Memorandum

To: April Talon, PE
Durham Town Engineer

Date: September 2, 2021

Project #: 52633.00

From: Peter J. Walker
on behalf of the VHB Team

Re: Oyster River Dam at Mill Pond – Supplemental Analysis
Public Questions and Comments

Our team's responses to the Supplemental Analysis questions and comments posed by the public are provided below. We have arranged these comments in the order they were received by the Town. Note that many don't require a specific response from our team, but are included here so that the Council is aware of all the comments received. We have also compiled the original comments in **Attachment A**.

Question from Andrea Bodo on Thursday, July 15, 2021: *There has been a lot of white stuff coming over the dam the past few days…… Have to wonder what is in the watershed?*

Response: The white foam observed in the river was very likely the result of high flows interacting with naturally occurring compounds (tannins) which leach from decaying organic matter.

Questions/Comments from Doug Worthen on Wednesday, July 28, 2021: *To the Town Council, I am putting my trust in your understanding that a vast majority of Durham residents value the Dam and the Mill Pond. I also understand that the small but determined group who would like to destroy it are trying to make the removal seem inevitable, less expensive than maintenance, and somehow creating a new and "better" ecosystem. Human enjoyment and experiences are also part of Durham's ecosystem. Please consider that you would remove much more than the Dam itself should you vote to destroy it.*

Response: We acknowledge Mr. Worthen's comment in support of retaining the dam.

Comments from Sandy Blitzer on Wednesday, July 28, 2021: *I would like to express my hope that Durham will acknowledge the repeated advisories to remove the dam & restore the watershed to a more natural flow. There have been repeated studies made and all have noted that the dam removal would be both the appropriate environmental & economic choice. Please accept the advice and remove the dam & allow the water flow to resume. The Exeter dam removal is a clear example of how good it is for the environment. The current dam is not a "Historic" dam. It is a dam at an Historic site. The original dam is long gone. The concrete version present is just a replacement of a replacement of how many others at the site. It is time to remove & allow the watershed to revert to its natural state.*

Response: We acknowledge Ms. Blitzer's comment in support of dam removal.

Comments from Charles Blitzer on Wednesday, July 28, 2021: *This letter is to request the town council proceed with the obvious answer to remove the Mill Pond dam. The recent report VHB only further emphasizes that dam removal is the only reasonable way to proceed. I would like the council to pursue appropriate sources of supplemental funding that this river restoration will allow. When this is accomplished, we can look forward to an environmental restoration that has significant recreational, economic, and cultural improvements for this resource. If this is in doubt, please see Exeter River. We should have an appropriate historic marker acknowledging that there was a dam (not the current dam which is barely 100 years old) on this site.*

Response: We acknowledge Mr. Blitzer's comment in support of dam removal.

2 Bedford Farms Drive
Suite 200
Bedford, NH 03110-6532
P 603.391.3900

Comments from Andrea Bodo and Steve Burns on Wednesday July 28, 2021: *For many many years, Durham residents of all ages have been able to enjoy recreation on the beautiful historic Mill Pond. From early spring observing the first ducks, geese, birds, and waterfowl residents have delighted in the beauty of nature on the Pond, the columns of ducklings and goslings. People sit along the banks watching the activity, young children delight in the wildlife watching the turtles, beavers etc. writers, artists, boaters all come out to enjoy the area. People have written to me about their children's first steps on the banks of the pond, to the excitement of seeing the eagles and osprey. The Pond has been a focal point for Church Hill housing and people have told me how they can't wait to get up in the morning and see what is going on out on the Pond…the Milne's longtime residents, conservationists, nature lovers gave a beautiful parcel of land on the Pond so that others might enjoy the beauty of the Pond. When the weather is warmer, many people have kayaks and canoes on the Pond…the kids swim in the Pond! fish in the Pond! In Hamilton Smith's Day, there was a lit trail along the Pond where they walked in the evenings. How can you measure the value of a treasure like this? Many towns would love to have a water feature in the middle of their town. Durham is so lucky. It has one of the most scenic ponds and vistas along the MILLS SCENIC HIGHWAY Route 108. In the wintertime when the pond freezes, hundreds of kids can be seen skating on the Pond. It is quintessential New England. Sadly, the Pond has not been cared for, the gates have been closed for years, and we watch the eutrophication of a once beautiful Pond. Its fate is now before the Town Council. These places matter. "In a world that is constantly changing, old places provide people with a sense of being part of a continuum that is necessary for them to be psychologically and emotionally healthy." Please don't let the historic Mill Pond dam be lost because once it is removed, this all is gone forever.*

Response: We acknowledge Ms. Bodo and Mr. Burns's support for retaining the dam.

Questions from Suzy Loder on Thursday, July 29, 2021:

SL1) *Have Council members made a site visit to the upper reaches of the Hammel Brook* (sic) *– Oyster River – extent of the water in summer, in winter? Did they note its use for recreation in all seasons?*

Response: This question is directed to the Council.

SL2) *With potential exposure to salt water has the evolution of the pond into a saltwater mosquito breeding marsh been considered?*

Response: Mosquito species vary in their tolerance to salt water. Certain species require freshwater, while others occur only in saltwater habitats, and still others species occurring in both types of habitats. It should be expected that saltwater tolerant species may occur further upstream if the dam is removed, while intolerant species that would currently be expected to reproduce in portions of the impoundment may decline in abundance. The extent of this possible effect has not been studied specifically for either remaining alternative.

SL3) *What preparation/mitigation will be made for a repeat of the Mothers' Day flood of a decade ago? Where will all the silt go? What effect will that have on oyster culture and other activities?*

Response: This question was addressed in the November 2020 Feasibility Study. We also provided clarification on this topic in our February 8, 2021 response to questions from the Town Council. *Option 2 – Active Channel Restoration* is a recommended mitigation measure to help manage downstream migration of accumulated sediments if the town selects *Alternative 5 - Dam Removal*.

SL4) *Has the Council considered simply 'maintaining' the Mill Pond Dam as with any other facility of the town?*

Response: This was addressed in the November 2020 Feasibility Study, especially Chapter 2, and was discussed at previous public meetings. Considering its age and indications of serious structural deterioration documented by recent structural inspections, the dam requires more than simple maintenance to ensure its stability for the future. *Alternative 3 – Dam Stabilization* outlines a recommended conceptual design if the Town decides to retain the dam.

Questions/Comments from Scot Calitri on Thursday, July 29, 2021: *Thanks again April for dealing with us passionate souls. This is a crossroads for our town and the time for us to walk the talk with regards to sustainability, respecting modern science and listening to our Indigenous peoples. One key question that should help most involved understand the financial impacts: After the recent supplemental study, it seems that we're back to two choices: Remove the Dam or Repair the Dam with Dredging.*

Can you outline the costs associated with each of these two options, including invasive species mitigation estimates, ongoing dredging and dam repair needs, etc? Even more importantly, what would the cost per Durham household be for these two remaining options?

Response:

We understand that the Town's business office is planning to provide the cost per Durham household for the dam removal and dam stabilization options.

Table 1 itemizes the initial capital costs by alternative, including the invasive species management program and downstream fish passage notch (Alternative 3).

Table 1. Preliminary Estimates of Initial Capital Cost, by Alternative

	Alt 3: Stabilization	Alt 3: Stabilization & Option 1: Pond Restoration	Alt 5: Removal	Alt 5: Removal & Option 2: Channel Restoration
Construction Components	**$485,000**	**$485,000**	**$295,000**	**$295,000**
General Construction Items	$77,000	$77,000	$98,000	$98,000
Spillway Stabilization	$327,000	$327,000	N/A	N/A
Repair Scour and Undermining	$3,000	$3,000	N/A	N/A
Gated Outlet Structure	$78,000	$78,000	N/A	N/A
Spillway replacement	N/A	N/A	N/A	N/A
Raise Left abutment	N/A	N/A	N/A	N/A
Construct Auxiliary spillway	N/A	N/A	N/A	N/A
Construct Dike	N/A	N/A	N/A	N/A
Demolition of Dam	N/A	N/A	$197,000	$197,000
Environmental Components	**$156,370**	**$3,306,370**	**$129,350**	**$840,350**
Pond Restoration Dredge (Option 1)	N/A	$3,150,000	N/A	N/A
Active Channel Restoration (Option 2)	N/A	N/A	N/A	$711,000

Invasive Species Management	$91,370	$91,370	$129,350	$129,350
Downstream Passage Notch	$65,000	$65,000	N/A	N/A
General Items	**$428,000**	**$428,000**	**$308,000**	**$308,000**
Bonds & Contingency	$128,000	$128,000	$78,000	$78,000
Engineering, Design, & Permitting	$180,000	$180,000	$150,000	$150,000
Construction Phase Services	$120,000	$120,000	$80,000	$80,000
Total Initial Capital Cost	**$1,069,370**	**$4,219,370**	**$732,350**	**$1,443,350**

Table 2 provides the Life Cycle Cost for each alternative which incorporates future operations and maintenance. Please see Section 2.9.2 of the November 2020 Feasibility Study for background on Life Cycle Cost analysis. Table 2 updates the analysis to account for the additional costs for invasive species management and the construction and operation of the downstream fish passage notch.

Table 2. Life Cycle Cost Analysis, by Alternative (30 Year Analysis)

	Alt 3: Stabilization	Alt 3: Stabilization & Option 1: Pond Restoration	Alt 5: Removal	Alt 5: Removal & Option 2: Channel Restoration
Initial Capital Investment				
Discount Factor	1	1	1	1
Initial Capital Cost	$1,069,370	$4,219,370	$732,350	$1,443,350
Capital Replacement Cost				
Assumed Design Life (yrs)	50	50	N/A	N/A
Assumed CIP Cost Percentage	60%	60%	0%	0%
Discount Factor	0.412	0.412	0.412	0.412
Operations & Maintenance				
O&M Costs	$3,000	$3,000	$1,000	$1,000
Discount Factor	19.6	19.6	19.6	19.6
Total Present Cost	**$1,392,518**	**$5,321,198**	**$751,950**	**$1,462,950**

Comments from Diane Freedman on Thursday, July 29, 2021: *I hope you are well and thank you for recent Mill Pond-related correspondence. I am under the impression that questions based on the supplement report to the Mill Pond Feasibility Study are best submitted, to you, by tomorrow or end of today. I have many growing questions myself. But I am slogging through the report only now, so it is premature for me send them (and I need more time to express them clearly, in any case). As, alas, I pointed out in a kind of reality-check, protesting email earlier, I was and continued to be out of the country and without internet enough to read documents. Others also expressed dismay for the July 12 meeting without time to review the materials—but even now, more time is needed for the length of the report, a full reading of which is necessary if one is to understand the presentation or even executive summary.*

I myself have just gotten back from my remote travels and am digging in, but I (and many others, I imagine) need more time, in part because the report is technical and throws around a lot of acronyms, not all of which are defined and most of which terms, when defined, are defined after the master summary. But also because the report is long and, not being paid to be consultants, most of us have competing jobs and lives.

Quick feedback: More photographs rather than charts (and more actual and very recent studies rather than charts based on models) would be very helpful to the Council members and most others, including of prior drawn-downs with water widths indicated from those times and arrows showing projected ultimate usual and seasonal water widths—sorry my own prose here is so boggy! I would hope everyone urges the Council members to reread prior correspondence, especially because the supplemental report or supplement to the report completely leaves out the context of the value and cost to and of history, scenery, recreation, access, the existing diverse ecosystem, and property-values.

***I myself hope/intend to send a(nother) letter—to you, for VHB and for the Council, with better articulated queries, but I am wondering if there is more time to do so and wishing there were, certainly. Right now, I just want to register my intent and also disappointment about relatively tight deadlines/meetings (when I first heard that the Council would not be meeting again on action until September, I certainly thought I and others had more time).*

> **Response:** Ms. Freedman suggests that photographs of drawdown conditions would be helpful, so we have appended our complete set of photos from the September 2009 and November 2009 drawdowns to this memo. (See **Attachment B**.) Most locations should be recognizable. Unfortunately, we have no photos of the impounded reach of Hamel Brook, which we believe is of most concern to Ms. Freedman. We have included a few photos of the impounded Hamel Brook at full pond, as well as the unimpounded reach of Hamel Brook above the influence of the dam.

Questions/Comments from Larry Harris on Friday, July 30, 2021: *I listened to the VHB presentation on the follow-up report and read the document. As with the initial report, it is obvious that there is a bias towards dam removal (Option 5) and the report leaves of number of issues that have not been addressed or the implications discussed. Following are a series of thoughts and questions about the VHB report and presentation. The initial report does not have the artist's representation of restoration next to the dam presented by Peter Walker in the original power point and one has to go to the very end of the appendices to find a few of the images on the impact of dam removal on the pond system presented by Andrew Walker in the follow-up presentation after many pages of compressed profiles. One cannot help but conclude that the reports were not balanced and informative as they should be for an unbiased decision-making process. Your decision will have long term consequences for the Town. I hope you will seriously consider the issues raised by those of us who support retention of the dam and Mill Pond system.*

LH1) Tidal incursion*. The presentation and report talk about tidal incursion into the Mill Pond with dam removal. However, the power point presentation by Peter Walker in the original presentation showed an artist rendition of restoration at the dam site that included grass and shrubs that could not survive saltwater influxes. None of the drawdowns beginning with the installation of the fish ladder in 1974 have either mentioned tidal influx or seen it. Why is it so emphasized in the presentations and where is the evidence?*

> **Response:** The extent of tidal influence if the dam is removed would depend on several factors, most importantly, the final grade and size of a restored river channel, sea level rise, and changes in the streambed and adjacent marsh elevations due to subsidence or sediment migration. A review of historical tidal data at the nearest long-term NOAA tide gage (Fort Point in Portsmouth Harbor) indicates that, during 2019, the

lowest high tide reached el. 2.5 ft NAVD88 and the highest high tide reached el. 6.2 ft, which would extend approximately 150 and 3,200 feet upstream of the existing dam location, respectively, depending on changes in bed contours. This question discussed in Sections 3.2 and 3.10 of the Feasibility Study (see Figures 3.2-7, 3.2-8 and 3.10-2).

We suspect that no tidal intrusion was noted during previous drawdowns because the presence of the dam created a hydraulic barrier to upstream tidal flow.

Our team has not sought to emphasize the potential upstream tidal migration, but it is certainly an important probable effect of Alternative 5 that we believe the Town should consider when weighing the alternatives.

A second part of this question relates to whether there is a discrepancy in the rendering of post-removal conditions at the dam site in which grass and shrubs were shown. The renderings were intended to convey general information about the likely size and shape of the river channel and the general visual character expected under a dam removal scenario. Such renderings seek to present a realistic picture based on known elevations, but always require some assumptions and interpretations. We expect that the habitat that would eventually develop in the lower portion of the project area near the dam site would be tidal river with adjacent salt marsh to brackish marsh. Further upstream, the most likely outcome would be that certain portions of the impoundment would retain "freshwater" species while other areas would be dominated by salt-tolerant species, likely in bands related to tidal exposure. Herbaceous species are certainly present in these habitats, while shrubs are typically far less common.

***LH2) Sediments**. The reports detail how the sediments contain high levels of toxic chemicals and are overly high in nutrients. The current pond does sequester some of those nutrients and toxic chemicals, but dam removal would result in flushing of much of the sediments. The channel modification proposed as part of Option 5 will also require dredging, which will destabilize the sediments and result in flushing during fall storms. How is dam removal going to impact the tidal portion of the Oyster River and Great Bay, including the oyster farms adjacent to Wagon Hill?*

Response: This was addressed in the November 2020 Feasibility Study, as well as in our February 8, 2021 memo to the Council. If Alternative 5 is selected, final engineering design will develop a plan that would stabilize the most at-risk sediments; NHDES and the Army Corps would not permit a project design that would leave unstable sediments within the restored channel, or which would present a significant ecological risk to downstream resources.

***LH3) Fish runs**. One of the primary reasons given for dam removal is to restore Alewife and Blueback Herring runs. However, the report describes very limited water levels in the main pond and backwater up through Hamel Brook. There will be no vegetated quiet areas without the pond, which is what Alewives need for spawning. The only area of running water with hard substrate which Blueback Herring use will be above Thompson Lane; that stretch is short and narrow and has a resident population of Fall Fish (Semotilus corporalis), a large and predatory minnow, along with perch, bass, and pickerel. How will the juveniles of the herring survive until they are due to migrate down to the estuary in late summer? How will dam removal do anything to improve fish runs instead of eliminating them?*

Response: Based on consultation with fisheries managers at state and local agencies and our team's analysis, we conclude that the presence of the dam adversely impacts the river herring population in the Oyster River, and that its removal would benefit the resource. The dam's primary impact is related to fragmentation of the river caused by the presence of the dam, which forms a barrier to upstream and downstream fish passage. The

dam also contributes to poor water quality in the impoundment, which has been cited by fisheries managers as an important factor in the observed decline in the herring run.

Regarding blueback herring spawning habitat, the reduction of water levels in the lower portion of the Oyster River, between Thompson Lane and the confluence with Hamel Brook is likely to increase the preferred spawning habitat somewhat. The loss of the shallow vegetated pools at Mill Pond may, however, decrease the overall surface area available for alewife spawning. It is important to remember that these species have habitats preferences, and that presence of the preferred habitat optimizes productivity, but NHF&G and other fishery agencies have observed successful reproduction in other habitat types as well.

VHB has asked fisheries managers from New Hampshire, Massachusetts, and Maine whether any previous dam removals have caused elimination of an anadromous fish run. We have not seen any documentation that a dam removal has caused elimination of a naturally occurring anadromous fish run in New England, but clear evidence exists for the increase in fish counts following dam removal or modification.

***LH4) The Notch**. The report did have a very short section on a notch to allow migratory herring and their young to depart the pond during low flow periods. 2020 was not unique as a low flow year. Die-offs of both herring species have been occurring due to lack of water flowing over the dam for many years without any effort to address this issue either with a notch or a fish ladder that would allow exit of migratory herring species. Why was this issue not addressed since it has been a recurring problem and is one of the reasons given for dam removal (see section 3)?*

Response: The Supplemental Analysis included development of a downstream fish passage notch in direct response to this concern. If Alternative 3 is selected, then the team recommends installation of a notch to allow for flexibility in managing downstream flows for fish passage.

***LH5) Pond ecosystem**. The current pond and backwater support a diverse and rich assemblage of wildlife, including frogs, turtles, fish, birds, and mammals. The projected width and depths of the pond and backwater will not support that community, but the exposed areas of the former pond will support a rich growth of invasive species (observe College Brook adjacent to the Mill Plaza for a preview). Why did the report say nothing about what the impact of dam removal would be on the current aquatic ecosystem?*

Response: Sections 3.8 through 3.12 of the original Feasibility Study provided a discussion of the existing aquatic ecosystem present in the impoundment, including fisheries, wildlife, wetlands, rare species, and invasive species. These sections did, in fact, discuss the probable effects on these resources from dam removal. The Supplemental Analysis extended the analysis of the potential for invasive species impacts in consultation with several local experts.

Clearly, the presence of the dam is a major ecological factor that helps to determine the types of plant and animal species that occur in the impounded reach, as well as their distribution and abundance. Dam removal would cause substantial change which would decrease habitat for some warmwater species, while benefitting other species which prefer free-flowing riparian and wetland habitat. Many dam removals have occurred throughout the northeast and the nation, and the changes that result from returning a river to a free-flowing condition generally have been welcomed by the ecologists and resource managers involved in those projects since they tend to favor native/sustainable ecological processes and have demonstrable benefits. The impacts and benefits of dam removal have been documented in both peer-reviewed and gray literature.

In this specific case, it is important to bear in mind that it is the imperiled anadromous fishery that is most likely to benefit from removal, although that may come at a cost of local habitat for other warm water freshwater species. Overall, the anadromous fishery in the Oyster River is one component of a critical regional resource that supports the larger Little/Great Bay estuary and the Gulf of Maine as a whole. Based on input from professional fisheries managers at state and federal agencies, our team has concluded that the presence of the dam is a primary factor in the decline of the anadromous fish population due to the loss of habitat connectivity and declining water quality in the system.

***LH6) Recreation**. The Executive Summary mentions recreational activities on the pond, but the report says nothing about them. The pond and backwater provide a diversity of recreational activities that are most obvious in the winter when ice skating, snow shoeing and cross-country skiing are in evidence. Fishing, kayaking, canoeing, and paddle boarding are available the rest of the year, not to mention wildlife viewing. Why was the loss of all these recreational activities not addressed?*

Response: The November 2020 Feasibility Study discusses recreational resources and impacts. (Recreation was not included among the list of questions posed by the Town Council for the Supplemental Analysis.) Clearly, recreation on the impounded portion of Mill Pond and Hamel Brook will change substantially if the dam is removed, which is an important consideration for the community. Most notably, flatwater paddling and winter skating, snowshoeing and skiing on the Hamel Brook and Mill Pond portions of the impoundment will be significantly reduced or eliminated. Other forms of recreation, including fishing and wildlife viewing will change but would still be available.

Questions from Janet Mackie on Friday, July 30, 2021:

***JM1)** Why was only one method of Mill Pond aeration discussed, when there are other methods that are more practical, useful, and inexpensive to improve oxygenation and lower temperature?*

Response: A range of oxygenation/aeration techniques were screened by Don Kretchmer, a Certified Lake Manager. Of those, side stream aeration was evaluated in somewhat more detail in part at the request of the Town Council and previous public commenters. Most aeration techniques involve releasing air or oxygen at depth. Oxygen dissolves in the water as the bubbles rise. Mill Pond is so shallow that this would be a very inefficient process as there is not enough water column to dissolve sufficient oxygen. All of the common aeration and oxygenation techniques require shore based and in-pond infrastructure as well as ongoing power needs similar to the side-stream aeration. Costs would be expected to be in the same range or higher.

***JM2)** Why was a formula invented to show there is no water starvation of the Mill Pond caused by the Oyster River Reservoir dam, when Durham residents witness periods when no water flows over the crest of the UNH dam and the level of the Mill Pond falls below its dam?*

Response: The project team developed a detailed mass balance model of streamflow available to both the Oyster River Reservoir Dam and to Mill Pond to better understand the relationship between those two impoundments, their function, and their watersheds. The mass balance approach that we took in the Supplemental Study is a common approach in answering hydrological questions. Most run-of-river dams in New England experience one or more periods during summer low flows when no flow occurs over their primary spillway, which is one of the adverse effects of such dams, as is the case for these two dams. The mass balance model was designed (as requested by Town Council) to determine whether the Oyster River Reservoir

Dam and the associated drinking water withdrawals impact Mill Pond, including the duration, severity, and frequency of those periods when no flow occurs over the Mill Pond Dam spillway. The effect of the Oyster River Reservoir Dam is documented in the Supplemental Analysis Report. In short, a noteworthy impact to Mill Pond due to drinking water withdrawals occurs during droughts such as occurred during the summers of 2016 and 2020.

JM3) *Why is there no graph illustrating the 2015-2020 data filed at DES by UNH showing the days when no water tops the crest of the UNH Oyster River Reservoir Dam?*

Response: No such graph was included simply because a single graph of the entire 2015-2019 period, for which water level records were provided to the project team, would be illegible and would have taken up a great deal of space. We have attempted to summarize the historical operator data in **Table 3**.

Table 3. Number of Dry Spillway Days, Oyster Reservoir Dam

Year	Total Dry spillway days	Dry spillway days minus fall maintenance drawdown activities
2015	5	5
2016	59	35
2017	0	0
2018	40	15
2019	0	0
2020	78[1]	69[1]

Note: Data for 2015-2019 are from historical treatment plan operator records. Data from 2020 represents the output of the mass balance model, since no historical data was available for 2020.

Note that a "dry spillway" day was defined as a day in which the average reservoir level was less than 0.01 ft above the spillway invert. The number of days that the Oyster River Reservoir Dam's primary spillway was dry is complicated by two factors: 1) the occurrence of two maintenance drawdown events in September and October in 2016 and 2018; and 2) the fact that historical records of water level were visually estimated by operators at the water treatment plant adjacent to the dam rather than measured by hand or with automated equipment. A comparison of available data, however, indicates that during an extended period in August-September 2016, and to a lesser extent in 2018, many of the dry-spillway days occur when the upstream USGS gage data indicates that inflow to the reservoir were roughly one order of magnitude smaller than drinking water withdrawals and yet the observed reservoir levels remained unchanged for days, even weeks, at a time. This pattern suggests that some operators would, at times, record a default depth when the reservoir level was at or below the spillway invert.

JM4) *Why was phosphorus pollution dismissed as an impossible-to-remedy situation when many houses near the river have public sewer, not septic systems?*

Response: The Supplemental Analysis does not dismiss phosphorous treatment as an impossible-to-remedy situation. The VHB Team has consistently stated that non-point source control of stormwater is a valuable strategy to pursue, regardless of whether the town decides to stabilize the dam or to remove it. The Supplemental Analysis examines a specific question posed by the Town Council: Will the BMP program described in the 2018 Mill Pond Nutrient Control Measures report address the water quality issues within the Oyster River and Mill Pond? The analysis demonstrates that it will not, and that a much more extensive program would be needed to improve Mill Pond and eliminate its eutrophic condition.

The presence of a public wastewater collection system near the river certainly helps to reduce phosphorous loading. However, the Mill Pond watershed is large, and contributions of phosphorus are from a variety of sources. In addition to septic systems near the river, these include soil erosion, residential and agricultural fertilizer, pet and livestock manure, impervious cover, roadway runoff, waterfowl, and direct atmospheric deposition, among others.

JM5) *Why was phosphorus pollution dismissed as an impossible-to-remedy situation when phosphates were eliminated from household detergent products many years ago?*

Response: See answer to **JM4**. There are many sources of phosphorus in the watershed.

JM6) *Why was phosphorus pollution dismissed as an impossible-to-remedy situation when USGS maps show the Oyster River watershed is not a source of phosphorus from naturally occurring minerals?*

Response: As mentioned above, phosphorous loading is mostly a function of human induced effects on the landscape, which greatly increases the amount of phosphorus contained in runoff and the mobility of that phosphorus downstream.

JM7) *Why was phosphorus pollution dismissed as an impossible-to-remedy situation when most stormwater in Durham is collected by the sewer system and discharged into the Oyster River below the Mill Pond dam?*

Response: We believe this comment refers to the Durham wastewater treatment facility which discharges to the tidal portion of the Oyster River downstream of Mill Pond. Durham does not have a combined stormwater and sanitary sewer system. Stormwater is collected in a separate storm drain system or flows across the land surfaces and typically drains into the nearest water body or wetland, typically without effective treatment. Stormwater from the College Brook watershed, which includes a large portion of the UNH campus and developed portions of Durham around the Mill Road Plaza, Mill Pond Road and the Faculty Road neighborhood drains into the Oyster River above Mill Pond as well as portions of Nottingham, Lee, Barrington and Madbury. These areas all contribute to the phosphorus load to Mill Pond.

JM8) *Why were no specific point sources of agricultural phosphorus pollution considered, such as the huge Moore fields on Mast Road farmed by UNH?*

Response: The Supplemental Analysis did not attempt to identify any specific source of nutrient loading due to the size of the watershed, and the large number of individual contributors. Rather, the model examines categories of land uses. The Supplemental Analysis sought to determine the scale of the watershed loading problem rather than presenting a prescriptive plan to remediate individual sources.

The team does not have any specific data relative to Total Phosphorous (TP) contributions from Moore Field. It is one of many sources in the watershed, but Ms. Mackie correctly points out that agricultural land uses are often a major source of nutrient loading. A specific assessment would require researching the fate and transport of Total Phosphorous (TP) from the manure applied to the fields. We note that TP is much less mobile than Total Nitrogen and does not necessarily infiltrate but moves with eroded soils. Regardless of the selected alternative, the team believes that a partnership with UNH to better understand nutrient loading and to determine whether additional measures to control runoff would be a valuable step in a non-point source program. To produce meaningful improvements in Mill Pond, various management and structural BMPs would be needed for a variety of TP sources including the Moore Fields as well as much of the impervious cover area and lawn area in the watershed. It is quite likely that as much or even more TP is applied to all of the lawn area in the watershed as compared to the agriculture fields.

JM9) *What data supports VHB's statement at the TC presentation that the amount of water flowing through the Mill Pond does not alter the characteristics of the water around the vegetation outside the main channel?*

Response: This statement is based both on observations of the channel orientation as well as water quality data from the Wollheim Lab. The juxtaposition and orientation of the main channel relative to the side shore areas as well as observed location of several pockets of woody aquatic vegetation along the main channel appears to direct or confine flow within the channel area under most flow conditions. This is evident in that the surface accumulations of algae and duckweed does not change during most summer storms. Also, dissolved oxygen data collected and analyzed by the UNH WASG group at various locations within the Mill Pond prior to and following several storm events showed no improvement in dissolved oxygen levels in the side shore areas while brief increases in DO levels were observed within the main channel. The fact that similar DO spikes were not observed in the side shore areas would suggest that not much flow from the main channel is circulating or mixing into the side channel areas even with small to moderate increases in flow conditions or that any increased DO inputs to side areas due to greater exchange from the main channel is used up at a similar rate as under low flow conditions.

JM10) *What data supports VHB's continued characterization of the Mill Pond as a lake, with emphasis on its size relative to the size of the watershed, when the Mill Pond only exhibits certain characteristics of a lake during the late summer when the river flow is cut off by the UNH dam?*

Response: The characterization as a lake is only relevant in that there is a portion of the phosphorus load that is retained in a lake. As the flushing rate increases and the volume decreases, the amount of settling is reduced. For Mill Pond the amount of settling is very small due to the rapid flushing rate so the concentration of phosphorus in the pond is similar to that which enters the pond. Both are extremely high.

JM11) *Why is there no discussion that the Exeter River is still classified as an Impaired Water by DES after the removal of the Exeter dam?*

Response: The reach of the Exeter River formerly impounded by the Great Dam is no longer listed as impaired by NHDES.

For monitoring and reporting purposes, NHDES typically divides a river into multiple "assessment units" (AUs) based on the distinct physical and hydrological characteristic of its various reaches. The Exeter River has many such units.

NHDES had listed the entire lower Exeter River impoundment from the Great Dam upstream to the Pickpocket Dam, comprising approximately 7.5 river miles, as impaired since 2006 due primarily to low dissolved oxygen levels and elevated *E. coli* bacteria levels, similar to Mill Pond. Following the dam removal in 2016, NHDES collected water quality data from the formerly impounded river reach in July 2017. These data allowed NHDES to remove the impounded assessment unit (AUID NHIMP600030805-04) and its associated impairments from the 303(d) list. The now unimpounded reach of the Exeter River (AUID NHRIV600030805-32) has no listed impairments - except for mercury in fish tissue, which is an impairment currently applied to all surface waters in NH.

Ms. Mackie may be referring to a reach of the Exeter River in Brentwood and Fremont (NHIMP600030803-03) which *is* listed as impaired in the draft 2020 303(d) list. This portion of the Exeter River is far above the reach of the river formerly influenced by the Great Dam, but is impounded by a different dam.

JM12) *Will the Oyster River still be classified as Impaired by DES if the Mill Pond dam is removed?*

Response: It is difficult to predict with certainty because of the elevated *E. coli* level impairment. But based on the water quality improvements in the Exeter River following removal of the Great Dam, it seems reasonable to expect that the impairment listing will be removed, especially for the dissolved oxygen and chlorophyll *a* impairments. Any such change in listing status would need to be supported by water quality monitoring data collected by NHDES as part of their statewide assessment program.

Questions from Scott Bogle on Friday, July 30, 2021:[1]

SB1) *If Hamel Brook at the juncture with the Oyster River is only 4 feet wide at 2.5 CFS flow how wide and deep is it at 0.6 CFS – less than a quarter of the modeled flow rate? How wide and deep are the Brook higher up where it is connected to the Foss Farm trail system, and the River between the Hamel Brook split and the Milne Sanctuary at 0.6 CFS? How hospitable are those further diminished waters to herring young that remain in fresh water until late summer and fall, and to the broad range of other aquatic life that currently live in the impoundment?*

Response: The 4-foot top width of Hamel Brook during low flow conditions, typified by the average summer inflow of 2020 – is mistakenly indicated to occur at the mouth of Hamel Brook. In fact, the model cross-section from which that value is extracted is identified in the supplemental report as "RS 1558.227," which is approximately 1,558 feet upstream of the confluence of Hamel Brook and Oyster River. The Foss Farm trail system first approaches Hamel Brook approximately 750 feet upstream of that confluence. Another trail within that system parallels Hamel Brook from about 1,200 feet upstream of the confluence to the upstream limit of the impounded portion of the brook, a total of approximately 2,400 feet upstream of its confluence with the Oyster River. Therefore, model output from RS 1558.227 is an appropriate representation of the portion of Hamel Brook that is of interest to Mr. Bogle.

The 4-foot width value is associated with average summer flows during 2020, when approximately 2.47 cfs were entering Mill Pond on average, of which 0.24 cfs were originating from Hamel Brook. If Hamel Brook

[1] Mr. Bogle's comment letter contained important additional background information. For brevity, we have included only the direct questions posed in his letter. Reviewers should also read Mr. Bogle's original comment letter for more context and information. See **Attachment A** for his complete letter.

flows were a quarter of that, the brook width at RS 1558.227 would decrease from 4 feet to 2.4 feet under dam-out conditions. Please note that the cross-sections that define Hamel Brook in the hydraulic model were developed from 10-12 bathymetric survey points each, spanning from one floodplain to the other. While this is standard for hydraulic models of this type, this result should be interpreted carefully since the cross-section geometry is approximate. The model and its cross-sections were instead developed to understand, generally, the differences between dam-in and dam-out conditions across a wide range of flow conditions and at many locations within the existing impoundment.

Regarding the decreased stream widths and depths, please see our team's response to Questions **LH3** and **LH5** above.

SB2) *What does the Mass Balance Model show for channel depths and widths when late summer water withdrawals leave no flow over the upper dam and removal of the Mill Pond dam leaves no water impounded?*

Response: The mass balance model results that were representative of drought conditions, typified by the summer of 2020, are highly applicable to the situation posed by this question as the Oyster River Reservoir Dam was likely not spilling for much of August and September 2020. These conditions were simulated with the HEC-RAS hydraulic model of the Mill Pond Dam impoundment and the rest of the modeled Oyster River-Hamel Brook system. The results of those analyses were presented in the Supplemental Analysis Report and associated Town Council presentation.

SB3) *How would one day of no water flow below the dam in August and September impact juvenile herring and other fish living in the river and brook in the absence of impounded water? Three successive days? Five successive days?*

Response: Reduction or interruption of river flows due to upstream impacts can be expected to reduce habitat quality and present a stressor to juvenile herring, with the magnitude of this impact increasing with increased duration.

SB4) *Can we reliably say that extreme low flows related to drought conditions observed in 2002, 2016 and 2020 will not happen more frequently than every 20 years given accelerating climate change? Is the Town Council willing to bet on that?*

Response: As noted in our response to **LH4**, above, the summer of 2020 was selected to provide a snapshot of extreme low flow conditions in Mill Pond. In fact, based on the mass balance model output, inflows to Mill Pond were estimated to be lower during portions of the summer of 2020 than at any other time over the five-decade period from 1970-2020. Climate science research and guidance documents are consistent in their findings that weather and climate extremes will become more commonplace. For instance, periods of high temperature and low rainfall will increase in New England, causing more severe and more common drought conditions. We can see that trend in monthly average streamflow data recorded at the USGS Oyster River gage. For instance, between 1970 and 1995, the lowest monthly average flow that was recorded over that 25-year period was 0.865 cfs in August 1974; the second lowest monthly average flow over that period was 0.919 in July 1993. During the next 26 years, from 1995 to 2020, there were twelve months with average flows of less than 0.919, the two lowest, 0.363 and 0.398, occurring in September 2016 and September 2020, respectively. In short, drought conditions are already becoming more severe and more common.

It is important to note that the drought conditions experienced during the summer of 2020, and 2016 among others, are detrimental to the health of flora and fauna in both impounded and free-flowing habitats and in freshwater and brackish tidal ecosystems. Fish strandings that have been observed at Mill Pond Dam during many recent summers are evidence of this.

SB5) *Given anticipated lows for flow, channel depth and width identified during August and September and water withdrawal periods, and without the water volume of the impoundment, please identify 2-3 other tidal rivers in the eastern United States with approximately those conditions and their annual herring runs over the past 10 years.*

Response: We consulted with fisheries experts at NHF&G, the Massachusetts Division of Marine Fisheries, and the Connecticut Division of Fisheries. These experts suggested that the Parker River in Newburyport, Massachusetts, Brides Brook in East Lyme, Connecticut, and Town Brook in Plymouth, Massachusetts would be comparable tidal rivers. **Table 4** below provides data on each of these streams, along with the Oyster River. Direct comparison among the four streams is not possible due to the number of factors that influence the size of fish runs. However, the data does indicate that even small streams can host productive diadromous fisheries.

Table 4. River Herring Counts at Select New England Rivers, by Year

	Oyster River	Parker River, MA	Bride Brook, CT	Town Brook, MA
Drainage Area	**20.2 sq mi**	**24.9 sq mi**	**3.7 sq mi**	**9.0 sq mi**
Length	**1.7 mi[1]**	**7.0 mi[2]**	**2.5 mi[3]**	**1.6 mi[4]**
Year				
2010	19,006	1,800	164,149	195,091
2011	4,755	3,624	196,996	142,633
2012	2,573	5,416	287,003	171,141
2013	7,149	7,149	354,862	107,413
2014	4,227	7,189	260,926	135,737
2015	1,803	19,852	218,076	173,567
2016	863	75,202	147,552	199,368
2017	4,492	31,869	397,805	160,668
2018	5,716	31,217	400,008	185,071
2019	4,969	39,321	296,703	230,860
2020		29,925	409,115	190,810
2021			244,090	136,626

Notes:

1 From the Mill Pond Dam to the Oyster River Reservoir

2 From head of tide to dam at Pentucket Pond Outlet Reservoir

3 From head of tide to a small pond upstream of N Bridebrook Rd., which appears to be the approximate end of a significant waterway

4 From head of tide to the Billington Sea outlet

SB6) *Please provide revised comparative graphics that: 1) focus only on the area of the impoundment to achieve a scale suitable to better show differences in the scenarios; and 2) include a true extreme drought low flow scenario equivalent to flow levels from September 2020 (or September 2016 or September 2002).*

Response: We replotted the original inundation maps at a scale of 1 inch = 200 ft. Please see the figures in **Attachment C**.

SB7) *What can be expected to happen to fish and other fauna that depend on the current aquatic habitat if that habitat is reduced by 75%-80% with elimination of the dam (and more in true drought conditions as exemplified by August and September 2020)?*

Response: This question is similar to one posed by Larry Harris. Please see the response to Question **LH5**.

SB8) *If poor water quality was in fact an issue throughout the impoundment how is it that these species seem to be functioning just fine? Are these species of fish more tolerant of sub-optimal water quality than herring? Do they simply avoid those sections of the impoundment with more impaired water quality?*

Response: We do not have any data on existing fish populations within the impoundment with which to assess the health of the existing fish resource. But, anecdotal information and our team's observations indicate that the species present within the impoundment are tolerant of warmwater, which is typical of shallow ponds and impoundments in New England. Warmwater freshwater fish species (e.g., bass, sunfish, catfish) have evolved to survive in stagnant, relatively low DO systems. And even those warmwater species may be forced out of areas of the impoundment or to the better oxygenated surface and edges rather than using the entire impoundment. Anadromous fish and salmonids have a much higher oxygen demand and lower temperature requirements.