

**AGREEMENT FOR PROFESSIONAL SERVICES  
BETWEEN  
VANASSE HANGEN BRUSTLIN, INC.  
AND  
THE TOWN OF DURHAM, NEW HAMPSHIRE  
VHB PROPOSAL NO. 81978.19  
September 12, 2019**

This Agreement is composed of Part I and Part II. Part I includes this scope description containing the details of the services to be performed and compensation. Part II contains the Terms and Conditions of Agreement, which are the general terms of the engagement between the Town of Durham, also called the "TOWN" or the "CLIENT," and Vanasse Hangen Brustlin, Inc. ("VHB") also called the "CONSULTANT" or "ENGINEER." Specific tasks included in this agreement are described in the Scope of Work provided below.

The project consists of a feasibility study of the potential removal of the Oyster River/Mill Pond Dam in the Town of Durham, New Hampshire. The study will supplement previous studies and would provide additional information to facilitate the Town's selection of a preferred alternative. VHB will be the lead consultant for this scope of work with overall responsibility for the study. Additional members of the VHB Team include: Pare Corporation, responsible for dam structural engineering; Weston and Sampson (W&S), responsible for hydrological and hydraulic modeling tasks; Independent Archaeological Consultants (IAC), responsible for archaeological field work; and Dr. Wilfred Wollheim, who will assist by providing water quality data and analysis.

**A. SCOPE OF WORK**

The following outlines our team's proposed approach to performing the tasks identified in the Request for Qualifications (RFQ).

**TASK 1. DATA COLLECTION & REVIEW**

**1.1 Collect and Review Available Data**

The VHB Team will collect and review available data and resource information on file with the Town of Durham, New Hampshire Department of Environmental Services (NHDES), New Hampshire Fish & Game Department (NHFG), National Oceanic Atmospheric Administration (NOAA), US Army Corps of Engineers (ACOE), US Fish and Wildlife Service (USFWS), other federal agencies and other applicable sources. These studies will include the following:

- 2018 NHDES Dam Bureau Letter to Town Re: Hazard Classification
- 2018 NHDES Dam Bureau Letter of Deficiency
- 2018 NHDES Dam Bureau Letter of Closure for 2002 Letter of Deficiency
- March 2018 Weston & Sampson Mill Pond Report
- 2014 Durham Ponds Assessment and Plan
- Mill Pond Dam 2010 NHDES Dam Bureau Letter

- Oyster River Dam Concrete Final Report July 2011
- 2010 Stephens Associates and Dr. Gress - Final Dam Concrete Evaluation Report
- March 2010 Dr. Gress - Final Report March 2010
- 2009 Oyster River Mill Pond Study Final Report
- 2008 Stephens Associates Relative Cost Comparison of Dam Rehabilitation vs. Decommissioning
- 2007 NHDES Dam Bureau Inspection Report
- 2002 NHDES Letter of Deficiency
- 2000 Inspection Report
- Historical Documentation of the dam and adjacent properties
- Property deeds for the dam and adjacent properties, if available
- Design plans for Longmarsh Road culvert upgrade
- As-built plans for NH Route 108 over Oyster River

VHB assumes that the Town will provide documents in PDF or hard copy format.

### **1.2 Dam Inspection**

During this task, Pare will complete field reconnaissance to complete a detailed visual inspection and document the current condition of the dam and regulating structures. The condition of the structure will be reviewed by means of a physical inspection of the dam and its appurtenant structures. The inspection will be visual in nature and will include accessible portions of the dam and its abutments, downstream area, spillway, fish ladder, and gate structures. During the inspection, a relative elevation survey will be performed to identify degree of potential settlements and verify dimensions as compared to available design information. Should evidence of displacements, advanced structural deterioration, or other indications of changing conditions be identified, recommendations for warranted further evaluations will be provided. General dimensions, locations, and descriptions of noted deficiencies will be recorded for incorporation into the final report.

The inspections will be completed by a team with expertise in dams, hydrology, geotechnical, structural and hydraulic engineering. The inspection team will be under the direction of a registered professional engineer. During the course of the inspection, digital photographs of specific deficiencies, as well as photographs of general alignments and configurations will be obtained for record and comparison to existing photographs. Photographs will include a scaled reference, when appropriate, and will be indicated on a site sketch depicting the approximate location and direction of the photograph.

During the fieldwork, the inspection team will interview the dam operator or caretaker to discuss operation and maintenance activities at the dam, current developments at the dam, and other information pertinent to the assessment of the dam's performance.

Inspection of the dam will be performed during near normal pool elevations, but with a slight drawdown to allow inspection. Prior to the inspection, the Town will be requested to lower the level of the impoundment to the spillway crest to allow access for tactile inspection of the Ambersen dam structure. (Note: NHF&G may require prior notification to lower the impoundment.) Lowering or draining of the impoundment below the spillway crest prior to inspection removes the normal load on the structure

and may obscure certain conditions that might otherwise be detectable if inspected under the normal operating environment of the structure, while elevated water levels limit accessibility and inspections of spillways, outlets and features along the upstream face.

The results of the above work will be summarized in a report detailing the findings of the inspection, progression of previously reported deficiencies as compared to those identified within previous reports, and commentary on the structural stability of the various dam components. The report will be stamped by a professional engineer registered in New Hampshire.

As part of the inspection and report, the Team will also provide discussion regarding the current hazard potential classification, potential impacts should the dam fail, and review of the appropriate hazard classification based upon current dam safety regulations.

A draft report will be prepared and submitted in PDF format via email to the CLIENT for review and discussion prior to report finalization. One (1) hard copy of the final report will be provided to the CLIENT along with one (1) PDF copy.

### **1.3 Geotechnical Investigation**

A subsurface exploration program will be completed at the dam site to assess current foundation conditions underlying the existing dam structure. Data collected as part of this task will be utilized to further assess the global stability of the various gravity structures of the dam to further the initial understanding of stabilization needs in the event of a repair program, foundation requirements in the event of a replacement program, and stream stabilization requirements in the event of a dam removal program.

Under this task, Pare will review existing geotechnical information for the site. Based upon findings of the review, an exploration program will be finalized to collect sufficient information to support the preliminary development of requirements for the dam. For the purposes of this proposal, it is assumed that the exploration program will consist of two (2) borings completed in the area immediately upstream of the spillway and gated outlet structure. Each boring will be advanced to a depth of approximately 15 feet below the mudline. If shallow bedrock is encountered, one rock core will be completed up to a depth of 10 feet to confirm the presence and quality of the rock. Up to one (1) day of additional probes will be completed within the impoundment upstream of the dam to identify bedrock elevation upstream of the dam. The explorations will be completed by a drilling subcontractor and are anticipated to be completed utilizing a track-mounted drill rig operating on a barge within Mill Pond.

Prior to commencing the subsurface exploration program, Pare will file a Locate Request Form with Digsafe and coordinate locating private utilities with the Town and local utilities.

It is anticipated that the explorations can be completed with two days of drilling, plus additional time for mobilization and site access. During the progression of the work, the program will be adapted to remain within the planned duration and budget to the extent practical; should conditions warrant an extended duration, Pare will coordinated with the CLIENT prior to extending the duration of the program.

Pare will provide a field engineer to classify the samples retrieved during the sampling procedures, and to generally coordinate the subsurface exploration program. Pare will prepare typed logs of the test borings for incorporation into the contract documents.

It is assumed that no hazardous or contaminated materials are present at the site. If it is determined that these conditions exist, remediation of said conditions may be added to this scope upon CLIENT approval of an amendment to this agreement. It is also assumed that the Town will open the gates at the dam to reduce pond levels sufficiently to limit the current in the spillway approach to allow for safe anchorage of the barge and completion of the exploration program. At the completion of the subsurface investigation, sieve analyses will be completed to verify field visual classifications, refine soil properties, evaluate the potential for reuse, and develop a grain size distribution of the overburden material.

Findings of the exploration program will be incorporated within project evaluations and deliverables; no separate Geotechnical Report is expected.

## **TASK 2. FIELD SURVEY AND BASE MAPPING**

Field surveys of the Mill Pond Dam and a portion of its impoundment were conducted in 2008-2009. Critical elevation and dimensional details of the dam were field surveyed, and a bathymetric map was produced. To supplement this survey and produce a complete base plan, VHB will provide additional survey as described below.

### **2.1 Field Survey, Property Research, and Monument Location**

VHB will perform limited property research for the parcels on Mill Pond from the College Brook confluence, downstream to the Newmarket Road pedestrian bridge. Parcel owners will be identified, current deed references and record plans for each parcel will be obtained for the dam site and abutting properties within approximately 1000-feet upstream and 200-feet downstream of the dam. Observed evidence (bounds, iron pipes, fences, walls, etc.) of the property lines on the pond/river will be field measured and compiled with record data to determine the approximate location of the property lines. (Note: Limited property line field work and analysis will be performed. This scope item is not intended to provide a complete survey of entire parcels, but rather to determine the approximate location of property lines directly adjacent to the river and main impoundment.) Property lines will be shown graphically, and record easements will be obtained and shown on the Existing Conditions plan in Task 2.3.

### **2.2 River and Impoundment Survey**

#### **2.2.1 Dam Structure Survey**

VHB will conduct an on the ground field survey to depict the existing dam structure and fish ladder. The limits of survey coverage will extend 50 feet outside of the dam structure. Specific features captured will include the spillway invert/crest elevation, spillway bent locations, upstream edge of the spillway at the pond bottom, and gate opening sizes and inverts. In addition, to assist with the hydraulic analysis, bridge elements such as piers, abutments, beams, girders, and wingwalls will be surveyed at the NH 108 bridge and the pedestrian bridge.

### **2.2.2 River/Impoundment Survey**

Up to 14 cross-sections will be obtained on the ground to supplement the existing bathymetric survey. The general location of these cross sections will be southerly along Hamel and Longmarsh Brook. This survey task includes:

- Detailed cross-sections will be surveyed at up to four locations – include one existing model cross-section and three proposed new cross-sections. Detailed bathymetry will consist of top/bottom of bank on both sides and 5-10 shots between the bottom of bank. There is potential for depths as great as 10-15 feet at these four cross-sections.
- Simple cross-sections at 10 proposed locations, which will consist of top/bottom of bank on both sides and at least one shot at the deepest point in the channel.
- Approximately five shots on roadway/curb surfaces at the three road crossings: at an existing Class VI road crossing of Hamel Brook, at NH 108, and at Longmarsh Road. These shots are needed to support the modeling of the crest profile where the water will first crest.
- Five shots to define the crest of a potential dam structure on Hamel Brook upstream of NH 108. This survey would locate the spillway or outlet pipe and obtain elevations of its sill or of the inlet/outlet inverts.

VHB will utilize a combination of traditional survey methods and GPS equipment to accomplish the above tasks. Additionally, VHB will obtain statewide LIDAR survey of the downstream portion of the Oyster River from the dam site to approximately the Durham Waste Water Treatment Plant and incorporate these data into the Existing Conditions Plan.

### **2.3 Existing Conditions Plan**

Data from Tasks 2.1 and 2.2 will be collected and post processed to produce the existing conditions base plan. This plan will serve as the source for the analysis of dam removal alternatives and public presentations. Drafting will be performed using AutoCAD. Plans will be prepared depicting the data in plan view and cross section view at an appropriate scale.

## **TASK 3. DETERMINE APPROPRIATE SCENARIOS and DEVELOP ALTERNATIVES**

### **3.1 Develop Conceptual Alternatives**

Under this task, the VHB Team will develop a preliminary list of conceptual alternatives, with preliminary conceptual sketch plans and engineering analysis. It is expected that up to eight conceptual alternatives will be developed, within the following general categories:

- No-Action
- Dam Removal with River Restoration
- NHDES Reclassification (per NHDES letter dated September 20, 2018; see also Task 5)
- Repair/Stabilization of the Existing Dam

- Reconstruction/Rehabilitation of the Dam

A repair/stabilization program would include measures to address areas of noted concerns (i.e., concrete deterioration) as well as modifications to the abutments to protect the dam from overtopping. Reconstruction/Rehabilitation would include complete replacement of portions or the entire dam and may include elements such as raising the crest of the dam and extending the dam into the abutments, replacing the spillway and gated outlet structure with a new spillway with effective lengths sufficient to accommodate the spillway design flood, permanent normal pool lowering, or other concepts identified during this phase of the work. Additionally, the Reconstruction/Rehabilitation alternative would include a discussion of the scope and costs of pond restoration through dredging, which would be further evaluated during the Alternatives Screening process described in Task 3.2.

During the early phase of the analysis, alternative designs would be conceptual in nature and intended to allow for the screening of preliminary alternatives. For each alternative identified, general sketches of the alternatives will be developed to facilitate preliminary screening, feasibility consideration, and evaluation of comparative magnitudes of project costs.

### **3.2 Alternatives Screening**

The VHB Team will work with the Town to finalize a set of screening criteria to evaluate the alternatives described above to identify a range of reasonable alternatives to be carried forward for modeling and impact assessment. Screening criteria are expected to be related to the following factors:

- Ability to Comply with NHDES Letter of Deficiency (LOD DSP #18-010) and Dam Safety Regulations
- Engineering Feasibility
- Conceptual Cost
- Constructability

It is expected that some of the alternatives described above will be eliminated during the alternatives screening process. Others will be identified as “reasonable” (i.e., feasible and acceptable) and carried forward for detailed analysis. This task will include development of a summary matrix to report the alternatives screening. Once completed, the VHB Team will meet with the Town to confirm the list of reasonable alternatives, and a final summary will be produced that will include brief descriptions of the conceptual alternatives, screening criteria and results, and the basis for eliminating certain alternatives or options.

### **3.3 Preliminary Plans**

Upon identification of feasible and acceptable alternatives, Pare will advance the sketches developed as part of previous phases to a schematic design level to facilitate a comprehensive comparison of the reasonable alternatives. Preliminary designs for each of the reasonable alternatives will be completed to identify the anticipated scope of the work required to implement the project. For this phase of the



project, preliminary designs are assumed to be limited to hydraulic designs to confirm geometries (i.e., heights and lengths), cursory stability evaluations, and conceptual evaluations of additional design requirements such as foundations, seepage mitigation, scour/erosion protection, and operations/maintenance requirements.

For the purposes of this proposal, the VHB Team assumes that up to four alternatives will be considered as part of this task including dam removal, two dam rehabilitation/replacement alternatives, and one dam repair alternative.

For each alternative considered as part of this task, conceptual site plans will be generated depicting the plan extent of the required work and typical sections of anticipated structures. Plans will also be developed showing access, staging, and control of water requirements for each alternative considered. The evaluation will include the development of conceptual sketches depicting potential access routes and identifying implications associated with use of private property, potential easement requirements, temporary construction to allow access to the work area, and traffic control requirements.

The alternative development will also include preparation of opinions of probable cost based upon recent project bid values, standardized cost estimating guides, material supplier information and experience. Based upon the level of design development at this submission, a 25% contingency will be included for each alternative as a separate line item to include design and construction contingencies. The opinion of cost will also include initial estimates as to the level of engineering, permitting, and construction administration that will be required through the completion of the project.

The potential schedule for implementing a particular alternative is another important consideration in the public decision-making process. Thus, the VHB Team will prepare preliminary schedules for each alternative in GANTT format for inclusion in the final Feasibility Study report.

#### **TASK 4. SEDIMENT EVALUATION**

##### **4.1 Quality Assurance Project Plan (QAPP)**

If required by project partner grant agreements, VHB will develop a QAPP describing the sediment sampling protocols consistent with the NHDES and EPA's required elements for sampling plans and quality assurance protocols for sampling studies. As discussed further below, based on the results and time since the previous sampling, some additional sampling is assumed to be necessary to address any potential uncertainty and agency concerns. The QAPP will cover aspects of the due diligence review of existing water quality and will describe the sediment sampling and quality control protocols for field sampling and analytical testing as well as the applicable ecological risk thresholds that will be used to assess concerns with respect to sediment quality and water quality. The VHB Team will utilize previously collected data to initially characterize existing water quality and sediment quality conditions. Procedures for data reporting, management and QA/QC review will be described. The QAPP will be submitted to the

project partners for review and comment prior to the submission to NHDES and EPA for approval. VHB will address comments for final approval.

#### 4.2 Sediment Sampling

VHB will conduct a due diligence review of existing sediment chemistry and physical characteristics compiled from previous sampling to assess any concerns and potential data gaps in the sediment quality and physical characteristic data with respect to sediment migration and ecological risk. VHB will rely on guidance contained in the NHDES Guidance Manual for Assessing and Managing Sediment Behind Dams/Barriers (WD-16-04) and will consult with NHDES water quality and dam bureau personnel to discuss any data needs and concerns. Given past sampling results and the 10-year time span since the previous sampling, some additional sediment sampling is anticipated to be needed to confirm or update the status of previously observed chemistry, particularly the elevated levels of Polycyclic Aromatic Hydrocarbons (PAHs) and several metals that were above NOAA ecological screening thresholds in certain locations.

VHB will prepare a brief sampling technical memo to outline the sampling goals and protocols and will consult with NHDES personnel to discuss and confirm exact locations and proposed analyses prior to collecting the sediment samples within the impoundment. The analytical results will be compared to applicable ecological risk thresholds for each contaminant using the most recent NOAA SQuiRT Tables or other relevant reference ecological risk values. Based on the selected ecological risk thresholds, the potential risk of adverse effects on benthic dwelling or higher trophic level organisms will be assessed.

For budgeting purposes, VHB has assumed that nine (9) sediment samples will be collected at the following locations where all nine will be analyzed for grain size distribution to help refine the sediment transport analysis and five will be submitted for chemical analysis consistent NHDES guidelines.

General Location Description	No of Samples	Chemical Analyses	Grain Size Analyses
Upper end of impoundment (bracket potential head cut area)	2	1	2
Mid-impoundment (outside channel east depositional area)	2	2	2
Hamel Brook confluence with impoundment	1		1
Hamel Brook upstream near impoundment limits	1		1
Oyster River channel mid-impoundment	1		1
Oyster River channel immediately upstream of dam	1	1	1
Downstream of Mill Pond dam tidal estuary	1	1	1
<b>Totals</b>	<b>9</b>	<b>5</b>	<b>9</b>

Notes: The eastern depositional area previously had elevated levels of PAHs and metals; thus two verification samples are included

These general locations are consistent with the suggested guidance contained in NHDES' Policy on Evaluation of Sediment Quality (NHDES-R-WD-02-9). Findings of the due diligence review will also be taken into considerations in selecting the final sampling locations. Each sample will consist of a composite core sample taken to the point of refusal and/or to the estimated streambed elevation.



The grain size distribution analyses will include both sieve and hydrometer testing to obtain the full particle size distribution range consistent with the American Society for Testing and Materials (ASTM) Method D-422 (or a comparable method).

#### **4.3 Sediment Toxicity Bioassay (Add Alternative)**

Depending on the sediment chemistry and grain size results obtained under Task 4.2 and the magnitude of the observed contaminant concentrations relative to the reported threshold or probable threshold effect levels, VHB will consult with regulatory personnel to determine whether biological assays need to be performed. Consideration for re-sampling to verify any potential "hot spot" areas will be included in the determination. If necessary, a long-term chronic bioassay (e.g., at least 20 days) will be performed on at least one recommended freshwater test organism. The testing will include the use of one reference sediment sample collected from a relatively undeveloped portion of the watershed. Both survival and growth indicators of the test organism will be reported. For budgetary purposes, VHB assumes that two hot spot samples and one reference sample will be collected and submitted for bioassays.

#### **4.4 Community Assessment (Add Alternative)**

If an aquatic benthic community assessment is deemed necessary, VHB would coordinate with the NHDES Bio-monitoring Program Coordinator and Water Quality Section. VHB would evaluate the effects of other possible aquatic stressors using EPA's Causal Analysis/Diagnosis Information System (CADDIS). VHB would then assess whether macroinvertebrate sampling will be a necessary step to determine whether benthic organisms may be affected by the sediment quality constituents. Depending on the number of sediment samples that have elevated levels, VHB will identify key locations to collect macroinvertebrate samples and would collect and analyze up to six (6) samples including up to two (2) reference locations.

#### **4.5 Sediment Transport**

A sediment transport analysis for the dam removal alternative will be conducted for areas determined from the hydraulic model to be areas of significant increase in shear stress on the bed. These calculations will be supported by the hydraulic analyses performed using HEC-RAS and the grain size distributions determined from Tasks 1.3 and 4.2. Channel stability and stable particle size will be evaluated for two (2) flow events: the bankfull event as it has the strongest influence on sediment transport and the evolution of a stream channel over time, and a 50-year continuous flow simulation as it will provide insight into how the channel may transform over a period of decades. These data can then be used to estimate bankfull sediment discharge and stable cross-section geometry. Particle stability will also include an evaluation of the sediment deposition likely to have occurred behind the dam.

Based on particle size distribution data and model-derived hydraulic parameters, particle stability analyses will be performed. Stability analyses will be consistent with field observations that indicate that sedimentation of fines is occurring within the backwater, disrupting sediment transport continuity, resulting in channel aggradation in the impoundment above the dam. Particle stability will be determined by shear stress assessment using an appropriate model depending on the particle size. The

appropriate methodology will be used to determine the particle size that will experience incipient motion (Simons *et al.*, 1982) for the flow events of interest.

Using the observed particle size distribution, the selection of an appropriate sediment transport equation will be used to predict bedload transport rates in the river. The appropriate method will depend heavily on the size distribution determined from the sampling in Task 4.2. Appropriate methods for determination of bedload rates may include Meyer-Peter Muller, Einstein-Brown, or Parker.

#### **4.6 Sediment Management**

Once the bedload rates are determined, an estimate of total volume of at-risk sediment will be calculated for both the upstream and downstream reaches. These calculations will assist in determining if degradation or aggradation of the bed and banks will occur from a change in velocity due to dam removal upstream and downstream of the dam. The analysis will provide a qualitative spatial assessment of the fate of released sediments and a discussion of potential impacts to downstream resources. Appropriate sediment management options, which may include a controlled drawdown of the impoundment, stabilization of sediment deposits after dam removal, sediment removal, bank stabilization techniques, or stream restoration activities will be evaluated and outlined in the Feasibility Report. This task will be qualitative in nature, based on professional judgment and the application of geomorphic principles, and does not involve additional modeling.

### **TASK 5. HYDROLOGY AND HYDRAULICS ANALYSIS**

#### **5.1 Hydrologic Study**

The VHB Team will supplement the previous W&S hydrological study by reviewing a related hydrologic model of the Lamprey River watershed, developed for the Town of Newmarket in support of a dam removal feasibility study of Macallen Dam. The existing model is designed to evaluate the volume, peak rate, and timing of overflows from the Lamprey River across NH 108 and into Longmarsh and Hamel Brooks, which run tributary to Mill Pond Dam.

#### **5.2 Hydraulic Study**

The VHB Team will conduct hydraulic analyses to predict water surface elevations and velocity profiles for both existing conditions and for build alternatives identified under Task 3 under a variety of flow conditions. HEC-RAS model geometries will be prepared for the existing condition (dam in place) and up to two proposed conditions (i.e., dam removed, and one dam reconstruction or repair alternative). The existing hydraulic model, developed in 2018, will be used as a starting point. However, channel geometry will be supplemented or updated based on survey and bathymetry data gathered in completion of Task 2. In particular, model geometry will be extended upstream to include Hamel Brook and downstream to include the tidal portion of the Oyster River as far as the Town's wastewater treatment facility.

A HEC-RAS model geometry will be developed to reflect potential post-removal channel geometry. Sensitivity analyses will be run to determine the influence of channel and overbank roughness on water levels, velocities and shear stresses, since a river may have slightly different hydraulic characteristics

immediately after dam removal with the hydraulic roughness increasing as the former impoundment is colonized by vegetation.

The results of the existing and proposed models will be compared to assess changes in water surface elevation and velocity profiles. The models will be compared for a variety of flow conditions, including bankfull flow, estimated summer baseflow, 5% and 95% spring fish passage flows, and two other flows of interest. The results will be analyzed (see other tasks) to identify if specific problems will need to be addressed during the design phase, such as scour protection around bridges, streambank stabilization, and sediment management among others.

### **5.3 Scour Analysis**

VHB will conduct a scour analysis of the NH 108/Newmarket Road vehicle bridge and the downstream pedestrian footbridge following the Federal Highway Administration (FHWA) Hydraulic Engineering Center Circular HEC-18 methodology to evaluate potential impacts to the bridge following removal of the dam. This analysis will use the hydraulic modeling results developed in Task 5.2.

### **5.4 Private Wells**

VHB will develop estimates of change of the groundwater elevation that may be caused by the removal of the dam and the resulting lowering of the water surface in the existing impoundment. These estimates will be developed using the HEC-RAS model, published groundwater data, existing well pumping test data (if any), and the results of the dam drawdown performed in 2009. Constraints to available drawdown in a pumping well will ultimately affect the safe yield of the well. VHB will develop a conceptual hydrogeologic model of the site based on existing geologic information, maps, well drilling logs, weather and streamflow records. The conceptual model will assess groundwater flow rates and directions, and the likely recharge zone for wells in the project area. VHB will develop a water budget for the study area including the interaction of groundwater with the river/dam impoundment and will assess whether the dam impoundment is hydrologically connected to the bedrock aquifer, sand & gravel aquifer, and shallow water-table aquifer. Based on this conceptual model, VHB will perform desktop calculations of the dam removal project's likely zone of influence in groundwater, to delineate a well study area. VHB will develop an inventory of private wells within this study area, based on well-completion logs in NHDES files and a targeted field review of specific wells. For wells within the study area, VHB will identify well type (e.g., drilled bedrock, shallow dug, spring, gravel-packed, etc.), basic well characteristics (e.g., well yield, total depth, hydraulic base, and static water level, if documented), and the estimated demand (gallons per day). VHB will estimate the changes to safe yields of existing wells within the well study area and will tabulate the results in the report. For budgeting purposes, VHB assumes that no more than 10 wells would be identified in the study area, and that no mitigation will be needed for project-related impacts on existing wells.

## **TASK 6. CULTURAL RESOURCES**

### **6.1 Historic Resources – Request for Project Review**

Dam repair or removal would require a federal permit through the US Army Corps of Engineers and will therefore be subject to review under Section 106 of the National Historic Preservation Act. VHB will assist the VHB Team in state and federal historic regulatory review requirements. Compliance with Section 106 of the National Historic Preservation Act is coordinated through the New Hampshire Division of Historical Resources (NHDHR) as the New Hampshire State Historic Preservation Office. To initiate this coordination, VHB, with support from an archaeological subconsultant, will prepare a Request for Project Review (RPR) for submittal to NHDHR as follows:

*Background and Literature Review.* A background and literature review will be conducted at NHDHR and through electronic map repositories, where appropriate. File review using NHDHR's GIS Enhanced Mapping & Management Information Tool (EMMIT) will collect data about prehistoric and historic archaeological sites, standing structures, and engineered features. Soils, topographic, historic maps, and technical cultural resources reports pertinent to the project area will be sourced through state and local repositories. Once the data are acquired and reviewed, pertinent information (known archaeological sites, historic districts, historic landmarks, etc.) will be graphically represented on project area maps. Archaeological site location data are considered confidential and not for public distribution. For planning purposes, however, such data are available to agencies for review. For this reason, the site location map will be marked "Not for Public Distribution."

*Site Visit.* Photographs of buildings in or adjacent to the project area is required for the RPR, whether in individual photographs or streetscape views. Additionally, all buildings over 50 years old in the project area will be identified by address, estimated date of construction, and brief description for the RPR.

*Reporting.* The data gathered during the background and literature review, as well as the project walkthrough will be incorporated into the RPR. The RPR includes text, figures, and photographs of existing conditions, extant buildings, and archaeological features, if found. Because it contains sensitive cultural resource data, the RPR is not for public distribution. The cultural resources staff and a GIS specialist will complete the RPR, and it will be subjected to two rounds of review: one in-house and one by the Town. Upon receiving the Town's comment, the RPR will be revised, and VHB will submit the RPR to the NHDHR. We will forward a copy of the transmission to the Town for their records.

### **6.2 Phase IA Archaeological Sensitivity Assessment**

VHB subconsultant IAC will complete a Phase IA Archaeological Sensitivity Assessment which will conform to the NHDHR guidance for dam removal studies. The study area will include the dam site, the impoundment upstream approximately 1000 feet on the Oyster River, Hamel Brook to the NH 108 crossing, and the downstream channel banks to the high tide mark. To the extent known during the feasibility study, the review areas will include locations proposed for access, and staging for dam construction or removal.

The background and literature review for archaeology will be coordinated with Task 6.1. The following source data will be reviewed:

- NHDHR site files covering access, staging, and fill removal/disposal areas
- University of New Hampshire (UNH) Diamond Library on-line USGS 15-minute map coverage
- Town of Durham library historic maps
- Sanborn Insurance Maps (Town of Durham)
- Historic map coverage as might be found during the title research (Task 2)
- NHDES dam records
- New Hampshire Department of Transportation road and bridge data

Previously reported sites within the project area (i.e., within the impoundment area) will be revisited and current conditions photographed; securing permission to access private property will be the Client's responsibility. Alternatively, IAC will visit from public property (i.e., from public roadway or by boat). IAC will conduct an inspection of judgmentally selected portions of the project area accessible by foot, vehicle or by boat as feasible; archaeologists will not conduct an underwater assessment at this time. The results of the document and field reviews will be reported in an archaeological sensitivity assessment report with recommendations for future steps. The sensitivity assessment will include both Pre-Contact (Native American) and Post-Contact (EuroAmerican) archaeological resources. The bibliography will include all sources used in the course of the research including interviewee contact information, on-line data sources and more traditional maps, books, and articles.

### **6.3 Historic Resources – Additional Surveys (Add Alternative)**

Although the area surrounding the Mill Pond Dam is already officially listed in the National Register of Historic Places (NRHP), NHDHR may request additional documentation on individual buildings or structures adjacent to the dam. The NRHP nomination is a relatively early nomination and was not required to substantially address the contributing status of its component resources. NHDHR may require an update to this nomination as an historic district form or additional documentation on resources that may be affected to assess the effects on these presumably contributing resources.

If required by NHDHR in their response to the RPR, VHB would update the National Register Nomination Form for the Durham Historic District to document significant changes to the district, such as intervening demolitions of contributing resources. VHB will prepare Historic District Area Form continuation sheets that address such changes. Preparation of the information that would be contained in the continuation sheets will include fieldwork and photography to document the significant changes to the district and a narrative that documents and explains these changes.

### **6.4 Ensuring Durham's History is Honored**

In addition to the tasks described above, VHB would consult with the Town, its project partners, and the community as needed to assess the effects of the various alternatives, including dam removal, on historical resources. This coordination would include meetings and communication regarding preliminary assessment of adverse effects and development of project measures intended to limit or mitigate such adverse effects. VHB would identify and describe potential mitigation measures such as



the preparation of a NHDHR Historic Property Documentation reports (including large format photography of the dam prior to and during its modification or removal); interpretive exhibits, archaeological monitoring, or other measures. Because NHDHR emphasizes local involvement in the assessment of effects and identification of mitigation, this task may include consultation with the Durham Town Council, the Durham Historic District Commission/Heritage Commission, and the Durham Historic Association.

This scope item is not intended to include full Section 106 Consultation services, including formal Determination of Effects or development of a Memorandum of Agreement with NHDHR and the lead federal agency. These elements are more appropriately completed during the design and permitting of the selected alternative, which has yet to be determined.

#### **TASK 7. WILDLIFE AND NATURAL COMMUNITIES**

VHB will review existing data to inventory wildlife and plant communities within the impoundment including state and federally-listed threatened and endangered (T&E) species located upstream and downstream of the Mill Pond. Using published data such as the NH Wildlife Action Plan, the NH Natural Heritage Bureau GIS database and data compiled by the Town of Durham, the team will assess what species or habitats are currently present, how the dam affects the distribution of those species or other species not present but expected to occur in the watershed, and how the dam removal might affect those species. This analysis would be developed in consultation with the ecologists at the NH Fish and Game Department, the NH Natural Heritage Bureau, the US Fish and Wildlife Service and the National Marine Fisheries Service if applicable.

#### **TASK 8. OTHER ISSUES OF IMPORTANCE**

##### **8.1 Fish Passage**

Upstream fish passage conditions will be evaluated under a dam removal scenario. This will be accomplished by using the hydraulic model of the dam removal developed under Task 5.2. If the dam were to be removed, a series of steep gradient rapids could exist where the dam is currently located. VHB will review the existing HEC-RAS model to verify that the existing model in combination with further hydraulic modeling performed under Task 5.2 is suitable for this analysis. We will rely on both existing bathymetric data and additional bathymetric and hydraulics of the river developed under Tasks 2.2 and 5.3 to detail and support the HEC-RAS model for purposes of evaluating the hydraulic profile of the river after dam removal. The HEC-RAS model will be used to characterize the depth and velocity of stream flow in steep gradient areas (primarily in the vicinity of the existing dam) given the slope and streambed geometry through the modified reach under a range of flow conditions that may occur during upstream fish passage (April-June). We will apply literature and model values (for example from USFWS, *Fish Passage Engineering Design Criteria*, June 2019) to determine if projected hydraulics are within the burst and sustained swim speed capabilities for the targeted species. Results will be presented in a brief report that will include both tabular and graphic data as well as model documentation.



## **8.2 Bridge and Infrastructure Impacts**

To assess structural impacts for bridges, retaining walls, and adjacent structure or building foundations, the VHB Team will gather information during field reconnaissance activities and review existing plans and subsurface investigations. This information will be used to estimate bedrock profiles and long-term degradation profiles for the stream bottom. The river hydraulics will be analyzed for existing conditions, transitional stages, and ultimate conditions where long-term degradation is expected to stabilize. The effects of stream velocity and scour will be assessed for bridge foundations and other structures to develop risk assessments and remediation requirements. This involves a multi-discipline effort involving experienced structural engineers, hydraulic engineers, geotechnical engineers, and geomorphologists.

This task would identify foundations for bridges, buildings, walls and other infrastructure that are supported on erodible geo-material (soil/rock) and that are not founded a sufficient depth below the stream bed and are therefore susceptible to scour. Ultimately, the VHB Team would provide preliminary recommendations for scour resistance, strengthening options and/or other protective countermeasures to minimize risk of foundation failures or adverse effects relating to unfavorable settlements.

## **8.3 Recreational Usage**

To assess recreational impacts or changes after dam removal, VHB will first describe existing recreational conditions and opportunities available in the impounded river and in the vicinity of the dam, and then estimate how dam removal is likely to effect a change on the recreation opportunities available including the creation of new recreational opportunities if the dam were removed.

Existing conditions will include a narrative description of recreational use of the river from the dam to the upstream end of the impoundment. VHB will map existing public access points, such as boat launches and popular swimming and fishing areas, as well as existing private shoreline facilities based on available information and discussion with the Durham Recreation Department. Public recreation facilities provided by the Town will be identified through consultation with the Durham Recreation Department, who may also provide information regarding current use of its boat launch facilities.

Using the results of the hydraulic modeling, we will determine the usability of existing access points under post-dam removal conditions. The map will be accompanied by a brief report discussing the anticipated changes with dam removal, such as the number and location of dangerous spots for boaters (such as steep rapids, bridges, etc.).

## **8.4 Invasive Species**

VHB will make an informal field inventory of existing stands of purple loosestrife (*Lythrum salicaria*), common reed (*Phragmites australis*), Oriental bittersweet (*Celastrus orbiculatus*) and Japanese knotweed (*Polygonum cuspidatum*) along the impoundment and will identify areas that may be impacted by colonization by these aggressive species. VHB will also contact the Department of Agriculture to identify species of concern in the watershed and to obtain any unpublished invasive species mapping. The project report will discuss the potential risk areas and the means to minimize and control the spread of these species. Such methods could include temporary cover plantings, monitoring,

mechanical removal and/or herbicide application in key areas or other means such as the use of biological controls (*Galerucella* spp.)

## **8.5 Wetlands**

Removal or modification of the Mill Pond would affect the hydrology of wetlands within or adjacent to the impoundment. Some of these wetland systems depend to some degree on the backwater conditions created by the dam. This relationship cannot be precisely defined at this level of study, but a reasonable estimate of potential effects can be developed using GIS analysis of the valley. Note that wetland delineations will not be completed; existing GIS data will be used as obtained through GRANIT, the Regional Planning Commission or the Town, supplemented and confirmed by field inspections and aerial photo interpretations.

VHB will analyze the influence of backwater conditions on wetlands and will derive a spatial expression of that relationship. GIS analysis would use this relationship to overlay a buffer onto National Wetland Inventory mapped wetlands to identify the extent and type of wetlands potentially affected. The ecological effects on these wetlands would be discussed in terms of the possible changes in community composition and wetland functioning.

## **TASK 9. WATER QUALITY**

### **9.1 Evaluation of Potential Water Quality Changes**

The VHB Team will review existing water quality data that has been collected over the years in Mill Pond and related tributaries as part of previous studies and monitoring efforts. The UNH Water Systems Analysis Group, led by Dr. Wilfred Wollheim, has collected extensive continuous and grab sampling data to evaluate nutrient dynamics in the pond. This information will be very useful in establishing baseline water quality conditions and assessing the influence that the Mill Pond Dam may have on existing water quality within the impoundment. The data will also provide insight in assessing the potential upstream sources and inputs of nutrients into the impoundment. Dr. Wollheim has been added to the VHB Team and will work with VHB water quality scientists to depict current baseline water quality conditions and assess the potential water quality changes that may result under more free flowing conditions if the dam was removed or with other dam modifications.

With nitrogen being a key parameter of interest for estuarine waters, the VHB Team will utilize the extensive nitrogen data to evaluate whether or not the current impoundment acts as a nitrogen sink due to possible denitrification processes under low dissolved oxygen conditions or if excess nitrogen is potentially released under certain conditions or times of the year. The data collected in the recent Durham Pond Limnological Study will be used to describe the limnological conditions and the extent to which thermal stratification and low dissolved conditions prevail and how this may affect nitrogen dynamics. This study also provides information on algal productivity through chlorophyll *a* levels (suspended algae densities) within the pond.

Dam removal may also change salinity levels in the current impoundment due to the upstream migration of high tide levels. Increased salinity will affect the distribution of vegetation species and

aquatic organisms that will become established within the tidally influenced areas. VHB will review and update the assumptions contained in the 2009 Mill Pond study with respect to predicted changes in tidally influenced zones based on tide elevation, bathymetry and topographic data under a dam removal scenario.

The VHB Team has assumed no additional water quality sampling data will need to be collected as part of this project scope given the extent of water quality data that is currently available. The VHB Team, however, has included time to compile, process and check the various data sources for quality assurance purposes and evaluate the results to identify the potential water quality changes and downstream effects with the proposed dam removal or modification scenarios. The compiled data and assessment results will be discussed with stakeholders and regulatory agency personnel to address any suspected concerns and/or permitting needs. The VHB Team will prepare an analysis that summarizes the data compilation, interpretation and analysis with respect to predicted changes and potential ecological and human risks under the proposed dam removal or modification scenarios.

## **9.2 Evaluation of Current and Potential Water Quality for Recreational Use**

The principal concerns with respect to recreational use include elevated bacteria levels with respect to primary or secondary recreational contact, elevated levels of toxic contaminants for fish consumption and the extent to which excessive algae or rooted vegetation growth disrupt open water areas for boating access. The 2016 state 303(d) list of impaired water bodies lists the Mill Pond as being impaired for secondary recreation purposes due to elevated chlorophyll *a* levels which is an indicator of algal cell abundance in the water column. The VHB Team will review and identify any trends or spatial distribution of chlorophyll *a* levels as well as rooted macrophyte plants within the pond. The existing data will be used to determine how chlorophyll *a* levels and macrophyte plant densities may change with the potential dam removal or dam modification scenarios.

The other key aspect with respect to recreational use is the potential change in the open water area and depth within the impoundment under the potential dam removal and dam modification scenarios. The VHB Team has included time in the scope to estimate potential changes in open water areas limits and depths under the proposed scenarios using the existing bathymetry data and predicted water elevation changes. The areas of particular concern will likely be the upstream riparian properties who currently have access and use the open water for recreation purposes. The results of the analysis will be included in the draft and final Feasibility Study.

## **TASK 10. OUTREACH AND COORDINATION MEETINGS**

With regard to meetings, it is assumed that the CLIENT will handle arrangements for all meetings such as reserving meeting space, advertising, issuing notices, paying for room fees, police details, etc. VHB will assist by drafting such notices and coordinating with agencies, organizations and attendees regarding the content of the meeting agenda.

### **10.1 Client Coordination**

Under this task, VHB will coordinate with project partners including Town of Durham Public Works Department and Town Council. Our cost estimate includes up to six meetings. In order to manage costs and schedule, VHB assumes that the Town will appoint a single point of contact to handle final decision making and communication with VHB. This task will also include assisting the Town in drafting responses to written comments received during the project duration.

### **10.2 Public Engagement Meetings**

VHB will be the primary presenter for public meetings to be coordinated and hosted by the Town to provide information and report on progress of the study. Three (3) public informational meetings are expected: 1) Initial project overview including timeline, issues to be addressed, and overview of existing data and review; 2) Approximately mid-way through completion, present information collected to date and provide timeline for completion of work and final presentation of draft feasibility study; and 3) Present draft final feasibility study and summary contained therein. This task will include preparation of plans, handouts and slide presentations for the public meetings. Materials will be provided to the VHB Team for review and comment two weeks in advance of the meetings. VHB will provide for a qualified historian to attend public informational meetings as needed. No more than three VHB Team members would attend any public informational meeting.

## **TASK 11 VISUAL ASSESSMENT**

VHB will prepare visual simulations that will help portray the visual effects of the removal of the Mill Pond Dam. For this task, VHB will use an approach that develops photomontages (i.e., the layering of other images onto a background photograph) with limited 3-D rendering of alternative structures based on the results of the hydraulic model.

### **11.1 Digital Photomontages**

VHB will consult with the Town to choose up to three points from which to create visual photomontages of the proposed alternatives. These points will be chosen based on the results of the hydraulic model and points of interest to the public. We anticipate that one or more of these locations will be chosen based on the presence of a property or district that is either listed in the State or National Register or is determined eligible for the National Register. Other points of interest may include current scenic vistas in the valley, recreational trails or similar sites. Subject to confirmation by the Town, we anticipate these three views would be:

- A view upstream from the Mill Pond Park;
- A view looking upstream from the NH 108 Bridge; and
- A third view from a location to be determined.

Other potential views are possible, given the Town's needs.

Once chosen, VHB will acquire digital images of the project site from each of the three locations with a 50-52mm (film) equivalent focal length (34mm digital). GPS points will be recorded for each viewpoint. The digital image will be brought into Bentley MicroStation or another platform as appropriate. Using the results of the hydraulic analysis completed under Task 4.2, VHB will use MicroStation and Adobe Photoshop to digitally superimpose a depiction of the alternative and/or the predicted water levels from each of the vantage points. These photomontages will be provided as pdf files as well as color images.

### **11.2 Visual Impact Assessment**

Using the results of Task 11.1, VHB would develop a brief discussion of the potential impacts to the visual environment resulting from the dam removal alternative, considering the expected visual experience, the distance from the project, the duration of view, the scenic quality of the view, and the expressed public value in either local, state or national planning or other documents. The visual assessment will be included in the final feasibility report.

## **TASK 12. FEASIBILITY AND IMPACT ANALYSIS REPORT**

### **12.1 Feasibility Study Report**

VHB will compile the results of each of the analyses described above into a comprehensive but understandable study report. Based on experience with similar projects, we expect that the report would be between 80 to 100 pages, exclusive of appendices, with up to 20 color figures. It is understood that the draft feasibility study will be prepared for review by the Town officials and project partners prior to its distribution to the public. A final report will be prepared after the public has had an opportunity to review and provide comment. The final feasibility study will be provided to Town officials prior to final publication. Up to eight (8) hard copies would be printed, and a PDF version suitable for posting on the internet would also be delivered.

### **12.2 Alternatives Summary Table**

In order to summarize the results of the study, VHB will compile an Alternatives Summary Table to provide a synopsis of each Alternative as well as the impacts, benefits and costs of each. To complement the table, the VHB Team will also produce a simple set of maps and/or graphics to summarize the information visually. This summary will be included in the draft report and provided at the third public information meeting and will be updated if needed at the project conclusion.

## **B. CLIENT-FURNISHED INFORMATION**

The CLIENT shall provide the CONSULTANT with the following:

- Landowner permission to enter private property to conduct inspections, field studies, *etc.* including temporary construction access agreements; and
- All plans and surveys related to infrastructure in the dam vicinity, including the dam itself and any utilities.

## **C. SERVICES NOT INCLUDED**



It is anticipated that the following services will not be required to complete the project and they are therefore excluded from this initial proposal.

- Engineering design including plans, specifications or estimates for project alternatives beyond a preliminary conceptual level;
- Environmental permit applications or FEMA Conditional Letter of Map Revision or Letter of Map Revision;
- Section 106 Consultation including determination of effects and MOA;
- Design of improvements to offsite structures (if required);
- Field survey beyond that specifically scoped above;
- Field survey for endangered species;
- Design of new or replacement foundations, culverts, headwalls, bridges *etc.*;
- Bid Phase Services;
- Construction Inspection/Observation and/or Field Construction Layout; and
- Additional studies not specifically included in this proposal.

If work is required in these areas, or areas not previously described, the CONSULTANT will prepare a proposal or amendment, at the request of the CLIENT, that contains the Scope of Services, fee, and schedule required to complete the additional items.

#### **D. COMPENSATION**

The CONSULTANT will complete the Scope of Services on a LUMP SUM PERCENT COMPLETE basis with an upset limit for labor and expenses of \$327,364, exclusive of Add Alternatives, which is based on the attached breakdown. If authorized by the Town, Add Alternatives would increase this contract amount by an additional \$22,459 including labor and expenses, for a total contract limit of \$349,823. Invoices will be provided monthly. The CONSULTANT shall be reimbursed for expenditures made specifically for the project such as: Subconsultant charges, printing and reprographics; travel and subsistence; computer charges; telephone charges; shipping, postage, and courier service charges; purchase of maps and similar documents; etc. These direct expenses will be billed at cost.

#### **E. SCHEDULE**

The CONSULTANT is prepared to begin the tasks outlined in this proposal immediately following written authorization of the CLIENT. Assuming CONSULTANT receives a written Notice to Proceed by August 20, 2019, CONSULTANT will endeavor to maintain the schedule as described below. The schedule is subject to timely delivery of information provided by the CLIENT and is subject to timely review of interim products by the CLIENT and other stakeholders. If the CLIENT requests that work under this Agreement be stopped, the schedule is subject to renegotiations when written authorization to proceed is received. Unforeseen site conditions or project delays beyond the control of CONSULTANT, and without



CONSULTANT'S fault or neglect, may result in an adjustment to the indicated schedule. Should such conditions arise, CONSULTANT will notify the CLIENT as soon as possible.

**Anticipated Project Timeline**

Task	Timeline
Project Kickoff Meeting	September 2019
Field Surveys	Fall 2019
Develop Preliminary Alternatives	Fall-Winter 2019
Preliminary Analysis of Alternatives	Winter-Spring 2020
Client Draft Feasibility Report	Summer 2020
Public Draft Feasibility Report Issued	Late Summer 2020
Final Feasibility Report Issued	Fall 2020

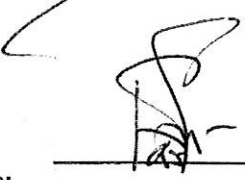
If this Agreement is satisfactory, please sign under client authorization and send us back an original for our files.

**VANASSE HANGEN BRUSTLIN, INC. AUTHORIZATION**

By: Martin F. Kennedy  
Title: SENIOR PRINCIPAL  
Date: 9/12/19

**CLIENT AUTHORIZATION**

THE TOWN OF DURHAM, NEW HAMPSHIRE agrees with this scope of services, schedule and fee and authorizes commencement of project work. Together with the attached terms and conditions, they constitute the entire Agreement.

By:   
Title: Todd I. Selig  
Date: 9/12/19 Administrator  
Town of Durham

