments that are now deposited in impoundments and confluences. A similar situation has been found in Lake Champlain[17].

With the expectation of changing sediment movement patterns as a result of operational changes, we can also expect concurrent movement and increased availability of sediment bound nutrients. In combination with frequent flooding, higher turbidity, and warming water, this can promote harmful cyanobacteria and/or algal blooms, particularly in inundated backwater and wetland areas. This is directly related to NH WQS 1703.14, as nutrients transported and made available as a result of project operations are not "naturally occurring."

As noted in the application, GRH study results indicate occasional deviations from pH criteria established in Env-Wq 1703.18. They attributed acidic deviations to "atmospheric deposition" and the basic deviations to algal photosynthesis in the forebay. Should shifting sediment transport and deposition patterns facilitate transport of available phosphorus an exchange with the water column, thereby promoting additional algal growth, high pH levels indicating impairment of the water quality may become more common. There are no data or modeled forecasts from the applicant addressing this issue.

NH DES must assess not only the impact of operations on water column nutrient concentrations presented in the application, but the indirect impacts of nutrient transport and

[16] K. Ashley, D. Cordell, D. Mavinic, A brief history of phosphorus: From the philosopher's stone to nutrient recovery and reuse, Chemosphere, Volume 84, Issue 6, 2011, Pages 737-746, ISSN 0045-6535, https://doi.org/10.1016/j.chemosphere.2011.03.001.

[17] See: https://www.nrcs.usda.gov/ceap/usda-legacy-phosphorus-assessment-project. And Kleinman, P.J.A., A.N. Sharpley, A.R. Buda, R.W. McDowell, and A.L. Allen. 2011. Soil controls of phosphorus runoff: management barriers and opportunities. Canad. J. Soil Sci. 91: 329-338. https://doi.org/10.4141/cjss09106.

cycling within the sediment compartment and exchange with the water column as a result of operational changes. GRH failed to address the potential for increased nutrient loading within their application, and DES should require real-time assessment of operational changes on riverbank erosion, sediment transport, and related transport/exchange of nutrients and contaminants. An improvement and mitigation plan must be mandated should negative impacts on designated uses and water quality criteria occur as a result of future project operations.

In summary, there is also no guarantee from GRH that monitoring the actual (real-time) changes to project operations on erosion rates, sediment and associated nutrient transport, and resultant habitat impacts will occur; NH DES must ensure that operations will not negatively impact designate uses. CRC recommends:

1. a multi-decade longitudinal study inclusive of all the impoundments, riverine reaches, and sections of river in between to monitor changes in sediment transport, erosion rates, and erosive forces
2. development of a process to respond to potential bank stability issues that may arise. Such a process should include periodic reporting, third-party verification, and,
3. an action/improvement plan utilizing nature-based solutions to mitigate any impacts to water quality or private property that may result from the operational change.

Project Operations Impede Public Access Recreational Uses

The lack of detail, specificity, and planning for supporting recreation uses of the river in the application means that NH DES cannot determine if the facilities will be in compliance with NH WQS, and subsequently the §401should be denied.

Protection of water quality for recreation is of paramount concern in NH WQS, being specifically addressed in Env-Wq 1703.01 and 1703.03 as a requirement that all surface waters must be able to be recreated in and on. NH communities bordering the Connecticut River are similarly concerned about the ability to safely and easily access the river for recreational purposes. Recreation on public waters is one of the designated uses for all waters in NH. Project operations and conditions addressing recreation will be affecting the river for the next 40 years. By obstructing, diverting, and regulating the river, hydroelectric projects impact opportunities to recreate in and on the water through their very existence. There are also indirect effects

impacting recreation related to issues raised above, such as altered substrate providing insufficient habitat to support desirable game fish populations and their prey, proliferation of AIS decreasing swimming and boating opportunities, eroded banks diminishing safe access to (and egress from) the river. GRH's use of, and profit from, a public resource impedes public access to and use of the river, yet the Connecticut River remains a public resource. Public access and use of the river must be maintained, and co-exist with, but not be diminished by the operations of the projects. The §401 WQC must ensure this to comply with WQS and support designated uses.

The GRH §401 application does not demonstrate that proposed operations protect and do not interfere with recreation opportunities and access for the river. At best, the application indicates that the current status quo regarding recreation will be maintained for the next forty years, but there is no guarantee that this minimum will occur as it is currently presented. The GRH applications recycle the same language for each project, indicating that "current access to the river within the Project Boundary will be maintained or enhanced through the capital improvements to the boat launches, improved portage and general recreation area access and parking" and that "fishing conditions and opportunities should continue or improve under the proposed operation" despite also noting that the higher surface water elevation may restrict fishing while wading in some unspecified locations. Swimming, which does occur in the river, and is a protected use, is not mentioned at all. Specific whitewater boating concern areas of Sumner Falls and the Bellows Falls bypassed reach are addressed in slightly more detail, however, overall, the application does not provide adequate detail to ensure that recreational opportunities will be supported and improved by project operations. This is true for documents referenced within the FERC record as well, where the GRH proposal provides conflicting information regarding the maintenance of current facilities, the addition of "new" facilities, and capital improvements.

The study reports, CRC's Recreation survey, and numerous public and municipal comments detail a broad suite of recreational needs within the project boundaries, and the proposal to either make no changes to recreational resources beyond incorporating already existing campsites into the formal project area (as stated in Exhibit E) or to make vague capital improvements does nothing to address these needs. As it stands, the proposed operational changes as addressed in GRH's §401 application appear to curtail and diminish recreational opportunities, with inadequate explanation of how they will be maintained and improved instead.

Aquatic Invasive Species Are Not Addressed

§401 WQC should require monitoring, prevention, management, and education regarding nuisance species with the project areas that may be directly or indirectly spread or enhanced by project operations.

GRH must be required to address the prevention and management of aquatic invasive species as a condition of the §401 WQC. Env-Wq 1702.33 defines nuisance species as those that interfere with a designated use of the surface waters. The proliferation of aquatic invasive plant species in particular can negatively impact recreation, aquatic community composition and function, habitat suitability, oxygen concentrations, and in some circumstances can have negative human health impacts, thus both directly and indirectly interfering with all designated uses for NH surface waters. For example, dense unmanaged mats of water chestnut (*Trapa natans*) can prevent motor and paddle boat use where it thrives, outcompete native species for light, nutrients, and substrate, and cause hypoxic conditions when large quantities decompose. Cyanobacteria, while a natural component of surface waters, can proliferate in slack or backwater areas created by impoundments. Cyanobacteria harmful algal blooms can pollute drinking water sources and cause illnesses in humans exposed to cyanotoxins, clearly meeting the definition of "nuisance species" at certain times. Changes in water flow, and increases in temperature and nutrients, all conditions associated with hydropower generation, can contribute to the proliferation of these and other nuisance species. Env-Wq 1703.03(C)(1)d. mandates that all surface waters be free of substances that result in the dominance of nuisance species,

There needs to be comprehensive consideration of prevention and management of aquatic invasive species ("AIS") throughout the project areas to ensure project operations do not contribute to the spread or proliferation of nuisance species as defined by the state. If project operations contribute to the growth or spread of nuisance species, they will not comply with NH WQS. GRH's §401 application indicates that there is one assessment unit impaired by the presence of AIS, however, little to no assessment of AIS presence has been undertaken within the project area to date. Throughout the GRH proposal there is no plan for detection, prevention, and management of AIS, however it was mentioned that invasive species ranges may expand under IEO/flex operations.

There are growing concerns about the Connecticut River strain of hydrilla, which has been detected in multiple lakes in Connecticut and Massachusetts, suggesting transport by

boaters. The extremely detrimental effects of hydrilla led the NH Exotic Aquatic Weeds and Species Committee (of which CRC is a member) to invite a presentation from the US Army Corps of Engineers regarding the current trials underway to determine a best management strategy[18]. It is critical that hydrilla does not continue to spread northwards. There are also two (known) active infestations of water chestnut within the project areas. The Hinsdale NH setbacks have an estimated 120 acres of water chestnut which are currently surveyed and managed mostly by volunteer hand pullers (insert photo). Albee's Cove in Rockingham VT/Walpole NH has a smaller affected area and is similarly managed. Additionally, Eurasian milfoil is found throughout the Project areas. These and other AIS are currently and will continue to negatively impact designated uses of recreation, fish consumption, aquatic life integrity, and drinking water.

Increasing education about the presence of AISs, how to prevent transport and spread of AIS, and monitoring for future spread is critically important. GRH, through management of water resources and recreational facilities can directly protect NH water quality by contributing to these efforts, and have a responsibility to do so by virtue of using our public waters for profit. NH DES should condition §401 certification to require GRH financial contribution to annual detection surveys for highly aggressive AIS like hydrilla coordinated with resources agencies and the Northeast Aquatic Nuisance Species Panel. GRH should additionally be required to provide boat cleaning CD3 type units to prevent the spread of AIS and display signage educating visitors about AIS prevention and particular species of concern at GRH owned recreation facilities and support efforts to eliminate currently known infestations that will have opportunity to increase in size under higher surface water elevations anticipated under the operational change.

Currently, the proposal does not indicate how GRH will uphold NH WQS relevant to AIS. Because there is no evidence provided as to how project operations will protect water quality in regard to nuisance species, the application must be denied.

Fish Passage Improvements are Unnecessarily Lengthy

To uphold NH WQS and support designated uses, fish passage improvements must be expedited and designed for all species; the low-head dam in the Bellows Falls bypassed reach

[18] https://www.nae.usace.army.mil/Missions/Projects-Topics/Connecticut-River-Hydrilla/

must be removed prior to fish passage improvements, and fish passage monitoring capability must be improved and financially supported to ensure that passages are effective and improving rather than impeding fish population recovery.

CRC has commented repeatedly[19] on the length of time in which fish passage improvements will occur, and the continuing negative impacts on migratory fish populations as a result. In summary, species such as sea lamprey, American eel, Shortnose sturgeon, and shad will continue to be negatively impacted by inadequate or ineffective passage facilities until proposed passage upgrades are completed. These fish are currently existing in the river and are prevented from accessing appropriate habitat by a lack of safe, timely, and effective passage, leading to a diminished community composition, structure, and function in comparison to the natural condition. This does not uphold NH WQS and should be rectified in the shortest possible term through expedited passage improvements. Additionally, recent eDNA sampling proves that endangered shortnose sturgeon are present within the project areas[20]. We reiterate from our previous comments to FERC, that this new information requires a community approach as opposed to a species specific one when addressing passage concerns, to ensure that designs intended for one species do not inadvertently harm passage of a different one. This failing occurred during the last relicensing when the passageways were originally designed for salmon but are not appropriate for the endangered and species of special concern which are currently utilizing them.

Lastly, the construction of the new turbine within the Bellows Falls dam was not considered when addressing passage and habitat concerns through the bypassed reach. The "fish friendly" turbine will facilitate passage of species downstream into the bypassed reach that would not be apt to enter the reach without it, particularly eel, a fact that GRH acknowledges by specifically proposing a turbine designed to pass fish. Passage of fish into the bypassed reach requires concurrent facilitation of fish ability to get out of the reach, and access to appropriate habitat and food while there. Minimum flows for the bypassed reach were agreed upon and removal of the salmon dam as part of the Fish Passage Settlement agreement occurred prior to

[19] Accession Number 20220901-5247. CRC, AMC, AW comments on Great River Hydro Fish Passage Settlement Agreement.; Accession Number 20240522-5202, pages 43-53.
[20] FERC Accession 20241220-5026 CRC shortnose sturgeon eDNA results; FERC Accession 20241223-5058 CRC comments on shortnose sturgeon presence

the proposal to include a minimum flow turbine in the dam, and thus the effects of the turbine on flow, habitat, fish movements, and other aquatic life integrity concerns in the bypassed reach were not considered when these agreements were made. The removal of the salmon dam must occur before construction of upstream and downstream passage improvements, in order to account for changing attraction flow patterns after removal and to accommodate the presence of more and more diverse fish in the bypassed reach as a result of the installation of the minimum flow turbine. GRH should be financially responsible for removing the dam as a condition of the §401 and the license. The bypassed reach is listed as impaired for aquatic life integrity and this impairment is a direct result of hydro project infrastructure and operations disrupting physical attributes and flow regimes within this reach. GRH projects will be in violation of NH WQS regarding habitat, aquatic life integrity, and recreation without the salmon dam removal at Bellows Falls and a shortened timeframe for passage improvements at all three projects.

Additional Water Quality Concerns

Financial Assurances for Decommissioning

§401 certification must include a mandated decommissioning plan and financial assurances for dam removal and river restoration for when the projects have reached the end of their useful life and are ready for retirement. Without these measures water quality will continue to be degraded long after hydropower has ceased operating. NH taxpayers should not bear the financial responsibility for decommissioning and restoring the river in order to be in compliance with NH WQS. Financial assurances are necessary now to fully decommission and remove these projects and restore the Connecticut River to a natural flow regime to protect existing and designated uses when the projects are retired.

Flooding and Drawdowns

§401 certification must include provisions to protect aquatic life and prevent impacts on designated uses resulting from project operations in response to predicted increases in flooding events.

GRH failed to address the impacts of project operations on flooding and drawdowns within the Project areas. In July of 2023 and 2024 parts of the Connecticut River watershed experienced catastrophic rainfall and flood events, impacting the river far beyond where the rain

occurred both temporally and spatially. These types of events are expected to become more common during the next license term as a result of increasing frequency and intensity of localized storm events under climate change. The extensive 2023 flooding resulted in structural failure of the stanchion flashboard at the Bellows Falls dam, requiring a drawdown of the impoundment to repair the spillway. Even though the drawdown did not happen instantaneously, the reduction of SWE far below what occurs during peaking operations resulted in the stranding and death of many organisms and the dewatering of important habitat, particularly in shallower backwater areas[21].

Drawdowns interfere with the designated uses of recreation, aquatic life integrity, wildlife, and potential water supply, and directly violate Env-Wq 1703.01(d). With the expectation that the need for them will increase, GRH must find a solution to limit the impact of these events on the river, designated uses, and water quality criteria. NH §401 WQC must ensure that sensitive locations and developmental time periods are protected by limiting the extent and timing of drawdowns both in terms of how long it takes to lower and refill the impoundment, how long the drawdown persists, and when during the year it may occur. CRC also recommends that GRH explores options that could replace the current stanchion board arrangement that would limit the future possibility of repeated failures and subsequent drawdowns for repair.

Interaction of Peaking at upper end of Wilder Impoundment

§401 certification must require third-party monitoring and reporting to assess ongoing changes to erosion, bank stability, and sediment deposition in the Wilder impoundment resulting from project operation changes interacting with upstream peaking flows.

As we have noted, Project operations effect on riverbank erosion and sediment transport dynamics has not been adequately addressed within the NH §401 WQC application, meaning that there is currently no evidence that operations will comply with NH Env-Wq 1703.01 (Water Use Classifications; Designated Uses), 1703.03 (General Water Quality Criteria), 1703.08 (Benthic Deposits), 1703.14 (Nutrients), and 1703.19 (Biological and Aquatic Community Integrity). Current erosion dynamics are enhanced at the upper end of the Project impoundments, due to the nature of peaking operations on the range of SWE changes both near and far from the dams. This dynamic has resulted in extremely exacerbated bank erosion in particular sections of

[21] Please see the appended VT 401 comments for images

the impoundment. The numerous filings from the town and community members of Lyme and Orford NH clearly demonstrate that this is a persistent, ongoing, and continuing area of concern for NH residents in this section of the Wilder impoundment. The loam and sand bank composition in this section of the river is particularly susceptible to erosional forces, of which Project operations have been a significant cause and contributor.

CRC would like to draw particular attention to fact that Project operational changes could exacerbate ongoing erosion in this area due to the interaction with peaking flows arriving from the upstream Fifteen Mile Falls projects. The applicant has stated that "[w]hile the impoundment upstream of Wilder dam extends upstream to Haverhill, New Hampshire, and Newbury, Vermont, WSE [water surface elevation] fluctuations in the upper impoundment are more significantly impacted by inflows from upstream" demonstrating clear knowledge that upstream inflows impact erosion in an area that is already prone to it; negatively affecting landowner properties, aquatic and riparian habitat availability and integrity, and recreation opportunities. Given that the influence of upstream peaking flows on erosion will continue, it is critical to understand how these flows will interact with the preferred operational regime specifically in regard to erosional forces in the Wilder reservoir. There is no analysis regarding this in the application and it directly impacts water quality in this section of the river. GRH should be required to undertake a long term (multi decade) assessment and evaluation of the flow regulation change impact on erosion and sediment transport and deposition in the Wilder impoundment to ensure that it does not continue to violate NH WQS.

Interactions with Massachusetts Projects Undergoing Relicensing

NH DES must implement their ability as a neighboring jurisdiction to comment on the Massachusetts §401 WQC and ensure that downstream projects do not continue to negatively impact NH waters.

Great River Hydro was required to file for §401 WQC in NH because the facilities and project areas are located in NH. However, NH's waters are also impacted by downstream projects in Massachusetts which are simultaneously undergoing relicensing. The Northfield Mountain Pump Storage Project (P-2485) ("NFM") operated by FirstLight has profound impacts on the Connecticut River, particularly with regard to flow, water surface elevation, riverbank erosion, and sediment transport. The direct and indirect effects of operation of NFM on water

quality criteria and designated uses extend beyond the border into NH, despite being upstream. NFM draws water from the Connecticut River as its lower reservoir. During generation, the large volume of water flowing back into the river interacts with surface water elevation regulated by operations at the Turners Falls dam in such a way that at times the river is forced back upstream, a dramatic departure from the "natural conditions" which NH Water Quality Standards seek to protect and enhance. This can clearly be seen as a negative flow at the Northfield MA USGS gage, as pictured below in Figure 2.

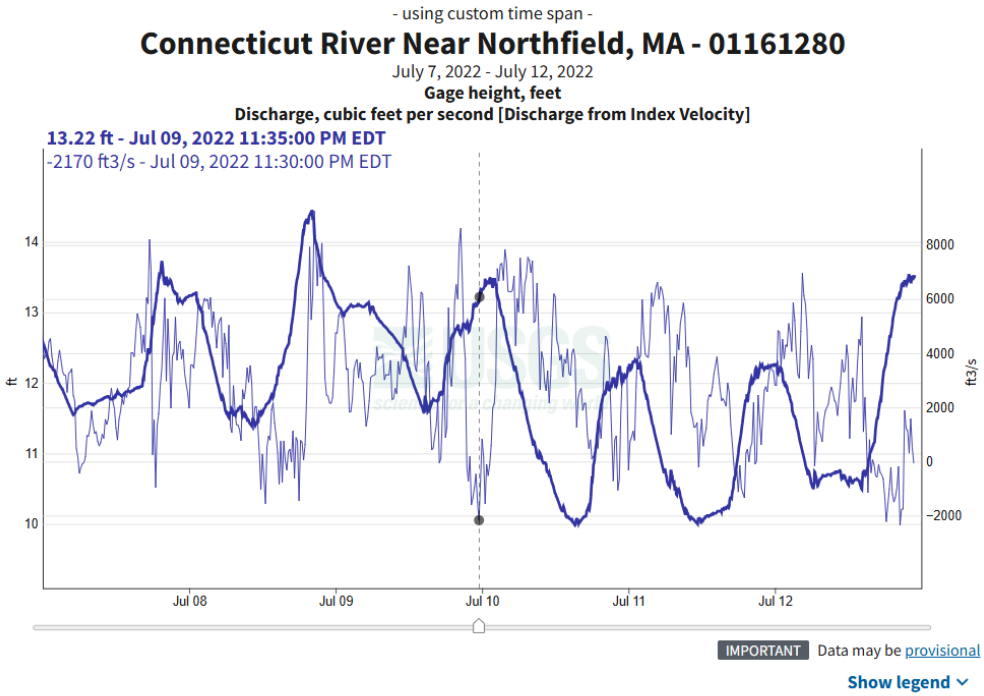

Figure 2. Screenshot of the USGS gage at Northfield MA depicting river height and discharge.

This directional change in flow, as well as the currently permitted up to 9-foot surface water elevation changes resulting from project operations directly impact bank erosion, the ability to recreate on the river, and aquatic habitat integrity[22]. The State of NH, as a neighboring jurisdiction to the Commonwealth of Massachusetts, has the responsibility to ensure that NH's water quality standards are upheld considering Project operations at NFM and Turners Falls. NH DES must comment on the Massachusetts draft §401 water quality certification and address recreation, erosion, habitat, community composition, and flow concerns resulting from the

[22] e.g. Accession Number 20240522-5244, pages 24-27 and references therein.

Massachusetts projects.

Thank you for considering these comments as part of the §401 water quality certification process. CRC maintains that the GRH §401 applications are flawed, and do not ensure that NH WQS will be complied with and designated uses protected in the face of proposed project operations over the next 40 years. As such, the certification must be denied.

Should you have any questions about our comments, our recommendations for specific conditions in a §401certification which CRC believes would ensure compliance with NH WQS, or require further information, please do not hesitate to contact Kathy Urffer (kurffer@ctriver.org, Director of Policy and Advocacy) and Marilla Harris-Vincent (mharrisvincent@ctriver.org, River Steward for NH).

Sincerely,

Dr. Kate Buckman
Aquatic Ecologist

Rebecca Todd
Executive Director

Scientists, Engineers & Environmental Planners Designing Innovative Solutions for Water, Wetland and Soil Resource Management

September 30, 2016

MEMORANDUM

To: Andrea Donlon, CRWC
David Deen, CRWC

From: Laura Wildman, P.E., Princeton Hydro, LLC
Paul Woodworth, Fluvial Geomorphologist, Princeton Hydro, LLC
Melinda Daniels, PhD, Fluvial Geomorphologist, Stroud Water Research Center

Re: FERC Re-Licensing Process for TransCanada Hydro Northeast Inc.
Peer-Review of ILP Study 2 and Study 3
Riverbank Transect and Riverbank Erosion Studies

The Connecticut River Watershed Council (CRWC) is a stakeholder and participant in the re-licensing process of the Federal Energy Regulatory Commission (FERC) for the three hydropower facilities owned by TransCanada Hydro Northeast Inc. on the Connecticut River, Wilder Dam, Bellows Falls Dam, and Vernon Dam. Princeton Hydro, with the Stroud Water Research Center, was retained by CRWC to complete peer-review of technical erosion studies, specifically Integrated Licensing Process (ILP) Study 2 and Study 3: Riverbank Transect and Riverbank Erosion Studies. ILP Study 1: Historical Riverbank Position and Erosion Study was reviewed for background data, as was the study plan laid out in the Revised Study Plan (RSP), dated August 14, 2013, and as revised in Appendix B: Staff's Recommendations on Proposed and Requested Study Modifications And Studies Requested, dated September 13, 2013[1]. This memorandum is a critical review of ILP Study 2 and Study 3 and aims to address the following questio*ns* as defined in 18 CFR § 5.15 Conduct of studies (d) Criteria for modification of approved study, and the RSP:

- Were the studies completed as per the Revised Study Plan?
  - Were the objectives set in the RSP met?
    a. If not, is additional data collection or analysis warranted?
  - Were the methods described in the RSP utilized?

[1] Our review was limited to the RSP, Study 1, and the Study 2 and Study 3 Report, as well as their associated Appendixes. No field work was conducted as part of our review, so we are not able to comment on if the observations stated in the studies accurately reflect field conditions within the project reach. In addition, we did not review, in any detail, the numerous other studies submitted to FERC as part of TransCanada's recent submittal.

- Was the analysis described in the RSP conducted?
- Was the Study conducted in a manner consistent with generally accepted scientific practice?
    a. Was the methodology utilized consistent with generally accepted scientific practice?
        i. If not, is additional analysis or a different type of analysis warranted to meet the RSP goals of conducting the study in a manner consistent with generally accepted scientific practice?
    b. Were the conclusions of the study consistent with the scientific evidence presented?
- Were the deliverables promised in the RSP included in the final study report submittal?

FRAMEWORK FOR THIS PEER REVIEW

For ease of review of this memorandum we have italicized, placed in quotes, and referenced page numbers for any text taken directly from the Revised Study Plan (RSP) or the combined Study 2 and Study 3 Report. Our comments have been structured as per the Integrated Licensing Process (ILP) regulations 18 CFR § 5.15(d)(1) regarding conduct of studies, and have been subcategorized to reflect the structure of the subsections taken from the Revised Study Plan, dated August 14, 2013, pages 19-36, and additionally revised September 13, 2013.

The Revised Study Plan was organized into 14 sections, including:

RELEVANT STUDY REQUESTS
STUDY GOALS AND OBJECTIVES
RELEVANT JURISDICTIONAL AGENCY RESOURCE MANAGEMENT GOALS
ASSOCIATION WITH OTHER STUDIES
EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION
PROJECT NEXUS
STUDY AREA AND STUDY SITES
METHODS
ANALYSIS
CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE
DELIVERABLES
SCHEDULE
LEVEL OF EFFORT AND COST
REFERENCES

We have organized our review to comment on only those sections of the Study 2 and Study 3 Report that we felt were not conducted as provided for in the Revised Study Plan, as per the ILP regulations 18 CFR § 5.15(d)(1) regarding conduct of studies. The sections we commented on relating to their consistency with the RSP are:

STUDY GOALS AND OBJECTIVES

METHODS
ANALYSIS
CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE
DELIVERABLES

All of our comments fall under the ILP regulations 18 CFR § 5.15(d)(1), which asks if "approved studies were not conducted as provided for in the approved study plan."

Each section of our review starts by including the exact statement from the Study 2 and Study 3 Report that we are commenting on, and then follows with our peer review comment and our recommendation.

STUDY GOALS AND OBJECTIVES

This section includes our comments on the "Study Goals and Objectives" as described in the RSP. We have specifically commented on the objectives from the RSP that we feel were not met or not conducted as provided for in the RSP.

Objective from RSP, under Study Goals and Objectives: *"Observed water-level fluctuations and shear stresses from nonproject-related factors will also be investigated."* (Page 19, RSP Study 2)

"Hydraulic modeling (Study 4) will be integrated into the study after field sampling ends to analyze the relationship between shear stress and bank erosion." (Page 25, RSP Study 2)

"Analyze hydraulic modeling data to provide information on flow velocity, stage (water surface elevation or WSE), and shear stress impacting riverbanks in the study area." (Page 5, Study 2 and Study 3 Report)

Peer Review Comment: No hydraulic modeling results, including shear stress impacting riverbanks in the study area, were analyzed or discussed in the Study Report. Without this analysis, a key part of the study as proposed in the RSP is missing and a fundamental driver in the erosion process (i.e. shear stress) has gone unassessed.

Recommendation #1: TransCanada should incorporate hydraulic modeling results from Study 4 into Study 2 and Study 3, and analyze the results to assess the relationship between shear stress and river bank erosion, as proposed in the RSP.

Objective from RSP, under Study Goals and Objectives: *"The objectives of this study are to: Ascertain the likely causes of erosion (e.g., high flows, groundwater seeps, eddies, and water-level fluctuations related to project operations)."* (Page 27, RSP Study 3)

"This study will ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors and how the importance of water-level fluctuations in the erosion process varies with soil type and geomorphic setting." (Page 21, RSP Study 2)

Peer Review Comment: The third objective of Study 3, to "*ascertain the likely causes of erosion" (page 27, RSP Study 3)*, has not been completed, nor has the study ascertained *"the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors"* (page 21, RSP Study 2). The Study 2 and Study 3 Report characterizes the cyclical processes of bank erosion but concludes that, *"Trying to distinguish specific effects of normal project operations among the panoply of potential controls on bank erosion in any given location is not possible"* (page 108, Study 2 and Study 3), and states, *"Attempting to identify a single cause for erosion fails to recognize that multiple processes operate collectively to effect change on the riverbanks through space and time"* (ES-3, Study 2 and Study 3 Report). The fact that there are multiple causes of bank erosion is a generally accepted assertion; the intent of the study was not to determine if project operation were the single cause for erosion but to ascertain the likely causes of erosion, in other words to ascertain which causes are more dominant than others and thus, to *"facilitate conclusions as to the association and effect of project operations on active erosion"* (page 13, RSP Study 1). The RSP's Project Nexus for Study 2, page 21, states that, *"This study will ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors*". The study fails to *"ascertain the relative importance"* of the project operations (i.e., WSE fluctuation) in relation to other contributing factors (e.g. high flows, groundwater seeps, eddies), because it uses a methodology that cannot accomplish this study objective, referred to in the study as *"the erosion ratio" (first described on page* 82, Study 2 and Study 3 Report), and which was not proposed in the RSP. Please see our comment under the section on "CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE" in this peer review.

In addition, no data was collected to ascertain groundwater seeps associated with water fluctuation as a likely cause of erosion. An investigation of groundwater seeps would have required identifying the elevation of groundwater adjacent to the banks with respect to the varying water surface elevation in the channel. The report states, *"the magnitude of water surface fluctuations in the study area is less than 2.0 ft for 75% of the study area's length so hydraulic gradients between groundwater levels in the bank and the adjacent river level are likely small"* (page 111, Executive Summary, Study 2 and Study 3 Report); however, no groundwater data was collected to affirm that statement, nor to assess the remaining 25% of the study area.

The Revised Study Plan provides a simple list of causes of erosion, *"e.g., high flows, groundwater seeps, eddies, and water-level fluctuations related to project operations,"* (page 27, RSP Study 3) that were considered at the outset of the project. However, the Study does not consider adjacent land use as a factor (other than the presence or absence of riparian vegetation at the top of bank), and yet numerous peer-reviewed research studies have investigated and confirmed that adjacent land use has a strong role in bank stability and erosion. In addition, the study does not consider the impact that daily WSE fluctuations may have on limiting vegetative growth at the toe of the river banks, although the study itself acknowledges the important role that vegetation can have on increasing bank resistance to erosion.

Recommendation #2: TransCanada should re-evaluate the existing data, or if necessary gather additional data, with respect to these important factors (i.e., methodology used, groundwater elevations, and surrounding land use) to "*ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors*" as per the RSP (page 21, RSP Study 2).

Objective from RSP, under Study Goals and Objectives: *"Identify the effects of shoreline erosion on other resources (e.g., riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat)."* (Page 27, RSP Study 3)

Peer Review Comment: The fourth objective of Study 3, *"to identify the effects of shoreline erosion on other resources"* (page 27, RSP Study 3) has not been completed. In the final section of the Study 2 and Study 3 Report, the Assessment of Project Effects makes brief references to other studies (page 112, Study 2 and Study 3 Report); however, these studies do not assess shoreline erosion project effects and in most cases these additional studies were not intended to do so. Specifically:

A. With regard to Water Quality, reference is made to Study 6 - Water Quality Monitoring Study (Louis Berger Group and Normandeau, 2016a), which *"found that the Wilder, Bellows Falls, and Vernon projects had negligible to no effect on turbidity"* (page 112, Study 2 and Study 3); however, the following statement, *"the few recorded spikes in turbidity were found to occur in response to high flows resulting from heavy rain events,"* (page 112, Study 2 and Study 3) fails to distinguish if bank erosion is a contributing factor in the turbidity peaks. Thus, the project effects on water quality remain unassessed and its conclusion that project operations had negligible effect on turbidity are unfounded.

B. With regard to Aquatic Habitat, reference is made to Study 8 – Channel Morphology and Benthic Habitat Study (Stantec and Normandeau, 2016), but acknowledges that the study did not quantify the effect of fine-grained riverbank materials on increased embeddedness of coarse-grained spawning substrates. Another reference is made to Studies 14/15 – Resident Fish Spawning in Impoundments and Riverine Sections Studies

(Normandeau, 2016a), Study 16 – Sea Lamprey Spawning (Normandeau, 2016b), and Study 21 – American Shad Telemetry Study – Vernon (Normandeau, 2016c) (page 112, Study 2 and Study 3); however, none of these studies had the objective of assessing the impacts of bank erosion on aquatic habitats. Thus, the project effects on aquatic habitat remain unassessed.

C. With regard to Rare Animal Populations, reference is made to Study 24 – Dwarf Wedgemussel and Co-Occurring Mussel Study (Biodrawversity et al., 2014; 2015, Study 25 – Dragonfly and Damsel Fly Inventory and Assessment (Normandeau, 2016d), Study 26 – Cobblestone and Puritan Tiger Beetle Survey (Normandeau, 2016e), Study 28 – Fowler's Toad Survey (Normandeau, 2016f), and Study 29 – Northeastern Bulrush Survey (Normandeau, 2016g) and they *"did not identify erosion resulting from normal project operations water level fluctuations as a potential factor"* (page 113, Study 2 and Study 3). However, none of these studies had the objective of assessing the impacts of bank erosion on rare animal populations, both direct (i.e. WSE fluctuation) and indirect (i.e. bank collapse impacts). Thus, the project effects on these rare animal populations remain unassessed.

Recommendation #3: TransCanada should revise the Study 2 and Study 3 Report to identify the effects of shoreline erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat, as stated in the RSP.

Objective from RSP revision of Sept. 13, 2013: "*The study's analysis will include a correlation of visible indicators of erosion with project-caused water-level fluctuations at the 21 transect locations established in the Riverbank Transect Study (Study 2)."* (Page 1 Study 2 and Study 3)

Peer Review Comment: This objective is not accomplished because the *"erosion ratio"* metric (page 82, Study 2 and Study 3) employed to attempt to identify correlation is not a generally accepted scientific practice. It lacks the rigor of other accepted statistical analysis techniques. For additional discussion on this topic please see our comments relating to "CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE" later in this memorandum.

The RSP notes on page 32 the importance stratigraphy can play in bank erosion: *"the layering of sediments within the banks can play an instrumental role in bank stability with contacts between permeable sand above impermeable clay providing a zone along which water can preferentially seep out of the bank. Consequently, identification of the various sedimentary layers within a bank is critical to understanding the distribution and causes of erosion."* In addition, the RSP states on page 29 that, *"Detailed information to be collected as part of this study on bank stratigraphy, depth to sand-clay interfaces, and their relationship to past water-level fluctuations is needed to confirm whether project operations are causing reductions in bank instability."*

While stratigraphic data were collected and provided in the appendices, these data were only referenced in general statements in the study and not analyzed or discussed, such that the relationship between WSE fluctuations and bank instability were unassessed. The Study 2 and Study 3 Report states:

- "*Banks composed of non-cohesive sediments and interlayered cohesive and non-cohesive sediments are the most susceptible to erosion.*" (page 10, Study 2 and Study 3 Report)
- *"Normal project operations result in daily or sub-daily fluctuating water levels. At many sites, the position of those daily fluctuations on the bank aligns with the location of notching at the base of the bank"(page 53, Study 2 and Study 3 Report)*. Figure 5.4.2-6, below, from the Study 2 and Study 3 Report illustrates this observation, with the location where the WSE fluctuation based on normal operating range intersects with the notch in the river bank, circled in red.

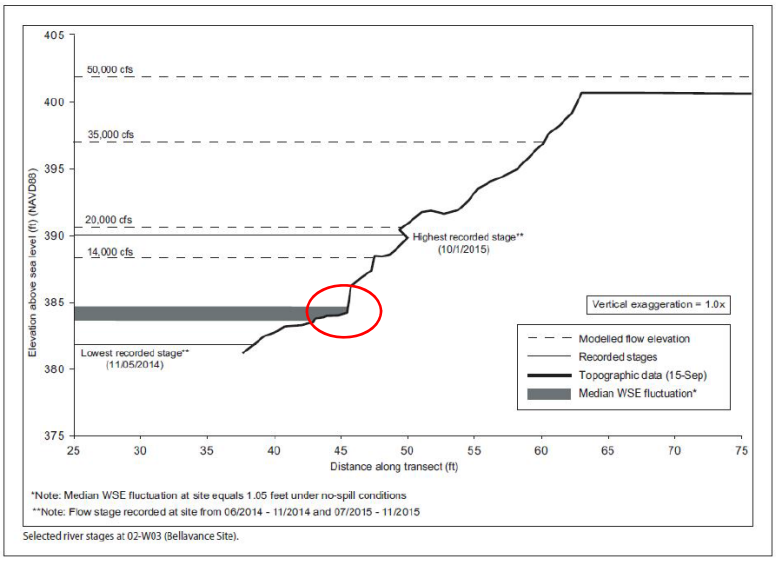

Figure 5.4.2-6. Position on bank of normal operating range aligns with location of notching at 02-W03 (Bellevance Site).

- *"Fluctuations in WSE related to normal project operations under no-spill conditions are consistent with notching and overhangs observed at the base of 8 of the 21 monitored banks at some point during the two-year monitoring period (Appendix A). Erosion can result from seepage forces generated by WSE fluctuations (Budhu and Gobin, 1995) with overhangs developing when seepage is focused along a single layer (Fox and Wilson, 2010)."* (page 111, Study 2 and Study 3)
- *"The character of sediments in the study area creates banks with limited resistance to erosion. The bank sediments at the monitoring sites, representative of the study area as a whole, are nearly ubiquitously comprised of fine-grained and unconsolidated floodplain or glaciogenic sediments particularly prone to erosion (see Appendix A stratigraphic columns). Frequently observed inter-beds of permeable sand and less*

> *permeable silt can further reduce the resisting force of floodplain sediments by creating horizontal surfaces along which groundwater can preferentially move, potentially increasing seepage forces acting on the bank."* (page 109, Study 2 and Study 3)

A more detailed discussion and analysis of these site conditions is warranted in order to determine "*their relationship to past water-level fluctuations" and "confirm whether project operations are causing reductions in bank instability"* as per the plan set forth in the RSP.

The study concludes that, "Trying to distinguish specific effects of normal project operations among the panoply of potential controls on bank erosion in any given location is not possible," (page 108). We suggest that a statistical method such as an Analysis of Variance (ANOVA), Multivariate Analysis of Variance (MANOVA), or Principal Component Analysis (PCA) would be consistent with generally accepted scientific practice and would yield more conclusive results. This is further discussed in our comments under "CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE" that follow in this memorandum. In addition to a statistical method, a modeling method, such as Bank Toe Erosion Model (BSTEM), coupled with a sensitivity analysis of the input variables, would assist in distinguishing the degree to which WSE fluctuation impacts bank stability versus other erosive mechanisms. The input variables in a bank stability model such as BSTEM typically include geotechnical and vegetation data, such as surface erodibility, critical shear stress, geotechnical strength, bulk unit weight, riverbank sediment particle-size distribution, maximum rooting depth of vegetation, and riparian species distribution. This type of bank stability model has the ability to run with various parameters either included or not included, in order to better assess the likely causation of erosion.

Recommendation #4: TransCanada should utilize the existing data to further assess the potentially "instrumental role" that WSE fluctuation may have on initiating the erosion cycle, by directly comparing the elevations where notching is observed and where the normal operational WSE fluctuations occur, and incorporate their data, relating to the "layering of sediments within the banks" and the stratification of permeable and less permeable zones, into this assessment. In addition, TransCanada should utilize a more rigorous statistical method to analyze the significant amount of data collected.

METHODS

This section includes our comments on the "Methods" as described in the RSP. We have only included comments on the sections of the "Methods" from the RSP that we feel were not conducted as provided for in the RSP.

Repeat Surveys

Statement from RSP: *"TransCanada will consult with the erosion working group during the 2-year monitoring period to discuss the need for, and locations of, increased sampling frequency based on the initial monitoring results and any information gleaned from the historical data research in Study 1 (Historical Riverbank Position and Erosion) that supports the need for more periodic monitoring based on significant erosion rates. The need for, and extent of, additional monitoring approaches (e.g., groundwater-level monitoring) could also be discussed in consultation."* (Page 23 RSP Study 2)

Peer Review Comment: TransCanada did not consult with the Erosion Working Group[2] during the 2-year monitoring period as described on page 23 of the RSP. The Erosion Working Group participated in choosing the transect locations, but was allowed only to review the study after the 2-years of monitoring were completed and the Study 2 and Study 3 Report were submitted.

This interim consultation appears to have been added to the RSP to justify the reduction in the number of monitoring sites from 30, requested by FERC (10 for each project), to 20 (page 21 RSP Study 2, an additional cross section was added later) and from a biweekly monitoring frequency, requested by NHDES, NHFG, and VANR, to "*at least four times per year for 2 years" (page 23 RSP Study 2),* and yet this consultation and interim reporting did not take place.

Recommendation #5: TransCanada should formally meet with the erosion working group as necessary to consider its comments and revise the Study 2 and Study 3 Report to reflect those comments, as proposed in the RSP.

Hydraulic Modeling

Statement from RSP: *"For this study, two-dimensional (2-D) modeling at up to six sites using River2D may be necessary to understand complex sites where HEC-RAS modeling does not adequately describe eddy flows that might develop, for example, upstream of valley constrictions or flow deflection that might occur, for example, around a mid-channel bar or island."* (Page 33 RSP Study 3)

[2] **TransCanada organized stakeholders into working groups to discuss study plans and study details. CRWC is or was a member of the Erosion Working Group.**

Peer Review Comment: The RSP stated that 2D modeling "may be necessary to understand the complex sites". No 2D modeling was prepared, nor was its use or reasons for not using it discussed in the Study.

Recommendation #6: TransCanada should add a discussion to the Study 2 and Study 3 Report that explains why 2D modeling was not completed and that the 1D modeling provided in Study 4 was adequate to analyze the more complex sites.

ANALYSIS

This section includes our comments on the "Analysis" as described in the RSP. We have only included comments where we felt that the Study Report was not conducted as provided for in the RSP.

Statement from RSP: *"TransCanada will consult with the erosion working group periodically to solicit comments to strengthen data collection procedures, analysis of erosion causes, and continuing studies during the 2-year study period."* (Page 35 RSP Study 3)

Peer Review Comment: TransCanada did not consult with the Erosion Working Group periodically to solicit comments to strengthen data collection procedures, analysis of erosion causes, and continuing studies during the 2-year study period for Study 3, as stated in the RSP.

Recommendation #7: FERC should consider the August 1, 2016 Study 2 and Study 3 Report to be the interim report and that the Erosion Working Group's current review of Study 2 and Study 3 Report be integrated into a revised study that the Erosion Working Group is then able to review as the final study as proposed in the RSP.

CONSISTENCY WITH GENERALLY ACCEPTED SCIENTIFIC PRACTICE

This section includes our comments on the Study 2 and Study 3 Report in relation to its "Consistency with Generally Accepted Scientific Practice" as described in the RSP. We have only included comments on the methods used and conclusions drawn that we feel were not conducted as provided for in the RSP. We have broken our comments down into two sections, to respond to the Study's consistency with generally accepted scientific practice, as stated below:

"The various methods to be used for this study conform to generally accept scientific practice" (Page 24 RSP Study 2), and *"The various methods to be used in the Riverbank Erosion Study conform to generally accepted scientific practice as detailed in the Methods section above"* (Page 35 RSP Study 3).

The first section relates to comments on how the methodology used in Study 2 and Study 3 is consistent with generally accepted scientific practice (i.e., cross section selection and the erosion ratio method utilized), the second relates to comments on whether the Study's conclusions are supported by the evidence given.

1. Consistency of Methodology with Generally Accepted Scientific Practice

Cross Section Selection for Monitoring

While we believe that the study selected the cross section monitoring sites in accordance with the RSP, the study extrapolates observations regarding bank erosion, on a project-wide basis, from monitoring sites that were "*selected so a range of"* conditions *"are incorporated into the analysis"* (page 22 RSP Study 2). Because the sites were not selected to reflect statistical occurrence along the project-wide reach, any extrapolation on a project-wide basis may not be well supported.

> **Recommendation #8:** TransCanada should revise the report to omit extrapolations to the entire study area based on the monitored cross sections unless a statistically based method is used to link cross-section observations with their likely occurrence frequency over the entire study reach.

Erosion Ratio

The primary metric relied upon for *"identifying the propensity of erosion to occur in association with certain conditions"* (Page 34 RSP Study 3) is the *"erosion ratio"* (Page 82, Study 2 and Study 3). This approach is not a generally accepted scientific practice and is not included in the RSP. It was presumably used to accomplish the objective of including a *"correlation of visible indicators of erosion with project-caused water-level fluctuations at the 21 transect locations"* (Page 1, Study 2 and Study 3). No citation or reference is provided for this metric, and the metric is not used, to our knowledge, in the extant fluvial geomorphic scientific literature. The Study does not demonstrate that the method *"conforms to generally accepted scientific practice"* (page 24, RSP Study 2 and Page 35 RSP Study 3).

The erosion ratio is too simplistic for attempting to ascertain the likely causes of erosion, when there are multiple known causes. It is defined as the ratio of two percentages: *"the percentage of bank erosion in the study site that is present within a specified feature divided by the percentage of bank length occupied by that feature"* (page 82, Study 2 and Study 3). According to the report, a value greater than 1.0 represents a propensity (or *"more likely to occur"*), and a value less than 1.0 indicates no propensity (i.e. *"less likely to occur"*).

Generally accepted scientific practices for analyzing processes with multiple causative variables rely on statistical analyses more sophisticated and robust than simple ratios. Such statistical methods that may be applied in these Studies, depending on the type and structure of the collected data, include Analysis of Variance (ANOVA), Multivariate Analysis of Variance (MANOVA), or Principal Component Analysis (PCA).

As much of the data is geographic in nature (e.g. the location of bank instability) and managed within a GIS, more rigorous spatial statistical methods should be employed to ascertain spatial autocorrelation or spatial regression, particularly to analyze *"correlation of visible indicators of erosion with the project-caused water-level fluctuations"* (page 1, Study 2 and Study 3).

For example, the data set that categorizes all banks within the study area into one of six classes: eroding, vegetated eroding, failing armor, stable, healed erosion, and armored (page 79, Section 5.6.4 Mapping Results, Study 2 and Study 3) should be re-analyzed through one of these multi-variate methods with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. It also should be noted that the classes *"healed erosion"* and *"armored"* are essentially banks that were eroding in the past but are not anymore, and those previously eroding banks may also have been due to project operations. Including those two classes in the larger *"stable"* category may lead to overlooking past impacts associated with project operations and could significantly change the findings in Section 5.3 Analysis of Historical Aerial Photography (page 23). For example, in Figures 5.3-1a, b, c, (Pages 25, 27, and 29, Study 2 and Study 3, respectively) it is unclear whether the decrease in bank erosion through time was influenced by bank armoring which may have arrested the process in some areas, while the source of the problem continued to exist.

In addition, the data set derived from the review of aerial photographs at 0.5-mile increments (Page 23, Section 5.3 Analysis of Historical Aerial Photography, Study 2 and Study 3) should also be re-analyzed with multi-variate methods with respect to the bank classification data mentioned above or with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. Further, the data set related to the 21 transects (Page 30, Section 5.4 Erosion Monitoring, Study 2 and Study 3) should be re-analyzed through a multi-variate method with respect to the erosion at the top, upper, mid, lower and toe of bank (Table 5.4.2-1, page 44) and to the median WSE fluctuation.

The erosion ratio appears to have limitations and be subject to biases. In discussing the erosion ratio associated with WSE fluctuations in the Vernon impoundment in Section 5.6.5 of Study 2 and 3, page 97, an abnormally high value is dismissed because the WSE range in question exists for such short lengths, which indicates that the erosion value can be easily skewed. To avoid 'interpreting results potentially skewed by short lengths', the analysis deliberately disregards any bank lengths that are less than 10% of the study area. This is problematic for two reasons. First, it overlooks banks that, albeit short, may be severely impacted by project operations. Second, multiple classes of 0.5-foot increment WSE fluctuations, which may fall below the arbitrary 10% threshold individually, collectively add up to a significant proportion, likely over 25%. Thus, in attempting to circumvent allegedly skewed results, the analysis dispenses with data that could otherwise be informative.

Recommendation #9: TransCanada should re-analyze the data in Study 2 and Study 3 Report according to generally accepted scientific practice, as specified in the RSP. The data set that categorizes all banks within the study area into one of six classes (i.e. eroding, vegetated

eroding, failing armor, stable, healed erosion, and armored (Page 79, Section 5.6.4 Mapping Results, Study 2 and Study 3)), should be re-analyzed through a multi-variate statistical method with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. In addition, the data set derived from the review of aerial photographs at 0.5-mile increments (Page 23, Section 5.3 Analysis of Historical Aerial Photography, Study 2 and Study 3) should also be re-analyzed with multi-variate methods with respect to the bank classification data mentioned above or with respect to the various contributing factors such as bank height, WSE fluctuation, riparian vegetation, bend geometry, etc. The data set related to the 21 transects should be re-analyzed through a multi-variate method with respect to the erosion on the bank (at the top, upper, mid, lower, and toe) and the median WSE fluctuation.

2. Consistency of Conclusions with Scientific Evidence Presented

Included below are our peer review comments relating to the consistency of the conclusions stated in the Study 2 and Study 3 Report. We believe that many of the Studies' conclusions were accurate and reflected a sound review of the significant amount of data, both historic and current, that was collected. Our comments below therefore only focus on Study conclusions that are not properly supported by the data presented in the Studies, or were not stated in conjunction with other related findings.

Study Conclusion #1: *"Taken together, natural conditions in the study area, by both reducing the resisting forces and enhancing the driving forces, create a situation where the riverbanks are likely near the threshold of erosion. As a result, minor natural or anthropogenic changes in the study area have the potential to initiate erosion already primed by the river valley's natural history and character."* (Page 109 Study 2 and Study 3)

"Given the significant changes in the rate and amounts of erosion documented through historical aerial photography and multiple mapping efforts, respectively, normal project operations that have changed little in several decades cannot adequately explain the observed patterns of erosion. Attempting to identify a single cause for erosion fails to recognize that multiple processes operate collectively to effect change on the riverbanks through space and time." (Page 115 Study 2 and Study 3)

Peer Review Comment: The study points out the significance of river banks that are at the "threshold of failure" by stating on page 11 "*When a bank is at the threshold of failure, a slight increase in shear stress or a small decrease in shear strength can lead to bank erosion"*. The study then concludes, on page 109, that the riverbanks in the study area *"are likely near the threshold of erosion"* and that *"As a result, minor natural or anthropogenic changes in the study area have the potential to initiate erosion already primed by the river valley's natural history and character."* These statements further support the need to confirm whether project operations are playing any role in the

reductions in bank instability. Because the study area has been classified as being near the threshold of failure, analysis of the data does not support a conclusion that dismisses the significance of the potential role of WES fluctuation in the cycle of erosion based on the fact that it is not the *"single cause for erosion" (page 115 Study 2 and Study 3)*.

Recommendation #10: TransCanada should revise the Study 2 and Study 3 Report to assess how the "threshold" conditions of the study reach may be impacted by even the slightest change in erosive force, whether acting alone, or in conjunction with other erosive forces.

Study Conclusion #2: *"The apparently increasing rate of erosion in the upper Wilder impoundment (Figure 5.3-1a) is more likely related to upstream inflows than Wilder project operations. The upper Wilder impoundment is closer to the McIndoes project than to Wilder dam. Therefore, McIndoes inflows along with significant natural discharges likely have a greater impact on erosion rates in upper Wilder impoundment than Wilder project operations."* (Page 111, Study 2 and Study 3, Assessment of Project Effects)

Peer Review Comment: This statement is not supported by any data included and described in Study 2 and Study 3.

Recommendation #11: TransCanada should provide their data on the upstream inflows in the Wilder impoundment and analysis to support their conclusion regarding the impact of these inflows.

Study Conclusion #3: ***"****The fact that these three sites experienced recession only once during two years of monitoring and that 12 additional monitoring sites mapped as unstable did not experience any bank recession at all may seem incongruous but actually indicates that bank recession, even in the most unstable areas monitored, does not occur annually but rather occurs episodically at time scales extending more than two years."* (Page 52, Study 2 and Study 3)

"Fluctuations in WSE related to normal project operations … are consistent with notching and overhangs observed at the base of 8 of 21 monitored banks at some point during the monitoring period." (Page 111, Study 2 and Study 3)

Peer Review Comment: Section 5.4.2 Repeat Monitoring indicates that only three of the 21 monitored transects experienced measurable recession at the top of the bank, and that erosion does not occur annually but rather episodically at time scales beyond the 2-year monitoring period. The study also acknowledges: *"At many sites, the position of those daily fluctuations on the bank aligns with the location of notching at the base of the bank: (page 53 Study 2 and Study 3), "Fluctuations in WSE related to normal project operations … are consistent with notching and overhangs observed at the base of 8 of 21*

monitored banks at some point during the monitoring period" (page 111 Study 2 and Study 3). These observations seem to indicate that as many as 38% (8/21) of monitored banks may experience notching as a result of project-caused WSE fluctuations. According to the final study the notching at the base of the bank likely drives the *"idealized cycle of erosion"* depicted in Figure 5.6.2-1 and results in eventual top of bank recession. It is noted therefore that this episodic erosion could be related to WSE fluctuation and may not be able to be adequately assessed within a 2-year monitoring period.

Recommendation #12: TransCanada should extend the cross section monitoring beyond the two-year monitoring period proposed in the RSP, for the above reasons and because the Study itself indicates that this period was not long enough to analyze the *"cycle of erosion"* at all sites.

Study Conclusion #4: *"The magnitude of water surface fluctuations in the study area is less than 2.0 ft for 75% of the study area's length so hydraulic gradients between groundwater levels in the bank and the adjacent river level are likely small, whereas waves breaking against the bank at the same elevation as water level fluctuations may generate stronger erosive forces."* (Page 111 Study 2 and Study 3, Executive Summary and Assessment of Project Effects)

Peer Review Comment: Hydraulic gradients depend on the elevation of surface water and groundwater, which were not measured. As there was no assessment of hydraulic gradients, wave actions, or erosive forces, no valid comparison can be made between the two bank erosion factors. This statement also raises the question of whether daily WSE fluctuations increases the vertical range on the bank that becomes exposed to wave action and ice jams and their associated erosive forces.

Recommendation #13: TransCanada should retract this conclusion, unless additional data is supplied that supports this statement. TransCanada should analyze how the WSE fluctuation may increase the vertical range on the bank that is exposed to additional erosive forces such as boat waves, piping and ice jams, which are all issues identified in the RSP.

Study Conclusion #5: "*The approximately 40% of bank instability mapped through the study area is similar to more free-flowing portions of the Connecticut River (Field, 2005), so normal project operations cannot be considered to be a cause of excessive erosion."* (Page 114, Study 2 and Study 3)

Peer Review Comment: Throughout Section 5.3 Analysis of Historical Aerial Photography (page 23 Study 2 and Study 3) and in subsequent sections, comparisons are made between impounded sections and riverine sections with the assumption that conditions

in the riverine sections are natural, normal or unaffected by project operations. However, riverine sections are also subject to the downstream effects of dams, which includes exacerbated / accelerated bank erosion due to sediment trapping by the dam and sediment deprivation in the downstream reaches. While these Studies are not focused on the downstream effects of the dams, this "hungry water" effect (Kondolf, 1997) renders any conclusions from such comparisons invalid.

Recommendation #14: TransCanada should provide additional data in Study 2 and Study 3 Report regarding the previous assessment of free-flowing portions of the Connecticut River, if it is to be used as a scientifically supported comparison to the impounded reaches. Specifically, TransCanada should show how these "free-flowing" reaches are not impacted by other factors such as limited upstream sediment inputs due to the presence of upstream dams.

Study Conclusion #6: "*Tractive forces generated by flood flows are the only mechanism capable of removing the sediment from the base of the bank that otherwise would lead to bank stabilization if not removed."* (Page 114, Study 2 and Study 3, Conclusions)

Peer Review Comment: This statement is not supported by any data included and described in Study 2 and Study 3. This statement speaks to the importance of flood flows and tractive forces in the *"cycle of erosion"* described in the study; however, it appears that no attempt was made to quantify the shear stress created by flood flows or to utilize relevant data from Study 4 – Hydraulic Modeling Study.

Recommendation #15: TransCanada should complete additional analysis of the hydraulic conditions.

Study Conclusion #7: *"While other processes such as waves or seepage forces created by project-related WSE fluctuations may exert some control on the cycle of erosion, they cannot be considered as resulting in excessive erosion that negatively impacts other resources since ultimately the continuation of erosion depends on flood flows that sustain the cycle of erosion*." (Page 114, Study 2 and Study 3, Conclusions)

Peer Review Comment: This study conclusion does not follow a logical thought process since although it is stated that *"seepage forces created by project-related WSE fluctuations may exert some control on the cycle of erosion"* the role of their impact cannot be negated based solely on the fact that these initial erosive forces are taking place in a riverine environment where high flows are ultimately transporting eroded material downstream and continuing the cycle indefinitely.

This statement discounts the role of fluctuating WSE on bank erosion because it is likely acting on only a portion of the *"cycle of erosion"*; however, the study describes a *"cycle of erosion"* that is initiated with the creation of a notch or overhang at the toe of the bank (see Figure 5.6.2-1). Further, the description from the Executive Summary states that *"Bank erosion in the study area is a cyclic process that begins with the formation of notches and overhangs at the base of the bank. The resulting over-steepening at the bank's base destabilizes the upper bank generating planar slips, rotational slumps, topples, and flows that transfer bank material downslope. Material supplied from the erosion of the upper bank accumulates at the base of the bank and can ultimately lead to the stabilization of the bank unless the sediment and fallen trees are removed by river currents, wave action, groundwater seepage, or other forces. If the material is removed, the notching at the base of the bank can begin afresh and the cycle of erosion repeated."* (Page ES-1, Study 2 and Study 3)

The study also reports that *"Erosion can result from seepage forces generated by WSE fluctuations (Budhu and Gobin, 1995) with overhangs developing when seepage is focused along a single layer (Fox and Wilson, 2010)"* (page 111 Study 2 and Study 3).

Recommendation #16: Based on the data presented, TransCanada should revise the statement as follows:

> "Processes such as waves or seepage forces created by project-related WSE fluctuations may exert some control on the initiation of the cycle of erosion; however, they cannot be considered as resulting in excessive erosion that negatively impacts other resources on their own, since ultimately the continuation of erosion depends on flood flows that sustain the cycle of erosion."

This revised conclusion is based on the observed results and acknowledges that bank erosion is caused by multiple contributors at different stages of the cycle of erosion. Importantly, it does not eliminate WSE fluctuation as one of the potential contributing factors. It is also important to note that the report does not include a discussion of the potential loss of resistive forces such as vegetation growth at the toe of the bank due to daily WSE fluctuation, which could also contribute to the ongoing cycle of bank erosion. Thus, the implication is that project-caused WSE fluctuations may not be the sole cause of bank erosion but that it could be exacerbating and accelerating bank erosion.

Study Conclusion #8: The study concludes in the last paragraph that *"normal project operations that have changed little in several decades"* (page 115 Study 2 and Study 3)

Peer Review Comment: There is no data or descriptions in the study on how operations have changed, or not changed, over time.

Recommendation #17: TransCanada should provide additional data supporting their claim that "normal project operations that have changed little in several decades".

DELIVERABLES

This section includes our comments on the "Deliverables" as described in the RSP. We have only commented on the deliverables from the RSP that we feel were not conducted as provided for in the RSP.

Statements from RSP: *"An interim study report will be prepared after the first year of study is complete synthesizing the above deliverables into a narrative that addresses the study goals and issues raised in various study requests. The report will be provided to stakeholders for review and comment."* (Page 25 RSP Study 2)*, and "The interim study report will be prepared after the first year of study is complete. The report will be provided to stakeholders for review and comment."* (Page 36 RSP Study 3)

Peer Review Comment: Interim Reports for Study 2 or Study 3 were never provided to the Erosion Working Group to review and comment.

Recommendation #18: FERC should consider the August 1, 2016 Study 2 and Study 3 Report to be the interim report and that the Erosion Working Group's current review of Study 2 and Study 3 Report be integrated into a revised study that the Erosion Working Group is then able to review as the final study as proposed in the RSP.

SUMMARY CONCLUSIONS

Based on our review of the Study 2 and 3 Report, our review team has made 18 recommendations as discussed earlier in this memorandum. Most critically, we find that the Study 2 and Study 3 Report did not "*ascertain the relative importance of water-level fluctuations associated with project operations in the erosion process relative to other contributing factors"* as stated in the RSP and has instead stated that *"trying to distinguish specific effects of normal project operations among the panoply of potential controls on bank erosion in any given location is not possible"*. A better understanding of causation should be ascertained with a different methodology such as a statistical analysis of the data collected or a bank stability model that utilizes a wider variety of geotechnical and vegetative parameters, such as geotechnical strength, maximum rooting depth, and hydraulic gradient between ground water and river water levels.

The Study Report does not consider adjacent land use as a factor (other than the presence or absence of riparian vegetation at the top of bank), and yet numerous peer-reviewed research studies have investigated and confirmed that adjacent land use has a strong role in bank stability and erosion. Nor does the study consider the impact that daily WSE fluctuations may have on limiting vegetative growth at the toe of the river banks, although the study itself acknowledges the important role that vegetation can have on increasing bank resistance to erosion.

The Study Report does not adequately "i*dentify the effects of shoreline erosion on other resources (e.g., riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat)"* as stated in the RSP, and instead bases its conclusions on other studies that were not tasked with assessing the effects of shoreline erosion on these critical resources.

In addition, the coordination with the Erosion Working Group promised in the RSP was not conducted, and the interim reports were not delivered for review, such that the study could have been adjusted as needed to successfully complete the objectives stated in the RSP.

TransCanada should revise the Study Report or issue an Addendum to the report that includes the revisions as per the recommendations set forth in this peer review.

Scientists, Engineers & Environmental Planners Designing Innovative Solutions for Water, Wetland and Soil Resource Management

May 15, 2017

MEMORANDUM

To: Andrea Donlon, CRC

From: Laura Wildman, P.E., Princeton Hydro, LLC
Paul Woodworth, Fluvial Geomorphologist, Princeton Hydro, LLC

Re: FERC Re-Licensing Process for Great River Hydro, LLC
Peer-Review of ILP Study 2 and Study 3
Riverbank Transect and Riverbank Erosion Studies
Final Study Report, dated February 4, 2017

FERC Numbers:
Project No. 1892-026 – New Hampshire/Vermont
Project No. 1892-045 – New Hampshire/Vermont
Project No. 1892-073 – New Hampshire/Vermont
Great River Hydro, LLC

The Connecticut River Conservancy (CRC) (formerly Connecticut River Watershed Council) is a stakeholder and participant in the re-licensing process of the Federal Energy Regulatory Commission (FERC) for the three hydropower facilities owned by Great River Hydro, LLC (formerly TransCanada Hydro Northeast Inc.) on the Connecticut River, Wilder Dam, Bellows Falls Dam, and Vernon Dam. Princeton Hydro (PH) was retained by CRC to complete a peer review of technical erosion studies, specifically the Integrated Licensing Process (ILP) Study 2 and Study 3: Riverbank Transect and Riverbank Erosion Studies, revised by TransCanada on February 4, 2017. This memorandum is a critical review of the revised ILP Study 2 and Study 3 and aims to address the following questions as defined in 18 CFR § 5.15 Conduct of studies (d) Criteria for modification of approved study, the RSP, and FERC's November 29, 2016 Determination on Requests for Study Modifications and New Studies – Wilder, Bellows Falls, and Vernon Hydroelectric Projects:

- Is the revised report now in compliance with the Revised Study Plan (RSP) dated 8/14/2013 and FERC's study plan determination dated November 29, 2016 on the study report from August?
- Were the new analyses conducted in a way that is generally accepted scientific practice?
- Are the results and conclusions valid?

COMPLIANCE WITH THE 8/14/2013 RSP AND FERC'S 11/29/16 DETERMINATION

FERC's Determination on Requests for Study Modifications and New Studies, dated November 29,2016, ("FERC's Determination") requested additional information regarding modeling (shear-stress and velocity analysis, as well as logistic regression analysis of bank instability), assessment of hydraulic gradient between water surface elevations and groundwater, and effects of shoreline erosion on other resources. The format of our response uses the section headings from FERC's 11/29/16 Determination, including: 1) *River 2D Modeling,* 2) *Hydraulic Gradient between Water Surface Elevations and Groundwater*, and 3) *Effects of Shoreline Erosion on Other Resource*, to discuss critical omissions such as a shear-stress velocity analysis, hydraulic gradient data, and an adequate analysis of other resources, respectively, as well as the inconclusive nature of TransCanada's logistic regression statistical analysis. Excerpts from FERC's Determination on Requests for Study Modifications and New Studies, Nov. 29, 2016 have been included at the beginning of each section below, followed by our peer review comments and recommendations. We conclude our document with short sections on Accepted Scientific Practice, and the Validity of Results and Conclusions, followed by a brief Summary section.

1. River 2D Modeling

Based on TransCanada's promise in response to comments dated October 31, 2016, to "**conduct shear-stress and velocity analyses** using the one-dimensional Hydrologic Engineering Center's River Analysis System (HEC-RAS) model in the revised report for studies 2 and 3…to identify the likely causes of erosion at the 21 erosion monitoring sites…", FERC recommended the following in its Determination:

"Using **HEC-RAS modeling in combination with logistic regression statistical analysis** may be adequate **to identify and describe the likely causes of erosion** at the 21 monitoring sites. When TransCanada files its revised study report in January 2017, we will review the results, including the proposed HEC-RAS modeling and regression analysis, and as appropriate, **consider the need for additional analysis**, including use of the River2D model. Based on the information available at this time, we expect that the revised report will be adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)). Therefore, we do not recommend requiring TransCanada to conduct any River2D modeling at this time."

Peer Review Comments Regarding Compliance with FERC Determination

Shear-stress and Velocity Analysis

No shear-stress and velocity analysis, using the HEC-RAS model to identify the likely causes of erosion at the 21 erosion monitoring sites, was included in the revised Study 2 and 3. The revised study again refers to the original Study 4 – Hydraulic Modeling Report dated March 1, 2016, which was not recently revised. There is no mention of a HEC-RAS model in the revised Study 2 and 3, and no results listed shear stress throughout the study reach, although it is presumed this data was used as input for the logistic regression analysis. Study 4 – Hydraulic Modeling Report also does not include the tabular output data from the one-dimensional HEC-RAS model, which would list velocity and shear stress by model cross section, nor does it include any of the standard water surface profiles or cross-sectional modeling data, such that Princeton Hydro could review the validity of this modeling.

The revised Study 2 and 3 does list velocity data for a limited number of flows, with no associated shear stress data, in Table 5.8-1 on page 123, Section 5.8, and in Tables 6.1-1 and 6.1-2. The velocity data and analysis in Section 6.1 focuses only on a single element of the cycle of erosion, the potential for sediment entrainment at the toe of the stream bank. The velocity data and discussion in Section 5.9 (Table 5.8-1) focuses only on the change in velocities during periodic operational drawdowns, in preparation for anticipated high flows (as described in page 120 of the report). The data presented in Table 5.8-1 actually show that velocities *increase* between 36% and 400% during these periodic operational drawdowns, resulting in velocities significantly in excess of the threshold velocity for sediment entrainment later discussed in Section 6.1. The data presented in Table 5.8-1 therefore suggests that periodic operation drawdowns, in preparation for high flows, could regularly mobilize sediment at the toe of the streambank at 9 of the 13 monitored impoundment cross sections. However, the revised Study 2 and 3 then attempts to discount the significance of this finding by running a scenario where only WSE fluctuates and flow remains constant even though they state that, "such a scenario does not actually occur" (page 122). Again, no shear stress was included in the velocity data included in Section 5.8.

The discussions included in section 5.9 and 6.1, do not "identify the likely causes of erosion at the 21 erosion monitoring sites" as was indicated in TransCanada's response to the requested study modifications, and as was stated in the FERC Determination dated November 29, 2016.

It is not possible for Princeton Hydro, FERC, or any of the stakeholders to review the one-dimensional flow analysis, referred to in Study 4, the presumed source for the velocity data listed in Study 2 and 3, without standard output tables, profiles, and model cross sections. HEC-RAS model reviews are typically completed by opening the actual model and reviewing both the input and output data, since reviewing just output data assumes that the model was set up and run accurately.

Princeton Hydro Recommendation: We recommend that TransCanada conduct the shear-stress and velocity analyses using the one-dimensional Hydrologic Engineering Center's River Analysis System (HEC-RAS) model to identify the likely causes of erosion at the 21 erosion monitoring sites, and provide all of the needed input and output data, as well as the HEC-RAS model itself, such that a review of the modeling and analysis is possible.

Logistic Regression Analysis of Bank Instability

A Logistic Regression Analysis was performed in partial response to requests by Princeton Hydro and FERC; however, we find the selected analytical test to be inappropriate, the results in conflict with the known causative physical forces of bank erosion, and the results to be invalid. The analysis focuses solely on the data set that categorizes all banks within the study area into one of six classes of stability or instability. The analysis does not include the data set derived from the review of aerial photographs at 0.5-mile increments, nor the data set related to the 21 transects, as was recommended in the FERC Determination dated November 29, 2016 or in Princeton Hydro's Recommendation #9 on page 13, in the memo entitled FERC Re-Licensing Process for TransCanada Hydro Northeast Inc., dated September 30, 2016. According to Appendix E of Study 2 and 3, the input data provided to the statistician who conducted the logistic regression analysis were two comma delimited text files corresponding to the left and right river banks, which included shear stress data at high normal operational flows and the 10-yr recurrence interval flood flow averaged across the full width of the channel. This input data was not

included in Appendix E, and again no tabular data relating to shear stress by location was reported, including at the 21 monitored cross sections.

Shear stress computations generated from one-dimensional modeled flow, which is averaged across the full width of the channel, yields single values for shear stress at a cross-section and do not generate results that differentiate between the outside and inside banks of the channel. Without explanation of the source and type of the shear stress data utilized in the analysis, the results associated with shear stress are difficult to interpret and may be invalid.

The analysis reduces the six classes of stability into two binary categories (stable or unstable). This initial step in the process could skew the analysis if, as explained in the September 30, 2016 Princeton Hydro memo (page 12), the bank category of "armored" is represented as "stable." Armored banks were previously unstable to such a degree to necessitate engineering intervention. Thus, their characteristics, WSE fluctuation, height, shear stress, etc. are all conditions that should be attributed to "instability".

The analysis concludes that there are no single strong predictors of bank instability; and, that bank height, shear stress (at the lower flow), and WSE fluctuation were the top three, albeit low (up to 3.5% deviance explained in the single predictor model, and 7.4% deviance explained in the multiple predictors model) predictors of bank instability. Statistical analyses are useful when they can account for much higher (e.g. greater than 50%) explanatory power. Regression analysis assumes observations are independent variables; however, as explained on page E-2 of Appendix E, the observations in this data set are not independent. Princeton Hydro had pointed out the potential for spatial autocorrelation in this dataset in the September 30, 2016 memo, and thus had suggested "more rigorous spatial statistical methods should be employed." The fact that the data is subject to spatial autocorrelation may be the cause of the poor predictive power of the analysis and brings into question the validity of comparing the results of shear stress, bank height, WSE fluctuation, etc.

The analysis produces a strongly counter-intuitive finding that there are no unstable banks at the highest shear stresses, and that bank instability does not increase with bank height, shear stress, and WSE fluctuation. A basic understanding of the physical forces and the cycle of erosion would clearly support the notion that bank instability would increase with one or all of those factors – this conclusion to the contrary is highly suspect and raises serious doubts about the validity of the input data, the statistical method employed, and its interpretation. For example, the use of cross-section-averaged shear stress from a one-dimensional model that is then extrapolated many thousands of feet from a modeled cross-section may be of insufficient resolution to provide meaningful quantitative connection to bank stability.

A statistical analysis of the dataset of the 21-transects, which was not completed, could incorporate the presence of bank materials and stratification, which are acknowledged as factors that contribute to bank instability relative to WSE fluctuation (discussed in section 2 below). While a much smaller dataset, the 21 transects are likely sufficiently separated so as to reduce or avoid problems with spatial autocorrelation.

Importantly, the revised study emphasizes how the shear stresses at high flows are the primary driver of the cycle of erosion as they are the only flows sufficient to remove soil from the bank toe (however, their data on Figure 6.1-1. page 131 does not support that statement). Assuming that the

results can be compared relative to each other (despite the inherent problems with this statistical test related to the nature of the dataset), this analysis finds high flow shear stress to have less effect than WSE fluctuation and bank height. This suggests that WSE fluctuation has nearly equivalent importance on determining the probability of erosion as high flows, contrary to assertions made throughout the revised study report. Furthermore, the results of the analysis indicate that WSE fluctuation is one of the top three factors that determine bank stability, an admission that project operations are in fact a significant factor in causing bank instability.

Princeton Hydro Recommendation: We request that the input data, or the regression residuals, be evaluated for spatial autocorrelation using Moran's I or a similar spatial index to determine the degree of spatial autocorrelation and spatial dependencies, and if significant, we request an alternative statistical test or at a minimum, further discussion about the utility and validity of the results despite the current test's limitations. Further, we recommend additional statistical analyses on the data set derived from aerial photographs at 0.5-mile increments, and on the data set related to the 21 transects as was recommended in the FERC Determination dated November 29, 2016.

2. Hydraulic Gradient between Water Surface Elevations and Groundwater

The FERC Determination stated, "It is unclear how or if TransCanada determined the hydraulic gradient between impoundment water surface elevations and groundwater elevations along the shoreline (i.e., the report for studies 2 and 3 does not include any groundwater elevation data). Therefore, Commission staff recommends that the revised report that will be filed in January 2017 include additional information that **describes how the hydraulic gradients were calculated and the resulting potential for riverbank erosion** (e.g., naturally occurring seepage and project-related seepage). The discussion should **include any observations of groundwater seeps or seepage-related erosion** at the 21 erosion monitoring sites **and any groundwater elevation data** that was collected during the studies."

<u>Peer Review Comments Regarding Compliance with FERC Determination</u>

The revised Study does not describe how the hydraulic gradients were calculated and the resulting potential for riverbank erosion, nor does it include observations of groundwater seeps or seepage-related erosion at the 21 erosion monitoring sites and any groundwater elevation data.

As previously stated in our September 30th, 2016 peer review of the original Study 2 and 3 and as per our current review of the revised Study 2 and 3, no ground water data, and thereby no hydraulic gradient data for the streambank, was collected or analyzed for the review of how operational WSE fluctuations potentially effect streambank stability. The revised Study 2 and 3 states that "even small WSE fluctuations could still contribute to bank instabilities" (page 138), but then discounts this potential without any data; basing their assumption on the magnitude of the assumed hydraulic gradient (discounting 25% of the reaches with higher fluctuations) and what they refer to as the short duration of the fluctuations, which occur on a daily basis.

The following four excerpts taken from the revised Study 2 and 3, further highlight the importance of assessing the hydraulic gradient between impoundment water surface elevations and

groundwater elevations along the shoreline, based on site specific groundwater field data for the 21 monitored sites.

> Page 138 : "While even small WSE fluctuations could still contribute to bank instability, the texture and stratigraphy of bank sediments are also important controls on the hydraulic gradient and associated seepage forces (Fox et al., 2010) such that the stability of two adjacent banks with slight differences in bank composition could be very different despite experiencing identical WSE fluctuations, thereby complicating efforts in discerning whether bank instability is the result of project-induced WSE fluctuations."
>
> Page 124: "The character of sediments in the study area creates banks with limited resistance to erosion. The bank sediments at the monitoring sites, representative of the study area as a whole, are nearly ubiquitously comprised of fine-grained and unconsolidated floodplain or glaciogenic sediments that are particularly prone to erosion (see Appendix A stratigraphic columns). Frequently observed inter-beds of permeable sand and less permeable silt can further reduce the resisting force of floodplain sediments by creating horizontal surfaces along which groundwater can preferentially move, potentially increasing seepage forces acting on the bank."
>
> Page 132: "When the water surface in an impoundment is increased when a dam is raised, the previously dry bank sediments inundated by the rising water becomes saturated, the pore pressures increase, and the resisting forces of the bank material decrease. Together with the added weight of the water in the bank sediment (causing an increase in the driving forces), the reduced strength of the bank material creates an unstable situation that leads to bank failure (Brunsden and Kesel, 1973; Lawson, 1985)."
>
> Page 165: "…although such operations could contribute to erosion by creating seepage forces associated with daily fluctuations."

This last excerpt was taken from Section 6.6, Study Conclusions, and clearly highlights the need to assess seepage forces associated with daily operational fluctuations.

In addition to assessing the hydraulic gradient associated with daily operational WSE fluctuations, it is also critical to assess the potential for streambank instabilities caused by periodic operational drawdowns in preparation for high flow events. The revised Study 2 and 3 does not include a discussion of the potential for seepage forces and bank instabilities during periodic operational drawdowns, which occur over longer durations than the daily WSE fluctuations. Although it does bring up stability concerns relating to periodic operational drawdowns, when it states on page 120 that, "As a result of lowering WSE at the dams, a convexity in the longitudinal profile develops in the impoundments, most pronounced at the lower end (Figure 5.8-1 on page 121 – this is the second figure labeled 5.8-1 in the report), that could potentially engender a channel response as a stable river profile typically has a concave-up profile in contrast to the observed convexity." This same discussion shows that velocities during periodic operational drawdowns exceed the threshold velocity for sediment entrainment at 70% of the 13 erosion impoundment monitoring sites, and as such periodic drawdowns to precipitate movement of accumulated sediment away from the tow of the streambanks, similarly to high flow events and a handful of the higher operational flow events at the 21 monitored cross sections.

Princeton Hydro Recommendation: We recommend that Great River Hydro collect groundwater elevation data and observations of groundwater seeps or seepage-related erosion at the 21 monitored transects and, as requested, analyze that data to determine how operational WSE fluctuations potentially effect streambank stability. This analysis is needed since, as stated in Study 2 and 3 on page 138, "even small WSE fluctuations could still contribute to bank instabilities." Great River Hydro should calculate the hydraulic gradients specific to the full range of operational WSE fluctuations including both normal operational WSE fluctuations and periodic operational drawdowns, inclusive of durations for both current operational practices. The analysis should incorporate the data already collected by TransCanada at the 21 transects relating to the layering of sediments within the banks and the stratification of permeable and less permeable zones. The studies should describe how the hydraulic gradients were calculated and the resulting potential for riverbank erosion (e.g., naturally occurring seepage and project-related seepage). The discussion should include data, observations, analysis, and discussion for potential riverbank erosion and all 21 erosion monitoring sites. Without this data the validity of the conclusions of Study 2 and 3 remain in question.

3. Effects of Shoreline Erosion on Other Resource

The FERC Determination stated, "An objective of study 3 (see the fourth bullet on page 27 of the approved RSP) was to 'identify the effects of shoreline erosion on other resources (e.g., riparian areas and shoreline wetlands, rare plant and animal populations, water quality, and aquatic and terrestrial wildlife habitat).' TransCanada proposed to conduct this analysis partly by using "maps showing the location of different bank conditions and features along the river […] to investigate whether bank erosion has the potential to affect other resources.' The report for studies 2 and 3 provides a limited analysis of other resources and suggests that other studies (i.e., studies 6, 8, 14, 15, 24, 25, 27, and 30) determined erosion is 'unlikely to have measureable negative effects on those resources.' The report for studies 2 and 3 does not include any maps comparing areas with documented erosion to the maps created for other studies.

…the discussion of existing information should be expanded to provide a more detailed description of the effects of ongoing erosion within the project boundary on other resources. Therefore, we recommend that the revised study report that will be filed in January 2017 include a **detailed qualitative discussion of the potential effects of ongoing erosion** within the project areas **on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic habitat, and terrestrial habitat**. Where possible, this discussion should include **comparative maps and site-specific observations**. "

Peer Review Comment Regarding Compliance with FERC Determination

Our comments on how the effects of shoreline erosion were assessed regarding other resources are addressed as follows:

3.1. Cultural and Historic Resources

No maps are provided. Six of seven sites were recommended for listing in the National Historic Register and protection. A qualitative assessment of the potential effects of ongoing erosion on these cultural and historic sites is not provided.

3.2. Recreation Facilities

67 public access sites are identified, 7 sites were linked to erosion concerns. No mapping is provided. TransCanada manages impacts from erosion, scour, and sedimentation at FERC Project recreation sites through as-needed maintenance. A qualitative assessment of the potential effects of ongoing erosion on these recreation sites is not provided.

3.3. Wetlands

Only three example maps are provided. Statistics were presented that show that wetlands are more prevalent at stable banks and in the dam impoundments than the riverine reaches. The discussion raises the question whether the wetlands promote bank stability or whether stable banks promote wetlands. A qualitative assessment of the potential effects of ongoing erosion on wetlands is not provided.

3.4. Rare Plants

Jesup's Milk Vetch

- Four known sites; no mapping is provided. Ongoing bank erosion is not likely to adversely impact Jesup's Milk Vetch as it inhabits bedrock outcrop crevices.

Northeastern Bulrush

- Not located in field surveys. Ongoing bank erosion is not likely to adversely impact NB as it inhabits beaver dams and habitats beyond the impoundment.

Other Rare Plants

- No mapping is provided. Other rare plants were 2x more commonly found at stable banks (65 out of 96 at stable sites, 23 out of 96 at unstable sites). One species is an erosion specialist and benefits from eroded sites. Ongoing bank erosion may adversely impact other rare plants.

3.5. Rare Animals

Cobblestone Tiger Beetle

- No mapping is provided. Cobblestone Tiger Beetle (CTB) was found at 7 of 14 study sites, 5 of which were stable. Erosion is an important process for maintaining CTB habitat; however, the discussion does not acknowledge that bank erosion rarely yields the coarse-grained material that forms CTB habitat. Contrary to the report's findings, ongoing bank erosion does have the potential to adversely impact CBT.

Fowler's Toad

- No mapping is provided. Fowler's Toad habitat is naturally rare in the CT River; FT was located at 1 of 10 study sites that had suitable habitat. The report concludes that periodic scouring and erosion during high flow events would contribute to creating and maintaining FT habitat.

Dragonflies and Damselflies

- Only two example maps are provided. Dragonflies and Damselflies (D/D) were found at 11 of 11 study sites, including 6 Species of Greatest Conservation Need. As species were co-located with stable and unstable sites, the report concludes that ongoing bank erosion is unlikely to adversely impact D/D and may maintain desirable habitat conditions.

3.6. Terrestrial Wildlife

Bank Swallows

- No mapping is provided. Bank Swallows require eroded banks for colony nests.

King Fishers

- No mapping is provided. King Fishers utilize eroded banks for individual nests.

Bald Eagles

- No mapping is provided. While single potential nest trees can be lost due to bank erosion, the report concludes that the greater population is unlikely to be impacted by ongoing bank erosion.

3.7. Aquatic Resources

Water Quality

- Water quality monitoring reported in Study 6 found turbidity to be within state standards. Few recorded peak spikes in turbidity were found to occur in response to high flows resulting from heavy rain events. However, there is no discussion of how ongoing bank erosion is contributing to measure peaks in turbidity. Further, periodic drawdowns in anticipation of high flows also generate high velocities which are likely to generate bank erosion and contribute to turbidity. Discussion is provided on the impacts of turbidity to spawning, although there is no assessment on the impacts to sight-feeding fish or gill respiration, both of which are known to be impacted by turbidity and total suspended solids (TSS).

Aquatic Habitat and Substrate

- Statistics are presented that show that fines are far more prevalent in the impounded reaches (72-84%) and that coarse-grained substrates are far more prevalent in the riverine reaches (65-75%). This stark contrast would seemingly have substantial effects on benthic communities; however, it is not acknowledged.

Fish Spawning

- Three species spawn in slack-water habitat. At least four species practice nest-cleaning behaviors, where they sweep away fine sediments. Six riverine species do not actively clean nests, and indeed multiple nests were found abandoned, for unknown reasons. These riverine species could be adversely affected by ongoing bank erosion, although the report does not clearly state this.

Freshwater Mussels

- Statistics are presented showing the co-location of Freshwater Mussels with stable and unstable banks. However, the report states that surveys were not conducted randomly but rather "purposely avoided areas with highly unstable banks, because, based on surveyor experience, mussels are less likely to be found near those types of banks." This fact renders the statistics invalid, and reinforces the concern that ongoing bank erosion could adversely effect freshwater mussel species.

Princeton Hydro Recommendation: We recommend that TransCanada include mapping as requested in the FERC Determination dated November 29, 2016 including riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic habitat, and terrestrial habitat. Locational information for stationary state-listed species can be made privileged. More importantly, we recommend further qualitative discussion about the potential impacts that ongoing bank erosion and the release of fine sediments may have on (i) the Cobblestone Tiger Beetle habitat, (ii) water quality impacts related to sight-feeding and respiration of fish, (iii) aquatic habitat and substrate, (iv) spawning of riverine fishes, and (v) freshwater mussels.

ACCEPTED SCIENTIFIC PRACTICE

- **Erosion Ratio**: While a statistical analysis was added to Study 2 and 3, the revised study still utilizes and makes conclusions based on the "erosion ratio." This approach is not an accepted scientific practice and was not proposed and a method for inclusion in the RSP. No citation or reference is provided for this metric, and the metric is not used, to our knowledge, in the extant fluvial geomorphic scientific literature. We understand through our conversations with CRC, that Field Geology Services used the erosion ratio in a table in their 2007 fluvial geomorphology study of the Turners Falls impoundment of the Connecticut River. The TransCanada study does not demonstrate that the method conforms to generally accepted scientific practice; in fact the revised study states that "the erosion ratio approach for identifying potential causes for erosion has not been widely used" (page 103 Revised Study 2 and 3). Please refer to our previously prepared peer review comments from September 30th, 2016, for a more detailed explanation of the potential biases associated with the erosion ratio.

VALIDITY OF RESULTS AND CONCLUSIONS

Study Conclusion #1: "Flow velocities and shear stresses during normal project operations have been shown to be inadequate, within the impoundment sections and at nearly all locations within the riverine sections, to mobilize sediment accumulating at the base of the banks and are by themselves unable to sustain the cycle of erosion." (from page 140 of the Revised Study 2 and 3)

Peer Review Comment: The study continually discounts the role that normal project operations may have on erosion, based on their statement that normal project operational flows are not responsible for mobilizing accumulated sediment at the base of the banks, even though their own data (Figure 6.1-1. page 131) demonstrates that operational flows can entrain sediment accumulations at the toe of the

slope. While we concur with the study that mobilization of eroded streambank sediment that has deposited at the base of the bank typically occurs during high flows, we do not concur that it therefore follows that WSE fluctuations caused by normal project operation do not play a role in initiating the erosion at the toe of the bank, which is also a critical element in the bank erosion cycle. While the initial toe of bank notching may result in a lower quantity of sediment being mobilized, it does directly contribute to the bank failures that then result in sediment deposits at the toe of the bank, once the bank has failed. The cycle of erosion is only propagated when all of its elements continue to occur. It does not logically follow to place a higher significance on only one element of the cycle, such as mobilization of the sediment depositions at the toe of the bank due to high flow. As the study states, "Not all causal mechanisms need be present at any given site to effect erosion, but where they are present they all work in concert to increase bank instability." (page 124)

In addition to the above referenced invalid study conclusion we would also refer FERC to our peer review comments and recommendations from our September 30, 2016 peer review for Study Conclusion #4 on page 15 and Study Conclusion #5 on pages 15 and 16.

PEER REVIEW SUMMARY

Princeton Hydro finds the revised Final Study Report, dated February 4, 2017 to be incomplete, inconclusive, and at least partially, invalid. The Final Study Report does not fulfill the obligations put forth in the Revised Study Plan, nor the follow-up requests in the FERC Determination on Requests for Study Modifications and New Studies, dated November 29, 2016. Essential data, related to the hydrologic and hydraulic analyses and subsequent analyses, including detailed stage monitoring and hydraulic modeling output of velocity and shear stress, were never provided for review or analysis. Statistical analysis from that data was compromised by spatial autocorrelation, rendered inconclusive results, contradicted assertions made in the Revised Study Report, and led to interpretations that are counter to the known physical processes that effect bank stability.

Scientists, Engineers & Environmental Planners Designing Innovative Solutions for Water, Wetland and Soil Resource Management

March 6, 2018

MEMORANDUM

To: Andrea Donlon, River Steward, CRC
Kathy Urffer, River Steward, CRC

From: Paul Woodworth, Fluvial Geomorphologist, Princeton Hydro, LLC
Laura Wildman, PE, Princeton Hydro, LLC

Re: FERC Re-Licensing Process for Great River Hydro, LLC
Peer-Review of ILP Study 2 and Study 3
Riverbank Transect and Riverbank Erosion Studies
Supplement to Final Study Report, dated 11/15/2017

FERC Numbers:
Project No. 1892-026 – New Hampshire/Vermont, Wilder Hydroelectric Project
Project No. 1892-045 – New Hampshire/Vermont, Bellows Falls Hydroelectric Project
Project No. 1904-073 – New Hampshire/Vermont, Vernon Hydroelectric Project
Great River Hydro, LLC

The Connecticut River Conservancy (CRC) (formerly Connecticut River Watershed Council) is a stakeholder and participant in the re-licensing process of the Federal Energy Regulatory Commission (FERC) for the three hydropower facilities owned by Great River Hydro, LLC (GRH, formerly TransCanada Hydro Northeast Inc.) on the Connecticut River: Wilder Dam, Bellows Falls Dam, and Vernon Dam. Princeton Hydro (PH) was retained by CRC to complete a peer review of the Supplement to Final Study Report, Integrated Licensing Process (ILP) Study 2 and Study 3: Riverbank Transect and Riverbank Erosion Studies, dated 11/15/2017. The Supplement to Final Study Report was in response to FERC's request to provide (i) an analysis of estimated critical shear stress, near-bank velocity, and the potential correlation of these factors with project operation at the 21 monitoring sites, and (ii) near-bank velocities associated with multiple water surface elevations (e.g., minimum flow, average project operating range, maximum project hydraulic capacity), as measured at the six sites with ADCPs. See the full wording of FERC's request below. Where necessary, this memorandum also refers to the Revised Final Study Report, dated 2/4/2017. This memorandum is a critical review of that report and aims to address the following questions as defined in 18 CFR § 5.15 Conduct of Studies (d) Criteria for modification of approved study, the RSP, and FERC's 11/29/2016 Determination on Requests for Study Modifications and New Studies – Wilder, Bellows Falls, and Vernon Hydroelectric Projects:

- Is the supplemental report now in compliance with the Revised Study Plan (RSP) dated 8/14/2013 and FERC's determination letter dated 7/21/2017?
- Were the new analyses conducted in a way that is generally accepted scientific practice?
- Are the results and conclusions valid?

Compliance with Revised Study Plan and FERC's determination letter

1. FERC's specific recommendation related to *River Transect Assessments* is as follows:

   "Because critical shear stress and near-bank velocities can play a significant role in the erosion process, staff recommends that Great River Hydro file an addendum to the revised study report by November 15, 2017, that includes an analysis of estimated critical shear stress, near-bank velocity, and the potential correlation of these factors with project operation at the 21 monitoring sites. This discussion should include a table for each monitoring site that lists critical shear stresses and near-bank velocities with respect to water surface elevations corresponding to project operation (e.g., minimum flow, average project operating ranges, maximum hydraulic capacity). For each monitoring site, Great River Hydro should describe the river channel features corresponding to each water surface elevation, including stratigraphy, the presence or absence of vegetation, the presence of any visual erosion indicators (e.g., slumps, falls, notching, undercutting), and other notable bank features (e.g., groundwater seeps)."

2. FERC's specific recommendation related to *Streamflow Velocity Analysis* is as follows:

   "…Commission staff recommends that Great River Hydro include, in the November 15, 2017 addendum, near-bank velocities associated with multiple water surface elevations (e.g., minimum flow, average project operating range, maximum project hydraulic capacity), as measured at the six sites with ADCPs. For the remaining 15 sites, staff recommends that Great River Hydro include the average velocity associated with multiple water surface elevations as calculated by the HEC-RAS model. If possible, Great River Hydro should include a discussion or estimate of the near-bank velocity for these 15 sites based on available data. Additionally, where available, this analysis should be supplemented with literature-based, soil-specific estimates of threshold velocities for each of the 21 monitoring sites, in order to determine the potential for project operation to effect riverbank erosion."

3. FERC's specific recommendation related to *Streamflow Velocity Analysis* is as follows:

   "Commission staff recommends that Great River Hydro make the requested HEC-RAS data available to stakeholders upon their request to allow for their supplemental analysis. Any data analyses filed by stakeholders in the proceeding will be independently reviewed by Commission staff."

While the Supplemental Study includes an analysis of estimated critical shear stress, near-bank velocity, and other factors regarding project operation at the 21 monitoring sites, certain elements of this study do not meet FERC's recommendation, as follows:

4. GRH did not initially make the native digital HEC-RAS model files available for review by stakeholders as recommended by FERC in (C) above. However, upon request they did provide the HEC-RAS files to CRC in a flash drive, which we were able to review briefly (see further comments later in this memo). In addition, the Hydraulic report (Appendix C) did not include model output such as graphics of the modeling domain with velocity and shear stress contours,

color-mapping, or output tables, all of which should be provided to evaluate the model's performance and accuracy. Resulting velocity and shear stress values are listed at the specific cross-section locations in the report body, but general output should also be provided, particularly in the absence of the native digital HEC-RAS model files. It is noted that standard HEC-RAS model output was also omitted from the Study 4 Hydraulic Modeling Report dated 3/1/2016; thus, no thorough evaluation of the HEC-RAS modelling effort has been performed to date.

5. Velocities measured with ADCP at six sites were not included as recommended by FERC in (B) above. Measured velocities provide a means of calibrating and/or validating the model results. PH requests the data associated with velocities measured with ADCP at the six sites as requested by FERC in (B) above.
6. While a table of values was provided for each river transect, cross-sections were not depicted showing the water surface elevations relative to bank conditions, including stratigraphy, the presence or absence of vegetation, the presence of any visual erosion indicators (e.g., slumps, falls, notching, undercutting), and other notable bank features (e.g., groundwater seeps). While Appendix A of the Revised Final Study Report (2/4/2017) included plots of transects, observed erosional features were plotted separately from water surface elevations that correspond to discharges, which differ from the discharges utilized in the Supplement to the Final Study Report (11/15/2017). Depicting all of these characteristics is essential to assess any interactions and potential correlation among the factors listed above. As this Supplement was specifically focused on the 21 transects, PH requests plotted cross-sections for each site with (i) annotations of erosional features (as depicted in the 2/4/2017 Final Report), (ii) water surface elevation fluctuation as measured by water level loggers, and (iii) the water surface elevations corresponding to the three discharges analyzed in the Supplement.

Accepted Scientific Practice

7. The methodology as described of the shear stress and velocity analysis conforms to generally accepted scientific practice. Literature references for published critical velocities and critical shear stresses are valid and applicable.
8. A preliminary review of the HEC-RAS model files yielded the following observations:
    a. Model domains appeared to cover substantial river length and over-bank areas.
    b. Of the 2-D geometries examined, it could not be confirmed if breaklines had been used to more accurately represent breaks in slope like at the top of bank or at the bottom of bank. River bathymetry appeared to be very uniform, potentially lacking detail. Topography on the floodplain appeared to be much more varied and detailed.
    c. Of the 2-D geometries examined, whole geometries were represented with a single Manning's N, or roughness, with no differentiation between in-channel roughness or floodplain roughness, which could produce erroneous results.
    d. While the model was run in "unsteady flow" (considered to be a more accurate mode), it was run at a single flow, which is functionally equivalent to running the model in "steady flow". This is atypical.

e. There were multiple model scenarios for each dam, and various dam heights and flows – a thorough outside review would require substantial time. Given the irregularities noted above and the complexity of the modeling effort, FERC should complete their own thorough examination of the modeling to confirm that standard hydraulic modeling practices were followed and that any deviations are adequately justified.

Validity of Results and Conclusions

9. The Supplemental Study diminishes the value of the critical shear stress because it does not account for cohesion, compaction, and other forces resisting entrainment. However, as reported on page 124 of the Revised Study 2 and 3 (2/04/2017), "The character of sediments in the study area creates banks with limited resistance to erosion. The bank sediments at the monitoring sites, representative of the study area as a whole, are nearly ubiquitously comprised of fine-grained and unconsolidated floodplain or glaciogenic sediments that are particularly prone to erosion (see Appendix A stratigraphic columns)." For this reason, PH believes critical shear stress is not as conservative a metric as claimed in the Supplemental Study.
10. Section 3.0 states "only 8 out of 21 sites show any potential for sediment entrainment." PH notes that this is over 30% of the surveyed cross-sections – a significant portion – and may not include the banks that have already been actively stabilized. (If the single site that had been armored is added, 9 out of 21 sites equates to 43%.)
11. The Supplemental Study reports that at least 15 sites exhibit a "beach" that fronts the bank. A "beach" feature is atypical of free-flowing rivers, but it is very common in the lower reaches of the CT River that are tidally influenced. The daily water surface fluctuation inhibits the establishment of natural vegetation on this portion of the bank; without this daily water surface fluctuation, this beach would likely re-vegetate and promote greater stability to the bank.
12. Assuming the study correctly demonstrates that near-bank shear stress and velocities during operational flows are insufficient to entrain sediment at the banks, this Supplemental Study and the Revised Study do not discount the role played by operational water surface fluctuations in perpetuating the bank erosion cycle as described in the Revised Final Study. We assert that this Supplemental Study was mistakenly focused on near-bank shear stresses and velocities, when sub-daily water surface fluctuations can still inhibit vegetation and cause bank instability. Water surface fluctuation directly contributes to bank failures that result in sediment deposits at the toe of the bank, which is then entrained, allegedly only by flows above operations. The cycle of erosion turns only when all of its elements continue to occur. This Supplemental Study does not definitively prove that project operations are not a contributing factor to bank erosion.