Multi-Year Habitat Monitoring at Johnsons Mill Dam Removal – 2022 Annual Report

PROJECT NO.

19-093

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Cover Photo: Large log in the Bogue Branch upstream of dam removal site.

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1. Introduction

The Johnsons Mill Dam removal was completed in August 2021. Prior to full removal, the dam was partially breached during a 100-year storm event that occurred on October 31, 2019. The dam was constructed of stone and concrete, and was located along the Bogue Branch in Bakersfield, Vermont. The Bogue Branch is a tributary to the Tyler Branch which flows into the Missisquoi River. The watershed area draining to the Johnsons Mill Dam location (44.83141, -72.75578) is 8.63 mi^2 (StreamStats, 2019). A majority of the watershed is forested, with only 2% considered developed land (StreamStats, 2019).

Post-removal monitoring is being completed along the Bogue Branch to improve our understanding of aquatic organism habitat following dam removal and to address knowledge gaps related to a removal design that had a minimal amount of sediment removed from the upstream impoundment prior to dam removal. Monitoring will take place annually over the course of four years and include streambed analysis, topographic and bathymetric surveying, woody debris evaluation, plant survival and coverage assessment, algal analysis, and macroinvertebrate analysis. Data collected will allow us to assess changes in stream habitat over time and increase our understanding of post-dam removal dynamics. This report summarizes the monitoring methods and results for 2022, the first year of monitoring. These data will serve as the baseline for future assessments.

2. Monitoring Data Collection

The monitoring reach extends from Witchcat Road near the intersection with Joyal Road to the crossing point just north of 1505 Witchcat Road, as shown in Figure 1. The monitoring reach is subdivided into three sub-reaches numbered from upstream to downstream. Reach 2 correlates to the limits of disturbance during dam removal. Streambed, wood recruitment, and vegetation monitoring were performed by Stone staff on November 2, 2022, using a combination of ESRI Field Maps, Survey 123, and a Trimble R2 GPS unit.

2.1. Streambed Material Analysis

Stone staff collected streambed material data at two locations, Site 101 and 102, representing different habitat types within Reach 2 (See Figure 2 for locations). At each location, Stone staff completed pebble counts using the Wolman pebble count method to determine grain size distributions. After pebble counts were completed, visual and tactile assessment methods were used to determine relative percentages of material beneath the surficial armor layer at one location toward the center of the channel at each streambed monitoring location. Each habitat feature, or monitoring location, was inspected for roughness boulders in accordance with the project Quality Assurance Project Plan (QAPP). Dimensions and angularity were recorded for each identified roughness boulder. Data were entered into ESRI Field Maps and Survey123 field forms and processed in MS Excel to determine grain size distributions and approximate percentage of materials. Photos were taken of each station and GPS coordinates recorded to facilitate navigation to the same sampling locations in subsequent years.

2.2. Topographic and Bathymetric Surveying

While no new topographic or bathymetric data was collected in 2022, existing data sets are being reviewed and compiled for use in future analysis. Additionally, preparations were made for topographic and bathymetric surveying to be completed by Whiteout Solutions in May 2023 in accordance with the project QAPP.

On November 2, 2022, Stone staff established ground control points GCP-1, GCP-2, GCP-3, GCP-5, and GCP-6 as seen in Figure 1. Ground control points were established by traversing the monitoring corridor using a GeoMax Zoom30 total station and Carlson Surveyor 2 data collector. Staff erected the total station on an existing control point that had been set during the design phase of the project, and back sighted to another existing control point. Once oriented, a series of turning points were set in Witchcat Road to allow staff to traverse the road and establish the ground control points. Ground control points are 24” lengths of 3/8” rebar driven into the ground with an orange cap flush at existing ground elevation. Grade stakes with survey flagging were also driven adjacent to the ground control points to aide in locating the control in the future.

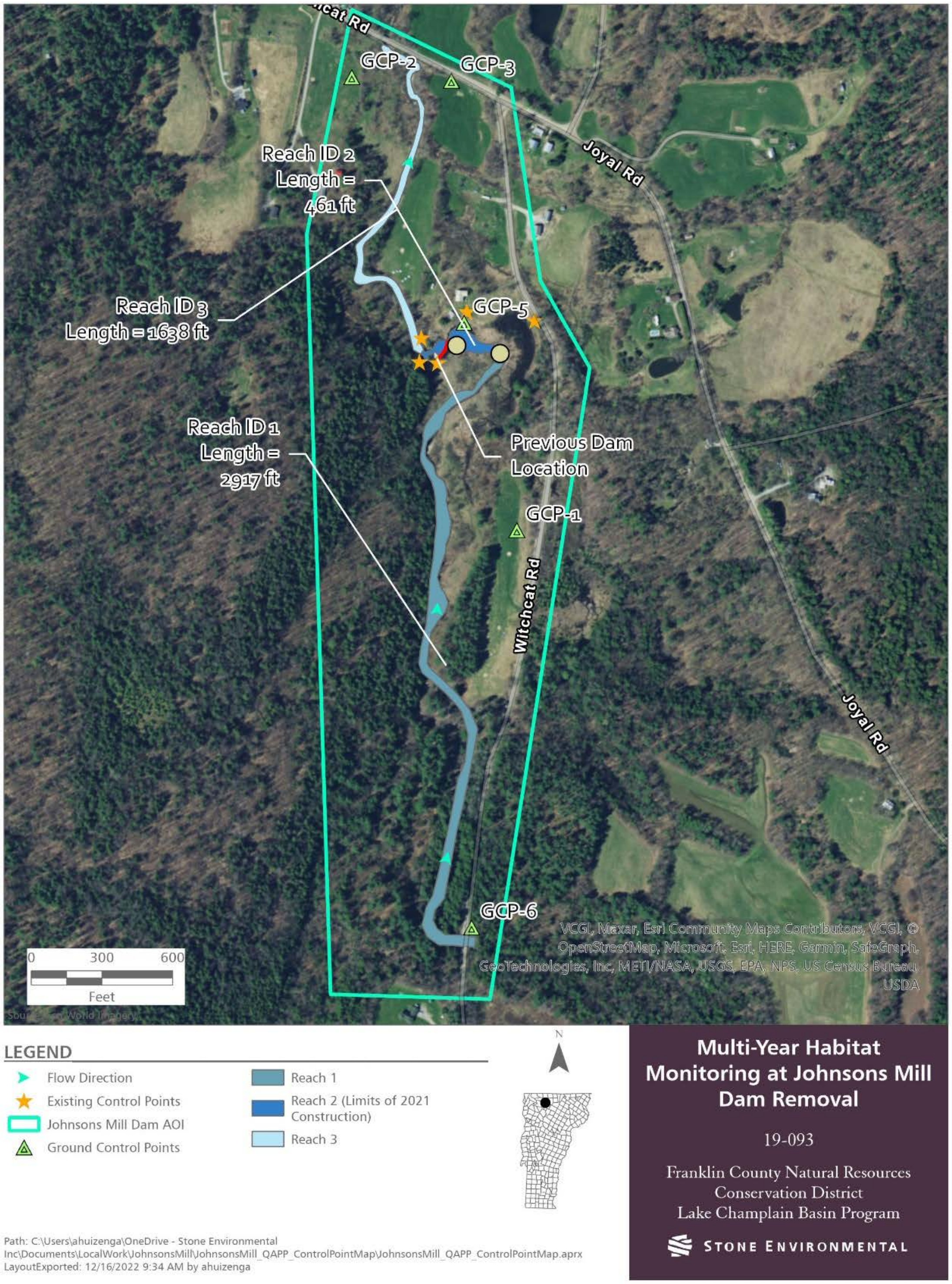


Figure 1. AOI and monitoring reaches identified for multi-year monitoring.

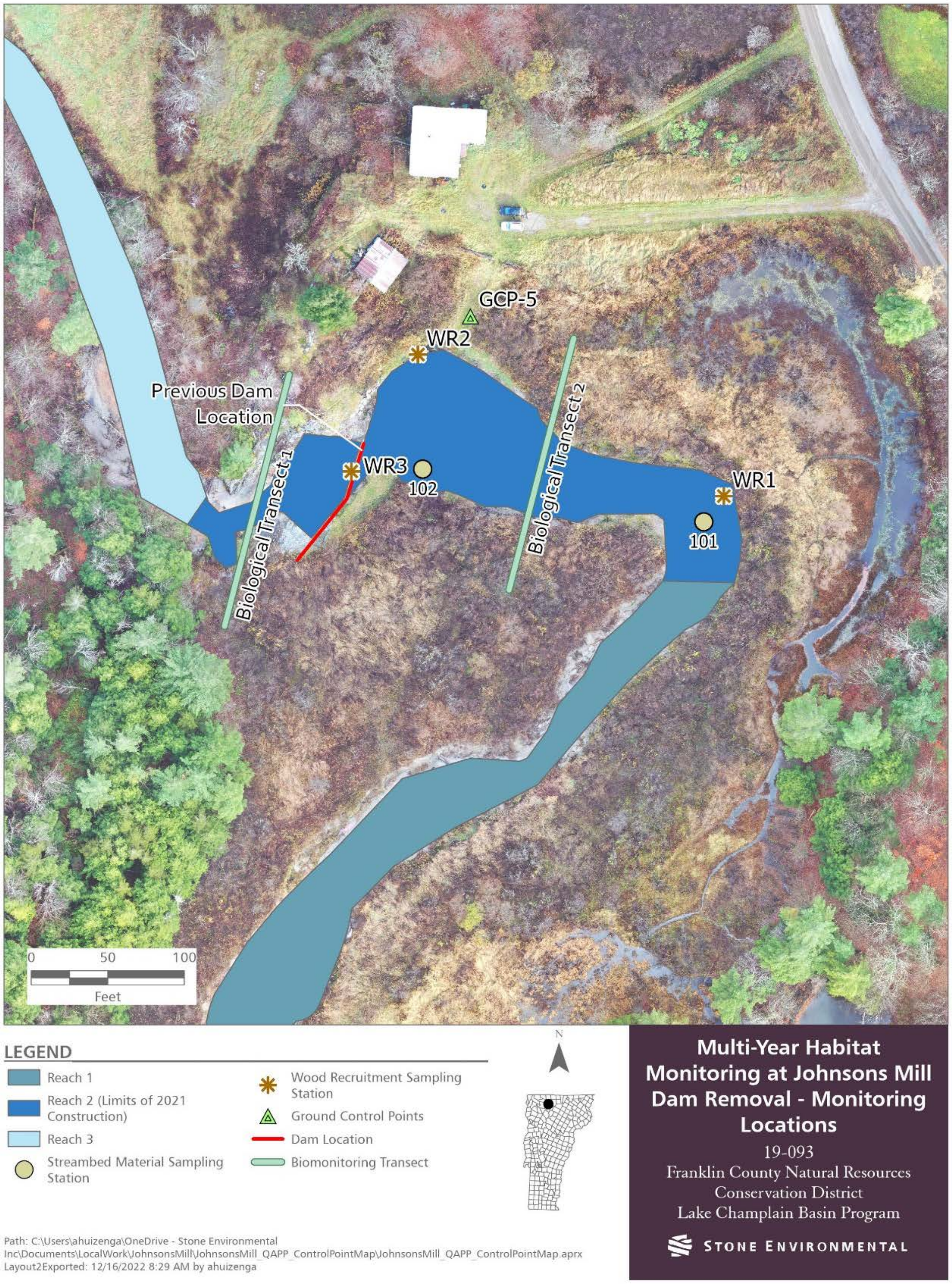


Figure 2. Wood recruitment, sediment sampling, and biological sampling locations established during 2022 monitoring.

2.3. Evaluation of Wood Recruitment

Wood recruitment is being monitoring and evaluated within Reach 2. Initial monitoring plans consisted of assessing wood recruitment at the rootwad installations completed during construction. These installations were made along two meander bends within Reach 2 and are identified as WR1 (upstream) and WR2 (downstream) in Figure 2. Channel migration and incising that occurred following dam removal resulted in the disconnection of the downstream rootwad installation (WR2) from the main channel and suspension of the upstream rootwad installation (WR1) above the water surface. As a results, a third monitoring location (WR3) was identified while in the field on November 2, 2022. WR3 is located directly upstream of the prior dam location and consists of a large timber log that was uncovered following dam removal that has begun to recruit wood.

The following data were collected for each wood recruitment monitoring station:

- Embeddedness in bank (distance from tag to bank) (only applicable for installed rootwads at WR1 and WR2)
- Tag ID
- General condition
- Count, length, diameter, and tag ID of recruited wood
- Photos

Natural woody debris and timber logs greater than 3" in diameter within bankfull width were also tagged, measured, and recorded in ESRI Field Maps and Survey123. Blue metal tags were affixed near the collar of the rootwads or one end of a timber log using nails (Figure 3 and Figure 4). Qualitative notes regarding the potential source of woody debris were recorded (i.e., natural recruitment vs timber log). The total count and distribution of wood length and diameters were quantified in MS Excel. Maps were created using ArcPro 2.9.5 to depict the location and relative characteristics of rootwads and tagged wood in the channel within Reach 2.

Figure 3. Stone staff tagging and collecting GPS locations of wood at monitoring station WR3.

Figure 4. Image of an installed rootwad at WR2 with the blue metal tag highlighted with a blue circle.

2.4. Evaluation of Plant Survival and Coverage

Stone staff completed an initial survey of plant communities on November 2, 2022. However, the time of year made it difficult to assess plant survival. It is anticipated that plant community assessments will take place prior to leaf off in subsequent years to provide a better evaluation of plant health. Stone staff walked from the prior dam location upstream to the beginning of Reach 1 to identify plant communities, tree stands, and individual trees within 30 feet of the channel along river left and river right. Plant and tree stands were delineated using the GPS unit. The following data were recorded as appropriate for each stand and individual tree:

- Leaf condition
- Stem condition
- Evidence of pests and/or disease
- Species composition
- GPS coordinates
- Photos

2.5. Aerial Imagery

On November 2, 2022, Stone staff collected aerial imagery (consisting of approximately 500 photos) of approximately 40-acres of the monitoring reach. Aerial imagery was collected using a DJI Mavic 2 Pro drone flown at an elevation of approximately 350 ft. Images were processed and orthorectified using DroneDeploy. The resulting orthomosaic and digital terrain model (DTM) will be shared with FCNRCD and are presented in maps within this report.

2.6. Algal Analysis

Algal data collection was completed in Fall 2022 by Avacal Biological Consulting.

2.7. Macroinvertebrate Analysis

In Fall 2022 temperatures were too cold to conduct the macroinvertebrate data collection. Macroinvertebrate surveys will be collected in subsequent monitoring years.

3. Monitoring Results

3.1. Streambed Material Analysis

Grain size distribution plots developed using the pebble count data collected at one pool (Site 101) and one riffle (Site 102) within Reach 2 are provided in Figure 5. Grain size distributions calculated using pebble count data from riffles in the reference reach (a portion of Reach 1) are provided for comparison. Reference reach pebble counts were completed on October 21, 2019, prior to the dam removal. In 2022, the dominant particle size in the pool (Site 101) was 11.3-16 mm, while the dominant particle size in the riffle (Site 102) was 32-45 mm.

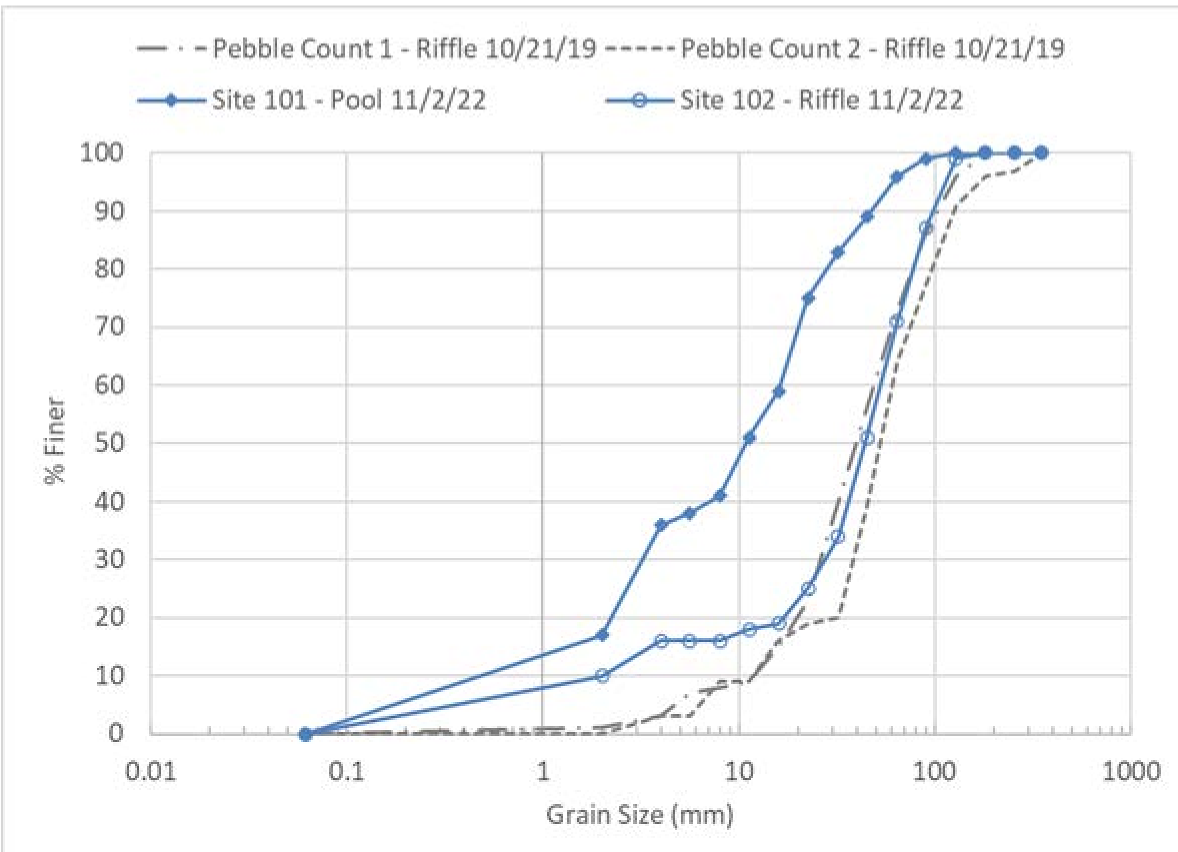


Figure 5. Cumulative grain size distributions pre- and post-removal. Note, pre-removal pebble counts were completed in the upstream reference reach and not at the same locations as the sediment sampling stations established for multi-year monitoring.

Roughness boulders were identified and quantified in the riffle only. No roughness boulders were identified in at the pool sediment sampling location (Site 101). A total of 4 boulders were located in the riffle, for an average of 8 boulders per 50 linear feet of stream. Roughness boulder characteristics are summarized in Table 1.

Table 1. Roughness boulder characteristics observed within the riffle at streambed monitoring Site 102

Count	Length (in)	Width (in)	Height (in)	Embeddedness (%)	Angularity
1	520	360	300	50	Sub-rounded
2	350	170	140	0	Sub-angular
3	280	130	100	5	Sub-rounded
4	300	155	120	25	Sub-angular
Average	**363**	**204**	**165**	**20**	NA

Results of the visual and tactile assessment of sediment beneath the surficial armor layer are summarized in Table 2. Photos are provided in Figure 6. Gravel was the dominate sediment type at both locations, followed by sand at the pool and particles sizes smaller than sand below the riffle surficial armor layer.

Table 2. Summary of visual and tactile assessment results for sediment below the surficial armor layer

Year	Location	Gravel (%)	Sand (%)	< Sand (%)
2022	Pool (Site 101)	75	20	5
	Riffle (Site 102)	70	10	20

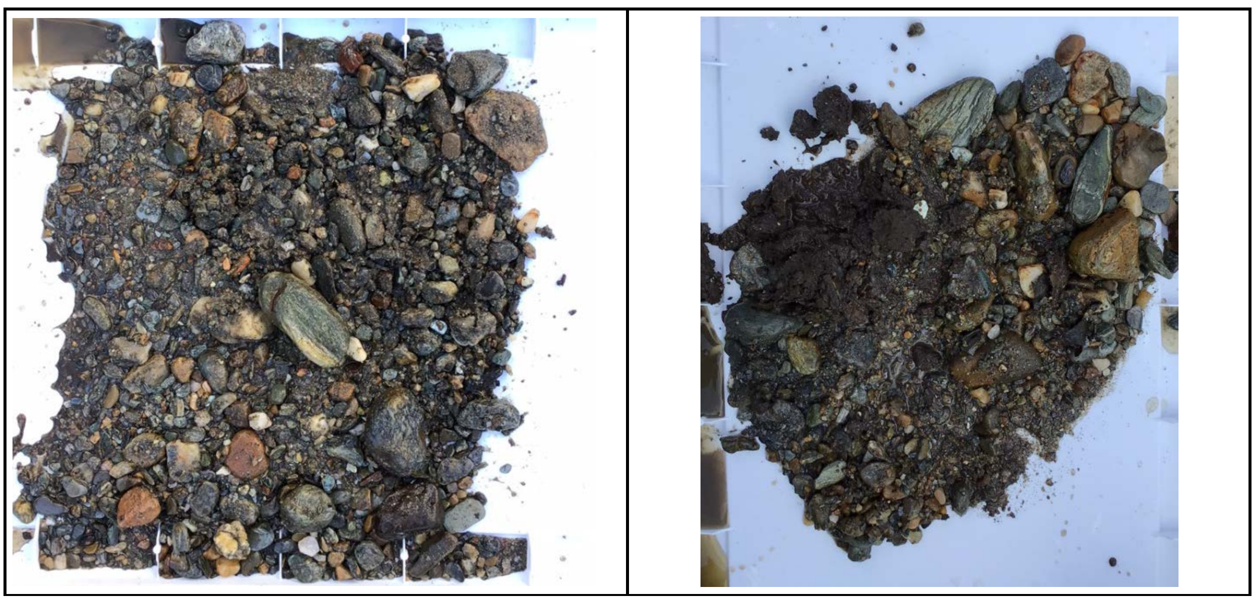


Figure 6. Photographs of the sediment below the surficial armor layer at Site 101 (left photo) and Site 102 (right photo).

3.2. Topographic and Bathymetric Surveying

No additional topographic or bathymetric data was collected as part of the monitoring project in 2022. Stone staff have begun assessing existing topographic and bathymetric datasets to determine the best methods for using pre- and post-removal data for assessing changes overtime. These datasets include the pre-removal data (both pre- and post-breach), post-removal as-built data, and UAV data collection completed by the UVM Spatial Analysis Lab in Spring 2022. Stone staff have generated DEMs from pre- and post-removal survey data. Initial volumetric, cross-section, longitudinal profile, and alignment comparisons will be made between pre-breach (prior to the Halloween storm), pre-removal but post Halloween 2019 breach, and post-removal as-built DEMs. Where possible or needed, survey data will be merged with ANR LiDAR data to cover the area of interest or area of expected change. Comparisons above the water surface will be made between the UVM Spring 2022 dataset and the pre- and post-removal DEMs. Whiteout Solutions will begin collecting topographic and bathymetric data using UAV for this project beginning in May 2023.

3.3. Evaluation of Wood Recruitment

Evaluation of wood recruitment included both assessing the installed rootwads and naturally recruited woody debris within the channel. Figure 7 provides the spatial distribution as well as relative size of tagged woody debris within Reach 2. Rootwads represented with dark green circles (0 – 2 inches embedded in bank) had become fully exposed from the bank and migrated downstream.

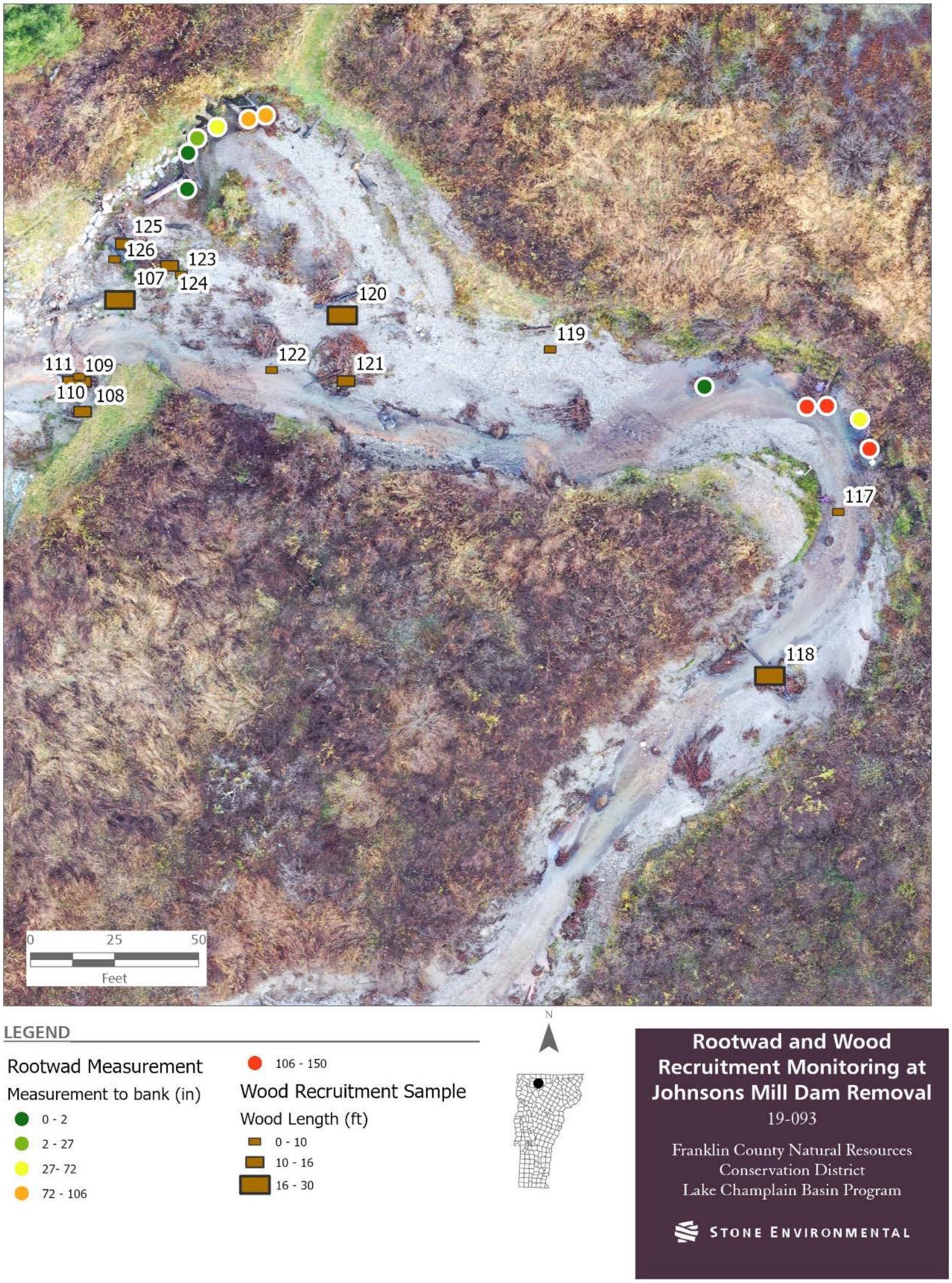


Figure 7. Spatial distribution of rootwads and channel recruited woody debris, along with relative embeddedness of rootwads and size of channel recruited woody debris.

Wood recruitment was assessed at sampling locations WR1, WR2, and WR3. Very little wood was recruited at the WR1 and WR2 locations due to migration and incision of the stream. As a result of the migration and incision, the rootwads became disconnected from the main channel, as shown in Figure 8. Rootwad embeddedness was also measured by measuring the distance from the blue metal rootwad tag to the bank. These measurements provide a baseline for tracking rootwad embeddedness over the course of the multi-year monitoring period. On the day of data collection, Stone staff observed that two of the rootwads at WR1 have slumped into the channel and were at the water surface with the potential to recruit new woody debris or become mobile and move downstream.

More woody debris was observed within the channel than anticipated. Most of the tagged woody debris pieces were timber logs that had previously been buried under the dam impoundment. These timber logs became exposed following dam removal and the subsequent channel adjustment. Figure 9 through Figure 11 summarize the dimensions and general locations of the wood debris greater than 3 inches in diameter. The majority of woody debris was located along the right bank, approximately 6 to 12 feet in length, and 11.5 to 17.5 inches in diameter. The total volume of the recruited wood equaled approximately 237 cubic feet.

In future years, the wood will be tracked as it migrates downstream and new pieces will be tagged and measured as they move into the monitoring reach. Migration distances and wood volume will be assessed throughout the monitoring period.

Figure 8. Perched rootwads extending from bank and over the water surface at WR1.

Figure 9. Summary of wood length within the monitoring reach of the Bogue Branch.

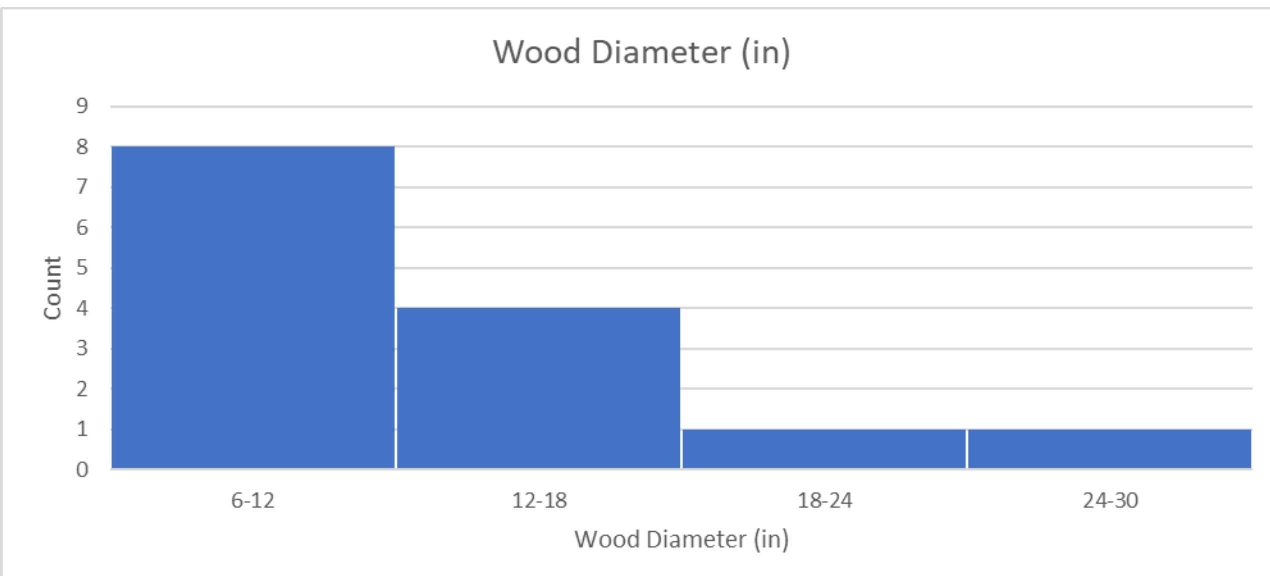


Figure 10. Summary of wood diameter within the monitoring reach of the Bogue Branch.

Figure 11. Summary of wood location within the monitoring reach of the Bogue Branch.

3.4. Evaluation of Plant Survival and Coverage

Plant survival and coverage were assessed to the best of Stone's ability given that the time of year made it difficult to assess plant survival. It is anticipated that plant community assessments will take place prior to leaf off in subsequent years to provide a better evaluation of plant health. This initial assessment, summarized in Figure 12 show the plant communities and general boundaries between assessed stands of similar vegetation. Stands are distinguished by changes in dominant vegetation type and generally extend to the monitoring extend of 30 feet from the top of bank. The main stands identified were "Planted Willow" (willows planted as part of the stream restoration project), "Natural Willow", "Mature Tree", and "Goldenrod/Grass". Mature trees were marked as individual stands so that their health can be monitored independently of the surrounding stand.

This data will be used to verify the Whiteout Solutions vegetation index imagery in subsequent monitoring years. Additionally, data on beaver activity within the reach will be collected in future monitoring efforts through the use ESRI Field Maps and the GPS unit. Line features will represent newly created beaver dams and polygons will represent areas affected by beaver activity. Monitoring will also be expanded to cover the entire river left floodplain through Reach 2 in 2023.

Figure 12. Map of dominant plant species in the monitoring reach of the Bogue Branch.

3.5. Aerial Imagery and Photographs

The aerial imagery collected on November 2, 2022, provides additional context for the field data collected on that day. The aerial imagery will be used as a baseline for tracking lateral channel migration and increase our understanding of seasonal changes within the monitoring reach. The processed orthoimage and DEM will be shared with FCNRCD. The aerial imagery was used as the basemap for Figure 7 and Figure 11. The boundaries of the 15-acre and 40-acre flight are provided in Figure 13.

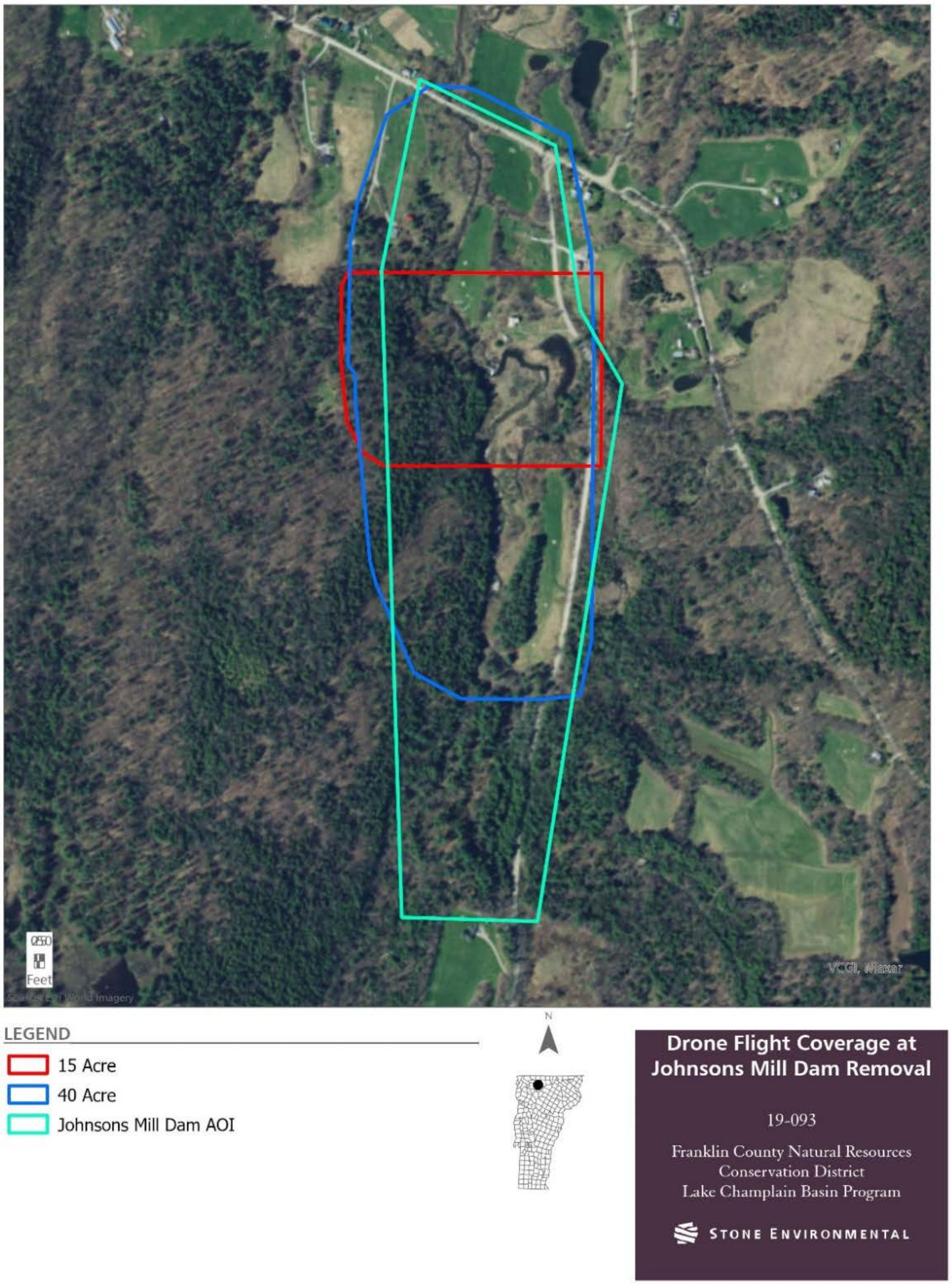


Figure 13. Map of initial drone flight extents as compared to entire AOI.

3.6. Algal Analysis

Results of the algal analysis were summarized and provided in a separate report and data package from Avancal Biological Consultants.

3.7. Macroinvertebrate Analysis

Macroinvertebrate analysis results are not available for 2022.

4. Conclusions

The Fall 2022 monitoring effort set the baseline for monitoring to continue in the Bogue Branch project area. Initial data collection efforts for streambed material, wood recruitment, plant coverage, and aerial imagery increased understanding of the current site conditions. While plant health was difficult to determine due to leaf off conditions it was possible to identify vegetation stands and set a baseline for monitoring of vegetation for subsequent years. Several improvements to the data collection have been identified for 2023, including expansion of the aerial imagery collected by Stone and area monitored for plant health. Subsequent annual reports will include a comparison to data collected in 2022.

Multi-Year Biological Monitoring at the Johnsons Mill Dam Removal Site
Annual Report for 2022
Submitted by: Avacal Biological
For: The Franklin County Natural Resources Conservation District

Introduction

Algal bioassessment complements physical and chemical data by providing corroborative evidence for environmental change. Taxonomic composition and diversity of algal assemblages are used to assess ecological health of habitats and to infer probable environmental causes of ecological impairments.

Algal samples were collected at the Johnsons Mill Dam Removal site on October 31, 2022 by Avacal Biological staff, for the Franklin County Natural Resources Conservation District as part of a three-year monitoring project. While the date fell outside of the standard collection timeframe, a baseline of algae present needed to be collected and will be treated as such. As the weather was not conducive for collection of macroinvertebrates, no data for 2022 was obtained.

Sampling and Data Acquisition Methods

Field data collection: Algal samples were collected along a transect above where the dam was removed (site 1) and below where the dam was removed (site 2). Site 2 was sampled first as to not disturb Site 1. Samples were collected on October 31, 2022.


Site 1

A multi-habitat sample was collected across the stream that represents all available habitat. Algal samples were collected off various substrates and include the following protocol:

<u>NATURAL SUBSTRATE SAMPLING – ROCKY SUBSTRATE</u> Sampling will focus on Epilithic algae.

~Clean sample trays, brushes, and other equipment with tap or stream water.
~Establish transects through riffles or runs.
~Across transect, collect scraping, suctioning, scooping of algae present at 10 locations along the transect.
~At each location, identify a cobble or boulder-sized rock, remove rock from water; Pick up the rock and hold it over a second sample tray that is clean. Place sampling device marker on rock and hold firmly. Sampling device/ marker is a piece of plastic with a 1in diameter circle opening in the center. Brush the area within the circle vigorously with a stiff bristled brush while holding rock over collection pan, note, you may need to scrape the area with a metal scraping tool first if the

algae is very thick. Rinse tools and sample area on rock with a squirt bottle filled with bottled water and collect sample in the large, white sample tray. Alternately if rock is too large to remove from water, use suction devise to scrap and suction sample from rock and place in white tray. Repeat process for other rocks and composite all rock-scrapings into multi-habitat sample container (rinse the tray and equipment to ensure all algae are in the container).
~Thoroughly clean all equipment, especially brush bristles, in water before leaving stream. Discard brushes if they get too grimy or difficult to clean.

Site 2

<u>NATURAL SUBSTRATE SAMPLING – SOFT BOTTOM</u> (To be included in multihabitat sample)
~ Sampling soft bottom streams, include the following methods:
Epilithic algae from log scrapings,
Epiphytic algae from plant clippings, Epipsammic and Epipelic algae from soft substrate.
~Epilithic algae from log scrapings: Clean large, white sample trays, toothbrushes, and metal scraping tools. Find logs or branches within the reach that can be lifted from the water, or suction scraped underwater. Using the following methods to collect samples along the 10 sites along the transect. Pick up a log/branch and hold it over a large, white sample tray. Place sampling device/ marker over the log/branch and hold firmly in place to define surface area to be sampled. Brush the area within the circle vigorously with a toothbrush and wash down brush and log/branch with a squeeze bottle into a collection pan (note, you may need to scrape the area with a metal scraping tool first if the algae are very thick). Alternatively, if the log is too large to remove from water, suction/ scrape sample from log. Rinse tools and sample area on log/branch with a squirt bottle filled with bottled water and collect sample in the large, white sample tray. Repeat process for other logs/branches or other parts of long logs/branches and composite all scrapings into sampling tray. (Rinse the tray and equipment to ensure all algae are in the multi-habitat sample container).
~Epiphytic algae from plant clippings. Clean scissors and large, white sample trays.
At each of the 10 previously identified locations, select plants that are underwater. Clip plant stems near their base, Place each stem into the multi habitat sample container.
~ Epipsammic and Epipelic algae from soft substrate: This method is appropriate for mucky bottom streams. Clean spatula, and white tray. At each location along the transect that contains soft substrate, lift a sample 1 in in diameter up using an unslotted spatula and place in multi habitat sampling container. Thoroughly clean all equipment in water before leaving stream.
Summary: At each of the 10 determined sample locations along the transect that is representative of the stream reach, collect algae from every available substrate and place into one multi habitat container for the entire transect.

<u>Sample Handling and Custody</u>
Samples were placed in a cooler, on ice and transported to the Avacal Biological, Vermont lab for full analysis. Samples were identified and enumerated within two weeks.

<u>Analytical Methods</u>
<u>Algae and cyanobacteria samples:</u>
All samples were examined with a compound microscope at the magnification necessary to identify all forms to lowest taxonomic level feasible.

Multi-Year Biological Monitoring at Johnsons Mill Dam Removal Site- Annual Report 2022
Avacal Biological

The taxonomist, Corrina King-Parnapy, has over ten years' experience in the field of identification of algae and cyanobacteria within Vermont, and New York watersheds. She used appropriate taxonomic keys, including Bellinger 2010, Van Vuuren 2006, Sherwood 2004, Round 1990, Prescott 1964, Wehr 2003.

All algal samples were individually homogenized, allowed to settle and a sub sample was taken and prepared according to the Environmental Protection Agencies alternate preparation technique (Validation of U.S.EPA Environmental Sampling Techniques, 2017) and placed on a gridded wet-mount slide. All forms of algae and cyanobacteria were identified to lowest taxonomic level possible and 100-300 algal "cell units" were counted. 300 cell units for diatoms (NYSDEC Periphyton Biomonitoring Protocols) [As Vermont does not yet have Periphyton Biomonitoring Protocols] and 100 for live and regional metrics.

__Algal Metrics Based on Composition__
Relative abundance and taxa richness
· Relative abundance of "soft" algae (including cyanobacteria, and chlorophyte) · Relative abundance of diatoms
· Total taxa richness
Metrics of biotic integrity
· **Total number of genera:** The generic richness should be highest in reference sites and lowest in impacted sites where genera become stressed. Total number of genera including diatoms and soft algae may provide a more robust measure of diversity than other estimates.
· **Total number of divisions:** Is represented by all taxa and should be highest in sites with good water quality and high biotic integrity.
· **Percent sensitive diatoms:** The sum of the relative abundance of pollution intolerant taxa.
· **Percent Achnanthes minutissima:** A cosmopolitan species with direct proportional abundance to toxic pollution.
· **Percent motile diatoms:** Indicative of areas containing high sediments.
Identification of cyanobacteria in sample
· In high densities, cyanobacteria are an undesirable component of freshwater ecosystems; they can produce hepatotoxins and neurotoxins that can cause fish kills, harm humans, wildlife and pets. Additionally, toxins produced can pose problems for households that get their drinking water from the body of water.
Diagnostic metrics that infer ecological conditions
· **Percent aberrant diatoms:** The percent of diatoms in a sample that have anomalies in stria or frustules shape. Indication of heavy metal contamination.
· **Percent motile diatoms:** The relative abundance of diatom genera that can crawl to the surface if covered by silt.
· **Pollution tolerance index (PTI):** The impaction level of that site to overall pollutants. · **Trophic index:** The impaction level of the site to nutrient levels.
· **Salinity index:** The impaction level of the site to salt.
· **Acidity index:** The impaction level of the site to acidic conditions.
· **Siltation index:** The impaction level of the site, as measured by motile genera. · **Palmer Algae Pollution Index:** A specific group of algae is associated with municipal sewage treatment plants. This group thrives in organically polluted waters and is used as a biological indicator of organic pollution. The Palmer algae pollution index (PPI) was compiled from reports by 165 authors and ranks the species/genera most often encountered in the waters with high rates of organic pollution. *__This metric in__*

*combination with other metrics and data is being utilized within the Septic Initiative of the Lake George Waterkeeper to assist with prioritization of nearshore septic systems for replacement or upgrades***.**
· **Indicator forms:** The notation of forms of algae that indicate eutrophic conditions.
· **Nutrient criteria for soft bodied alga:** determine minimum and optimal levels of nutrients needed for full algal growth. Assists in the determination of water quality impaction.
Other metrics that may be applied:
· **Percent Community Similarity Index:** based on relative abundance of forms present at test site against a reference site/ natural site.
· **Area-specific cell densities and bio volumes:** dividing the number of cells counted by the proportion of sample counted and the area from which the sample was collected.
· **% Cyclotella sp.** summer dominance of Cyclotella can cause a decrease in water clarity by scattering the light.
· **Impairment of ecological conditions:** the deviation between environmental conditions at sample site and a reference site.

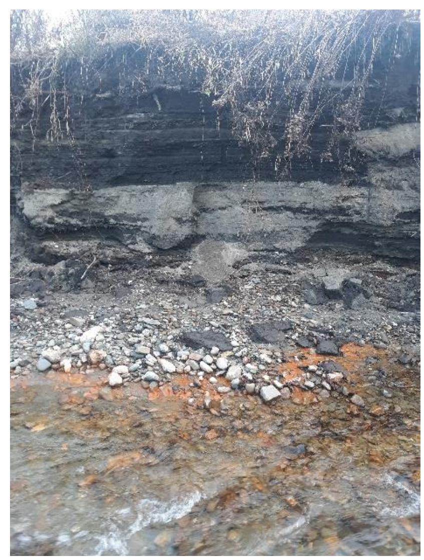
Results

Algal Metrics Based on Composition

Baseline data was collected for year one (2022). Data sheets attached for each site.

- Generic Richness; Should be highest in reference sites and lowest in impacted sites. While both site 1 and site 2 had low generic richness, this could be related to the high silt/sand at the location and the high levels of iron oxide.
- Number of Divisions; Highest in sites with good water quality and high biotic integrity. While both site 1 and site 2 had low number of divisions, this could be related to the late sampling date and possible recent higher water events and lack of recolonization.
- Presence of Cyanobacteria; (Blue-green algae) are of greater concern than other forms of algae, as they can, under the right environmental conditions produce toxins and form toxic blooms. Excessive growth of benthic blue-green algae within streams can cause health problems for humans, pets, livestock and wildlife. Excessive amounts of Cyanobacteria present can indicate higher levels of nutrients. Both sites did not have any Cyanobacteria found within samples collected.
- %Sensitive Diatoms; The sum of relative abundance of all intolerant genus of diatoms. Especially important in small-order streams where primary productivity may be naturally low, causing other metrics to underestimate water quality. Site 1 had 0% sensitive diatoms and Site 2 had 2% sensitive diatoms.
- Percent *Achnanthes m*; This cosmopolitan diatom has a very broad ecological amplitude. Frequently dominate in sites subject to acid mine drainage, and toxic pollution. Provisional ranges of impact are: 0-25% = no disturbance, 25-50% = minor disturbance, 50-75% = moderate disturbance and 75-100% = severe disturbance. Site 0 was at 0% and Site 2 was at 0.66% indicating no toxic pollution.
- Pollution Tolerance Index; The sum of relative abundance of forms multiplied by the pollution tolerance class of each form. Provisional ranges for the levels of impact are: >2.5 = non-impacted, 2.01-2.50 = slightly impacted, 1.51-2.00 = moderately impacted, and <1.50 = severely impacted. Site 1 was 2.22 indicating slight pollution impaction, while site 2 was 1.87 indicating it was moderately impacted for pollution.

- Trophic Index; A measure of % mesotrophic to hyperetrophic individuals. Provisional ranges for the levels of impact are; 0-50 = non-impacted, 52-70 = slightly impacted, 71-85 = moderately impacted, and 86-100 = severely impacted. Site 1 was 71, meaning it was moderately impacted at the trophic level. Site 2 was 87 meaning it was severely impacted at the trophic level.
- Salinity Index; A measure of % halophilous individuals, indicating dissolved salts. Provisional ranges for the levels of impact are: 0-10 = non-impacted, 11-30 = slightly impacted, 31-50 = moderately impacted and 51-=100 = severely impacted. Site 1 was 71, and site 2 was 92 indicating both sites are severely impacted for salinity. However, with not knowing the current makeup of nearby soils and roads where road salt could be utilized, this metric is just used as a baseline purpose.
- Acidity Index; A measure of % acidophilous individuals, reflecting acid effects. Provisional ranges for levels of impact are: 0-20 = non-impacted, 21-50 = slightly impacted, 51-75 = moderately impacted, and 76-100 = severely impacted. Site 1 was a 2 and site 2 was a 1, indicating no concerns or impaction from acids.
- Siltation Index; A measure of percent relative abundance of individuals belonging to motile genera. Provisional ranges for the levels of impact are: <20 = no siltation, 20-39 = minor siltation, 40-60 = moderate siltation and >60 = heavy siltation. Site 1 was a 28, and site 2 was a 22 indicating minor siltation at both sample sites.
- Palmer Pollution Index; A specific group of algae is associated with organic pollution and is utilized as a biological indicator of organic pollution. Provisional ranges for levels of impact are: A score of 20 or more is evidence of high organic pollution, A score of 15-19 indicates probable organic pollution present. Lower scores usually indicate less organic pollution, but they may also occur if something is interfering with algae growth. Site 1 was a 9 and site 2 was a 13, indicating lower levels of organic pollution present.
- Notes: With the abundance of iron oxide located at both sites, there is the possibility that algal growth has been inhibited. In addition, there could be implications for internal loading of phosphorus.



	Date	Initials
Entered	12/3/2022	CP
QC'd	12/4/2022	CP

LABORATORY ALGAE SAMPLE ANALYSIS DATA SHEET
Avacal Biological
Biological Assessment Program

Stream Johnsons Mill Dam Removal Site 1
Collection date 10/31/2022
Sample ID date 11/5/2022
ID by CP

Genus	Species	AKA	PT #	pH	Trop	Salt	ni	N	Ti x ni	PTI	pH	tropy	salinity	% A. min	Silt	% Sens.
Achnanthes	minutissima	linearis, affinis	3	0	0	1	0	300	0	0	0	0	0	0	28	0
Achnanthes	lanceolata	rostrata, oblogella	2	0	1	1	0	300	0	0	0	0	0			
Achnanthes	exigua		3	0	0	0	0	300	0	0	0	0	0			
Amphora	Neneta		3	0	0	0	0	300	0	0	0	0	0			
Aulacoseira	granulata		3	0	0	0	0	300	0	0	0	0	0			
Brachysira	serians	vitrea	3	0	0	0	0	300	0	0	0	0	0			
Campylodiscus	clypeus		2	0	0	0	0	300	0	0	0	0	0			
Cocconeis	pediculus	placentula	2.5	0	1	1	0	300	0	0	0	0	0			
Cymbella	naviculiformis		2	0	0	1	2	300	4	0.0133	0	0	2			
Cymbella	aspera		4	0	0	0	0	300	0	0	0	0	0			
Cymbella	tumida		2.5	0	1	1	0	300	0	0	0	0	0			
Diatomella	hiemale		3	0	0	0	0	300	0	0	0	0	0			
Diatomella	parva		3	0	0	0	2	300	6	0.02	0	0	0			
Encyonema	minutum		2	0	0	0	6	300	12	0.04	0	0	0			
Encyonema	gracile		3	0	0	0	0	300	0	0	0	0	0			
Encyonema	sp.		3	0	0	0	0	300	0	0	0	0	0			
Encyonema	prostratum		3	0	0	0	0	300	0	0	0	0	0			
Epithemia	sorex		3	0	0	0	0	300	0	0	0	0	0			
Epithemia	adnata		3	0	0	0	0	300	0	0	0	0	0			
Eunotia	pectinalis		3	1	0	0	0	300	0	0	0	0	0			
Eunotia	serpentina		3	1	0	1	0	300	0	0	0	0	0			
Eunotia	sp.		3	1	0	1	5	300	15	0.05	5	0	5			
Eunotia	arcus		4	0	0	1	0	300	0	0	0	0	0			
Eunotia	incisa		3	1	0	0	0	300	0	0	0	0	0			
Eunotia	minor		3	0	0	0	0	300	0	0	0	0	0			
Fragilaria	crotonensis		3	0	1	1	0	300	0	0	0	0	0			
Fragilariforma	viriscens	Fragilaria viriscens	3	0	0	0	0	300	0	0	0	0	0			
Frustulia	rhomboides	amphipleuroides	3	1	0	0	0	300	0	0	0	0	0			
Frustulia	vulgaris		3	0	0	0	0	300	0	0	0	0	0			
Gomphonema	truncatum		3	0	1	1	0	300	0	0	0	0	0			
Gomphonema	parvulum		1	0	1	1	6	300	6	0.02	0	6	6			
Gomphonema	acuminatum		2	0	1	1	15	300	30	0.1	0	15	15			
Gomphonema	augur		2	0	0	1	0	300	0	0	0	0	0			
Gomphonema	minutum		2	0	1	1	0	300	0	0	0	0	0			
Gyrosigma	spencerii	scalproides	2	0	0	0	0	300	0	0	0	0	0			
Melosira	varians		2	0	1	1	0	300	0	0	0	0	0			
Meridion	circulare		3	0	0	1	0	300	0	0	0	0	0			
Navicula	margalithi	tripunctata	2	0	1	1	0	300	0	0	0	0	0			
Navicula	capitatoradiata		2	0	1	1	0	300	0	0	0	0	0			
Navicula	cryptocephala		3	0	0	1	0	300	0	0	0	0	0			
Navicula	radiosa		3	0	1	1	0	300	0	0	0	0	0			
Navicula	angusta		3	1	0	0	0	300	0	0	0	0	0			
Navicula	lanceolata		2	0	1	1	15	300	30	0.1	0	15	15			
Navicula	rhynchocephala		3	0	1	1	0	300	0	0	0	0	0			
Navicula	notha		2	0	0	0	0	300	0	0	0	0	0			
Nitzschia	linearis		2	0	1	1	63	300	126	0.42	0	63	63			
Nitzschia	curvula	Stenoplerobia/ flexa	2	0	0	0	6	300	12	0.04	0	0	0			
Nitzschia	palea		1	0	1	1	0	300	0	0	0	0	0			
Nitzschia	gracilis	acicularis	2	0	0	0	0	300	0	0	0	0	0			
Pinnularia	borealis	gibba	3	0	0	0	50	300	150	0.5	0	0	0			
Pinnularia	viridis		3	0	0	0	0	300	0	0	0	0	0			
Pinnularia	abaujensis		3	0	0	0	0	300	0	0	0	0	0			
Pinnularia	microstauron		3	0	0	0	15	300	45	0.15	0	0	0			
Pinnularia	subcapitata		3	0	0	0	0	300	0	0	0	0	0			
Placoneis	sp.		3	0	0	0	0	300	0	0	0	0	0			
Pleurosigma	elongatum		3	0	0	0	0	300	0	0	0	0	0			
Rhopalodia	gibba		3	0	0	0	0	300	0	0	0	0	0			
Sellaphora	pupula		2	0	0	0	0	300	0	0	0	0	0			
Semiorbis	hemicyclus		3	0	0	0	0	300	0	0	0	0	0			
Stauroneis	acuta		3	0	0	0	0	300	0	0	0	0	0			
Surirella	striatula		2	0	0	0	0	300	0	0	0	0	0			
Surirella	brebissonii		2	0	0	0	0	300	0	0	0	0	0			
Surirella	sp.		2	0	0	0	0	300	0	0	0	0	0			
Surirella	amphioxys		2	0	1	1	0	300	0	0	0	0	0			
Surirella	ovalis		2	0	1	1	0	300	0	0	0	0	0			
Synedra	acus		2	0	1	1	0	300	0	0	0	0	0			
Synedra	ulna	actinastroides	2	0	1	1	115	300	230	0.7667	0	115	115			
Synedra	rumpens	pulchella	2	0	1	1	0	300	0	0	0	0	0			
Synedra	delicatissima		2	0	1	1	0	300	0	0	0	0	0			
Tabellaria	flocculosa		3	1	0	1	0	300	0	0	0	0	0			
							300			**2.22**	**2**	**71**	**74**			

	Date	Initials
Entered	12/3/2022	CP
QC'd	12/4/2022	CP

LABORATORY ALGAE SAMPLE ANALYSIS DATA SHEET
Avacal Biological
Biological Assessment Program

Stream Johnsons Mill Dam Removal Site 2
Collection date 10/31/2022
Sample ID date 11/5/2022
ID by CP

Genus	Species	AKA	PT #	pH	Trop	Salt	ni	N	Ti x ni	PTI	pH	tropy	salinity	% A. min	Silt	% Sens.
Achnanthes	minutissima	linearis, affinis	3	0	0	1	2	300	6	0.02	0	0	2	0.666667	22	2
Achnanthes	lanceolata	rostrata, oblogella	2	0	1	1	0	300	0	0	0	0	0			
Achnanthes	exigua		3	0	0	0	0	300	0	0	0	0	0			
Amphora	Neneta		3	0	0	0	0	300	0	0	0	0	0			
Aulacoseira	granulata		3	0	0	0	0	300	0	0	0	0	0			
Brachysira	serians	vitrea	3	0	0	0	0	300	0	0	0	0	0			
Campylodiscus	clypeus		2	0	0	0	0	300	0	0	0	0	0			
Cocconeis	pediculus	placentula	2.5	0	1	1	0	300	0	0	0	0	0			
Cymbella	naviculiformis		2	0	0	1	6	300	12	0.04	0	0	6			
Cymbella	aspera		4	0	0	0	0	300	0	0	0	0	0			
Cymbella	tumida		2.5	0	1	1	0	300	0	0	0	0	0			
Diatomella	hiemale		3	0	0	0	0	300	0	0	0	0	0			
Diatomella	parva		3	0	0	0	4	300	12	0.04	0	0	0			
Encyonema	minutum		2	0	0	0	0	300	0	0	0	0	0			
Encyonema	gracile		3	0	0	0	0	300	0	0	0	0	0			
Encyonema	sp.		3	0	0	0	0	300	0	0	0	0	0			
Encyonema	prostratum		3	0	0	0	0	300	0	0	0	0	0			
Epithemia	sorex		3	0	0	0	0	300	0	0	0	0	0			
Epithemia	adnata		3	0	0	0	0	300	0	0	0	0	0			
Eunotia	pectinalis		3	1	0	0	0	300	0	0	0	0	0			
Eunotia	serpentina		3	1	0	1	0	300	0	0	0	0	0			
Eunotia	sp.		3	1	0	1	0	300	0	0	0	0	0			
Eunotia	arcus		4	0	0	1	6	300	24	0.08	0	0	6			
Eunotia	incisa		3	1	0	0	0	300	0	0	0	0	0			
Eunotia	minor		3	0	0	0	0	300	0	0	0	0	0			
Fragilaria	crotonensis		3	0	1	1	0	300	0	0	0	0	0			
Fragilariforma	viriscens	Fragilaria viriscens	3	0	0	0	0	300	0	0	0	0	0			
Frustulia	rhomboides	amphipleuroides	3	1	0	0	0	300	0	0	0	0	0			
Frustulia	vulgaris		3	0	0	0	0	300	0	0	0	0	0			
Gomphonema	truncatum		3	0	1	1	0	300	0	0	0	0	0			
Gomphonema	parvulum		1	0	1	1	65	300	65	0.2167	0	65	65			
Gomphonema	acuminatum		2	0	1	1	16	300	32	0.1067	0	16	16			
Gomphonema	augur		2	0	0	1	0	300	0	0	0	0	0			
Gomphonema	minutum		2	0	1	1	0	300	0	0	0	0	0			
Gyrosigma	spencerii	scalproides	2	0	0	0	0	300	0	0	0	0	0			
Melosira	varians		2	0	1	1	0	300	0	0	0	0	0			
Meridion	circulare		3	0	0	1	0	300	0	0	0	0	0			
Navicula	margalithi	tripunctata	2	0	1	1	0	300	0	0	0	0	0			
Navicula	capitatoradiata		2	0	1	1	0	300	0	0	0	0	0			
Navicula	cryptocephala		3	0	0	1	0	300	0	0	0	0	0			
Navicula	radiosa		3	0	1	1	7	300	21	0.07	0	7	7			
Navicula	angusta		3	1	0	0	0	300	0	0	0	0	0			
Navicula	lanceolata		2	0	1	1	14	300	28	0.0933	0	14	14			
Navicula	rhynchocephala		3	0	1	1	3	300	9	0.03	0	3	3			
Navicula	notha		2	0	0	0	0	300	0	0	0	0	0			
Nitzschia	linearis		2	0	1	1	25	300	50	0.1667	0	25	25			
Nitzschia	curvula	Stenoplerobia/ flexa	2	0	0	0	12	300	24	0.08	0	0	0			
Nitzschia	palea		1	0	1	1	6	300	6	0.02	0	6	6			
Nitzschia	gracilis	acicularis	2	0	0	0	0	300	0	0	0	0	0			
Pinnularia	borealis	gibba	3	0	0	0	0	300	0	0	0	0	0			
Pinnularia	viridis		3	0	0	0	0	300	0	0	0	0	0			
Pinnularia	abaujensis		3	0	0	0	0	300	0	0	0	0	0			
Pinnularia	microstauron		3	0	0	0	0	300	0	0	0	0	0			
Pinnularia	subcapitata		3	0	0	0	0	300	0	0	0	0	0			
Placoneis	sp.		3	0	0	0	0	300	0	0	0	0	0			
Pleurosigma	elongatum		3	0	0	0	0	300	0	0	0	0	0			
Rhopalodia	gibba		3	0	0	0	3	300	9	0.03	0	0	0			
Sellaphora	pupula		2	0	0	0	5	300	10	0.0333	0	0	0			
Semiorbis	hemicyclus		3	0	0	0	0	300	0	0	0	0	0			
Stauroneis	acuta		3	0	0	0	0	300	0	0	0	0	0			
Surirella	striatula		2	0	0	0	0	300	0	0	0	0	0			
Surirella	brebissonii		2	0	0	0	0	300	0	0	0	0	0			
Surirella	sp.		2	0	0	0	0	300	0	0	0	0	0			
Surirella	amphioxys		2	0	1	1	0	300	0	0	0	0	0			
Surirella	ovalis		2	0	1	1	0	300	0	0	0	0	0			
Synedra	acus		2	0	1	1	15	300	30	0.1	0	15	15			
Synedra	ulna	actinastroides	2	0	1	1	109	300	218	0.7267	0	109	109			
Synedra	rumpens	pulchella	2	0	1	1	0	300	0	0	0	0	0			
Synedra	delicatissima		2	0	1	1	0	300	0	0	0	0	0			
Tabellaria	flocculosa		3	1	0	1	2	300	6	0.02	2	0	2			
							300			**1.87**	**1**	**87**	**92**			

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