



**Nineteen Mile Brook
2019 Baseline Environmental Assessment
Aquatic Biota and Water Quality
Tuftonboro, NH**

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1.0 Introduction

In 2008 Normandeau Associates, Inc. completed a baseline environmental study of the Nineteen Mile Brook watershed on behalf of the Tuftonboro Conservation Commission (TCC). The study was completed to evaluate the potential environmental impacts associated with a recently permitted (but not yet constructed) subsurface rapid infiltration discharge of up to 600,000 gallons per day of treated municipal wastewater (potentially expandable to 2 million gallons per day) in the neighboring Town of Wolfeboro, NH. This discharge is located near the Wolfeboro/Tuftonboro town line and is within the watersheds of Nineteen Mile Brook, Whitten Pond and Lake Winnepesaukee. The TCC commissioned the study due to significant concerns regarding the potential impact of the discharge on general stream, pond and lake water quality, macroinvertebrates, fisheries, wetlands, public health and lake and stream ecology.

The 2008 NAI study provided an assessment of aquatic habitat, surface water quality, benthic macroinvertebrate communities, wildlife and fish populations, and rare, threatened, and endangered species within a seven mile section of Nineteen Mile Brook, including Whitten Pond. The 2008 study resulted in the following findings (NAI, 2008):

- Baseline studies for water quality, aquatic and wetland wildlife and aquatic habitat and associated fish and macroinvertebrates all indicate that Nineteen Mile Brook from about ¼ mile above the Tuftonboro/Wolfeboro town line is a high quality small stream, typical of New Hampshire streams largely unaffected by cultural development.
- During the 2008 summer sampling program, water quality was found to be good to excellent in all locations and during each sampling event, based on field and laboratory measurements of selected water quality parameters.
- There was no significant evidence of water quality degradation, upstream to downstream, except for slight increases in conductivity during all sampling events. These increases may reflect the slightly greater amount of development present in the lower portion of the study area, but no upstream/downstream relationship was evident in chemical analyses from the laboratory tests.
- Aquatic habitat was determined to be excellent for supporting fish and benthic macroinvertebrates, based on the results of surveys in 4 sample locations.
- The benthic macroinvertebrate community was classified non-impaired at two of three downstream stations and slightly impaired at the third. Slight impairment at the most downstream station appears to be due to differences in habitat characteristics, such as substrate composition and current velocity.
- Fish data indicated a good quality, cold-water community at all sampling locations.
- All species of wildlife observed in the study area were common species that were expected to be present and more or less abundant. No listed threatened or endangered species were found

and none that were known to exist in Tuftonboro were expected to be present due to a lack of appropriate habitat.

In summary, the 2008 baseline study concluded that water quality in Nineteen Mile Brook and the biotic community supported by the brook was excellent throughout the study area as determined by multiple methods of assessment.

The Wolfeboro Rapid Infiltration Basin groundwater discharge project was made operational in 2009 after the conclusion of the 2008 baseline environmental studies. The RIB discharge site experienced performance issues shortly after the system began operating in 2009 with increased flows and breakouts from pre-existing seep areas above Nineteen Mile Brook which resulted in discrete channelization in previous areas of sheetflow, erosion from the hillslope and sediment deposition in the adjacent wetland areas above Nineteen Mile Brook (Wolfeboro, 2019). In 2009, a slope failure was documented in the seep areas as well as the development of a sink hole and downslope sand migration into wetland areas. In response to the performance issues, discharge rates were reduced below design and permit limits from 600,000 gallons per day (GPD) to 300,000 to 500,000 GPD in an attempt to reduce the groundwater flow rates emerging from the seep areas. Further sediment erosion and deposition in Nineteen Mile Brook associated with the site was documented in 2010 and sediment deposition controls were installed at weirs in the seep areas in response. Flows were further reduced from the RIBs to 200,000 to 400,000 GPD in 2010 and 200,000 to 300,000 GPD in 2011. A piping system was added to the groundwater breakout areas on the hillslopes to convey water away from the seep areas and wetlands directly to the sand traps above Nineteen Mile Brook. An Administrative Order by Consent was issued by NHDES in 2015 citing the groundwater breakouts and resulting erosion and deposition as violations of the Wolfeboro RIB discharge permit. Further engineering controls are being evaluated by Wolfeboro and their consultants in coordination with NHDES to restore the function of the RIB discharge system while protecting the impacted water resources in the area of the project.

On October 15, 2018 Steve Wingate of TCC requested NAI to provide a study plan to repeat the 2008 studies completed by NAI on Nineteen Mile Brook. The goal of the study would be to determine any environmental changes in the watershed since construction and activation of the Wolfeboro rapid infiltration discharge and provide a new baseline environmental assessment. We also proposed to review the Wolfeboro rapid infiltration discharge permit file, including any water quality data collected and reported as a permit condition, to evaluate water quality in the brook including any trends or other changes since activation of the rapid infiltration discharge. Normandeau was then hired in 2018 to complete the file review portion of the work plan and based on that provide revised recommendations for further field studies. Following the permit file review, Normandeau modified the proposed scope of work to include aquatic habitat assessment, macroinvertebrate sampling, a fisheries assessment, water quality monitoring, and an updated review of rare, threatened, and endangered species.

A file review of the Wolfeboro groundwater discharge permit was completed in January, 2019 and included collecting and reviewing all of the publicly available information located on the New Hampshire Department of Environmental Services Onestop Data Portal. The rationale for the file review was to determine the state of water quality in Nineteen Mile Brook following nine years of operation of the Wolfeboro rapid infiltration discharge. Field studies in Nineteen Mile Brook began in May, 2019 and included a five month long water quality study as well as a fisheries study, aquatic habitat assessment, and macroinvertebrate sampling in August, 2019. Macroinvertebrate taxonomic evaluation was

completed in September, 2019 and data summaries and analysis were completed in December, 2019 as presented in this report. The results of the 2019 field studies are presented to evaluate the ecological condition of Nineteen Mile Brook after 10 years of operations of the Wolfeboro RIB discharge and offer a direct comparison to baseline conditions presented in the 2008 study. The field studies and analysis were able to be successfully completed as outlined in the proposal. One exception was the unexplained loss of water quality data in September, 2019. Continuous specific conductance monitoring by deployed data loggers was interrupted by a communication hardware issue at all sites and resulted in a total data loss for the month of September. While unfortunate, we don't believe this data loss affects our results or analysis as the expected range of flow and temperature conditions in the stream were captured in the preceding months. The data loss and implications are discussed in Section 7.

1.1 Study Area

Nineteen Mile Brook is a tributary of Lake Winnepesaukee located in the Towns of Wolfeboro and Tuftonboro in the Central New Hampshire lakes region (Figures 1 & 2). The brook generally flows from east to west and has a drainage area of approximately 6.28 square miles where it discharges into Nineteen Mile Bay in Lake Winnepesaukee. The Wolfeboro RIB discharge site is located in the Town of Wolfeboro adjacent to the Tuftonboro/Wolfeboro town line with the discharge structures located approximately 1,000 ft. upslope of the north bank of Nineteen Mile Brook. The drainage area of Nineteen Mile Brook in the RIB discharge zone is approximately 1.8 square miles. Treated wastewater is intermittently pumped to the RIB structures and allowed to infiltrate into groundwater in accordance with the current Wolfeboro groundwater discharge permit (NH Groundwater Discharge Site #200707014). The groundwater discharge system was designed to infiltrate water into the subsurface with emergence into the brook through groundwater discharge areas. Since operation of the RIB system there have been multiple issues with the system, particularly in the discharge areas, as discussed in Section 2. The 2008 baseline study included portions of the brook from Nineteen Mile Bay up to the area immediately upstream of the discharge zones. In the 2019 baseline study we reviewed the same general areas and monitoring locations to facilitate comparisons between the studies.

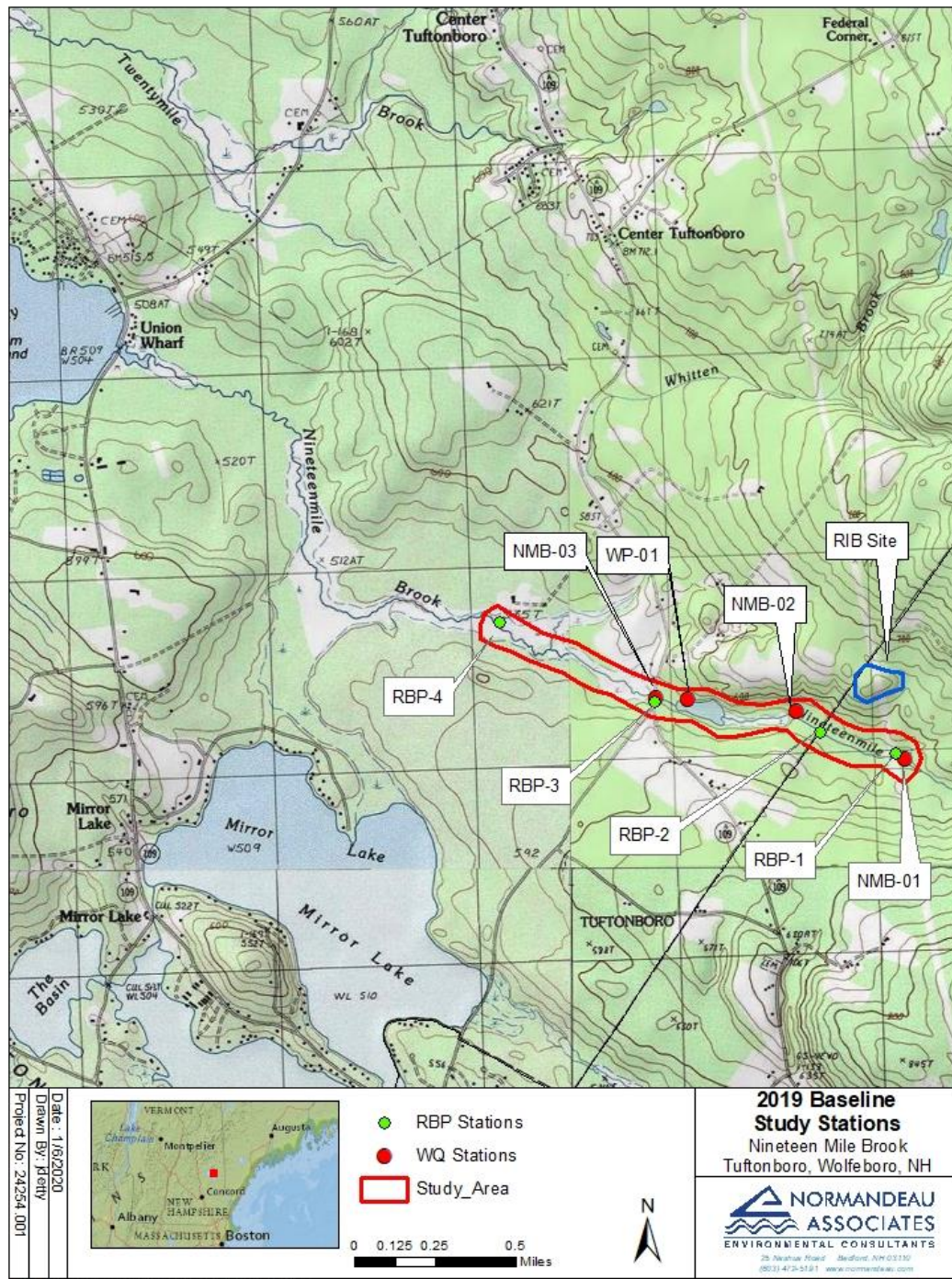


Figure 1. Site map of Nineteen Mile Brook 2019 baseline study area

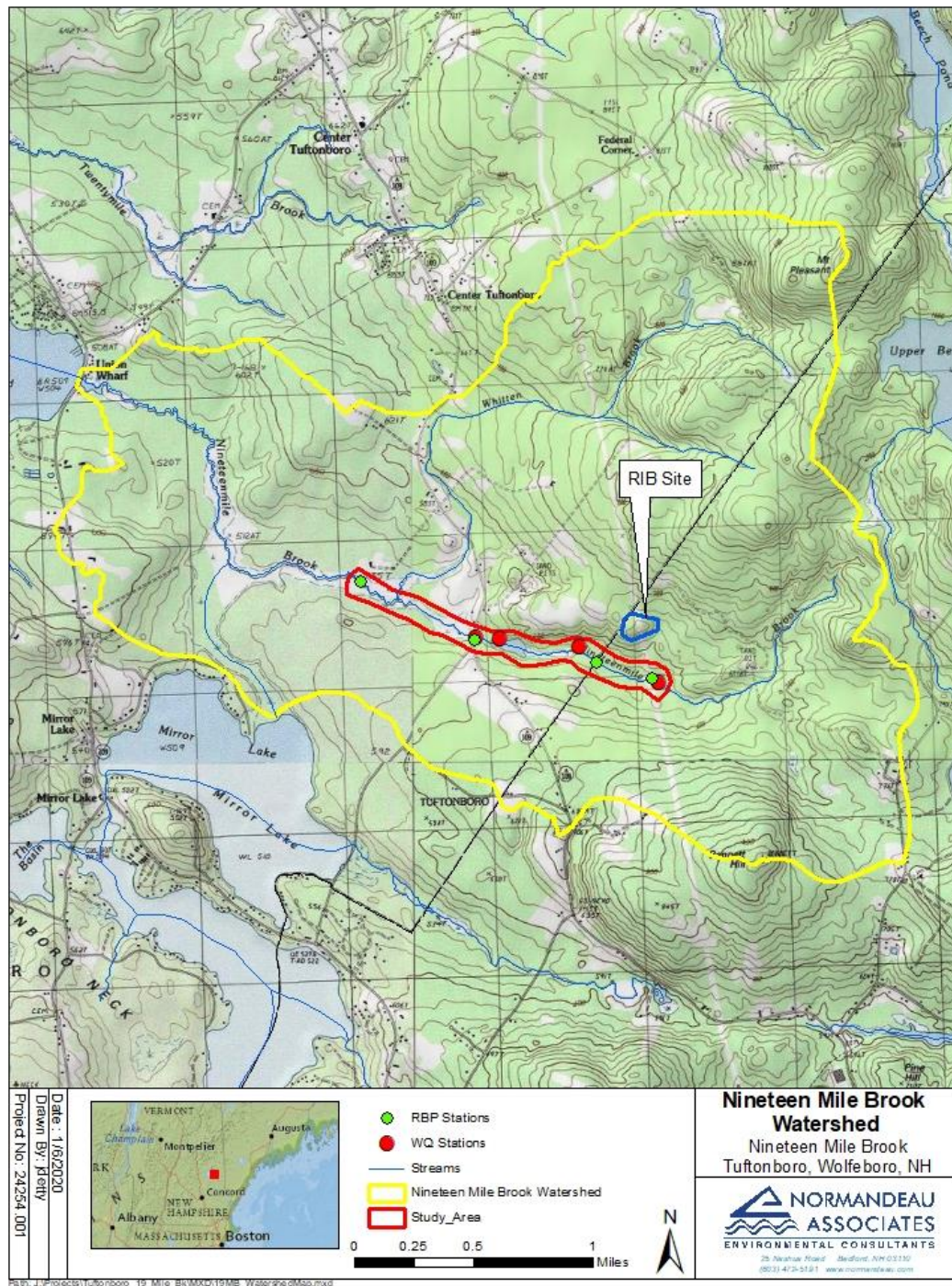


Figure 2. Nineteen Mile Brook watershed map and 2019 baseline study area

1.2 Study Overview

The 2019 Nineteen Mile Brook baseline study included several concurrent field studies and data analysis as detailed in Sections 5 through 7. These studies included the use of the US Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBP; Barbour, 1999) to evaluate aquatic habitat and collect benthic samples from the stream for analysis of macroinvertebrates. A fish community assessment was completed at the same time as the RBP evaluations following NHDES Biomonitoring Program Protocols (NHDES, 2013b). The RBP and fish evaluations were completed at four locations in Nineteen Mile Brook consistent with the 2008 studies and shown in Figure 1. The stations were located to document conditions at an upstream location that was outside the influence of the RIB discharges and at three other locations including within the RIB discharge zone, within a recovery zone, and at a downstream location. Aquatic habitat was evaluated for a series of habitat metrics to provide a numerical habitat ranking. Benthic samples were analyzed for macroinvertebrate composition and abundance following NHDES biomonitoring protocols (NHDES, 2013a) and EPA RBP protocols (Barbour, 1999). Fish data were analyzed using analytical metrics provided in the RBP first edition (Plafkin et al., 1989) including Species Richness and Composition Metrics, Trophic Composition Metrics, and Fish Abundance and Condition Metrics to evaluate overall stream quality for supporting aquatic biota. A water quality study was also completed, beginning in May, 2019 and continuing through September, 2019. The water quality study included monthly collection of water samples at four stations (see Figure 1) - a background reference station, a station in the discharge area, a station in Whitten Pond, and a station at the Route 109A road crossing. In addition to water sampling, conductivity and water temperature were continuously recorded at the four stations for the study period to document short timescale variations in water quality that could be missed by monthly or even weekly sampling. These studies were designed to repeat the efforts of the 2008 baseline study to allow a comparison in water quality over the ten year interim and also provide additional information to assess the overall water quality in Nineteen Mile Brook.

2.0 Wolfeboro Rapid Infiltration Discharge Permit File Review

In 2018 NAI was hired by Tuftonboro to complete a review and evaluation of the Wolfeboro rapid infiltration discharge project file, as publicly available from NHDES, to review water quality in Nineteen Mile Brook and assess the overall condition of the brook, changes in water quality over time, and any information gaps that might limit a comprehensive assessment of water quality in the brook. Normandeau completed a file review in December 2018 and January 2019 and included a review and evaluation of all data reports, data submittals, and other relevant information included in the project file. The amount of information available in the groundwater permit file was extensive and we found it necessary to focus our efforts on the file materials determined to be most relevant to the objective of this study – i.e. determining the state of water quality in Nineteen Mile Brook following nine years of operation of the Wolfeboro rapid infiltration discharge. In addition to evaluating the available information, we identified any additional data that would be informative (but not a permit requirement) based on our understanding of the observed or potential project impacts on water quality. A summary of the Wolfeboro discharge project file review is presented in this section.

Overview of Wolfeboro discharge site

The information reviewed for this study was accessed from the NHDES Onestop website (<https://www.des.nh.gov/onestop/index.htm>) and included the project materials associated with the

Wolfeboro Rapid Infiltration Basin Facility (Whitten Site) Groundwater Discharge Site #200707014. This included the Groundwater Discharge Permits issued for the Site in 2007, 2012, and 2017 and the associated file materials (applications, reports, memos, data submittals, etc.) for the Site as accessed from the NHDES Onestop website. The Wolfeboro Rapid Infiltration Basin groundwater discharge project was made operational in 2009 after the conclusion of our 2008 baseline environmental studies in Nineteen Mile Brook. The RIB discharge site experienced performance issues shortly after the system began operating in 2009 with increased flows from pre-existing seep areas above Nineteen Mile Brook which resulted in discrete channelization in previous areas of sheetflow, erosion from the hillslope and sediment deposition in the adjacent wetland areas above Nineteen Mile Brook. In 2009, a slope failure was documented in the seep areas as well as the development of a sink hole and downslope sand migration into wetland areas. In response to the performance issues, discharge rates were reduced below design and permit limits from 600,000 gallons per day (GPD) to 300,000 to 500,000 GPD in an attempt to reduce the groundwater flow rates emerging from the seep areas. Further sediment erosion and deposition in Nineteen Mile Brook associated with the site was documented in 2010 and sediment deposition controls were installed at weirs in the seep areas in response. Flows were further reduced from the RIBs to 200,000 to 400,000 GPD in 2010 and 200,000 to 300,000 GPD in 2011. A piping system was added to the groundwater breakout areas on the hillslopes to convey water away from the seep areas and wetlands directly to the sand traps above Nineteen Mile Brook. An Administrative Order by Consent was issued by NHDES in 2015 citing the groundwater breakouts and resulting erosion and deposition as violations of the Wolfeboro RIB discharge permit. Further engineering controls are being evaluated by Wolfeboro and their consultants in coordination with NHDES to restore the function of the RIB discharge system while protecting the impacted water resources in the area of the project.

Site Description

The main stem of Nineteen Mile Brook flows past the RIB Site approximately 800 - 1,200 ft. south of the RIB infiltration structures and flows westerly into Whitten Pond and eventually into Lake Winnepesaukee. An unnamed tributary to Nineteen Mile Brook flows south around the east side of the RIB site and joins Nineteen Mile Brook approximately a quarter mile upstream of Whitten Pond. On the southwest slope below the RIB cells there are two areas of groundwater seeps with hillslope wetlands (Western Groundwater Discharge Area and Central Groundwater Discharge Area) that discharge from culverts beneath the Site access road as small surface water tributaries to Nineteen Mile Brook. Engineering reports show that the majority of RIB discharge water passes through these seep areas and then enters Nineteen Mile Brook as surface water through two minor tributaries (referred to as WGDA Tributary and CGWDA Tributary in this report). Surface water sampling stations were established along the main stem of Nineteen Mile Brook and the Unnamed Tributary, as well as in the Groundwater Discharge Areas. Table 1 lists the sampling stations that were reviewed for this report and their position in the watershed. Figure 3, from Meeting Minutes for a NHDES meeting on October 2, 2015, (Wolfeboro, 2015) shows the Site and sampling station locations.

Table 1. Wolfeboro Groundwater Discharge Permit surface water sampling stations on
Nineteen Mile Brook and tributaries (from Wolfeboro, 2015)

Station ID	Easting	Northing	Surface Water Body
19MB-01	1100230	412039	Main Stem Nineteen Mile Brook
19MB-02	1098627	412735	Main Stem Nineteen Mile Brook
19MB-04	1096086	413100	Main Stem Nineteen Mile Brook
19MB-06	1099847	412663	Unnamed Tributary
19MB-07	1098580	412856	Western Groundwater Discharge Area
19MB-08	1099044	413022	Western Groundwater Discharge Area
19MB-09	1099010	412441	Central Groundwater Discharge Area
19MB-10	1099193	412778	Central Groundwater Discharge Area
19MB-11	1099441	412694	Access road east of Central Groundwater Discharge Area
19MB-12	1099921	412866	Unnamed Tributary
19MB-13	1100020	412970	Unnamed Tributary
19MB-14	1100128	413033	Unnamed Tributary
19MB-15	1100225	413337	Unnamed Tributary
19MB-16	1100068	413482	Unnamed Tributary
19MB-17	1099852	413581	Unnamed Tributary
19MB-18	1099729	412147	Unnamed Tributary
19MB-19	1099651	412143	Main Stem Nineteen Mile Brook
19MB-20	1099014	412355	Main Stem Nineteen Mile Brook
19MB-21	1098437	412866	Main Stem Nineteen Mile Brook

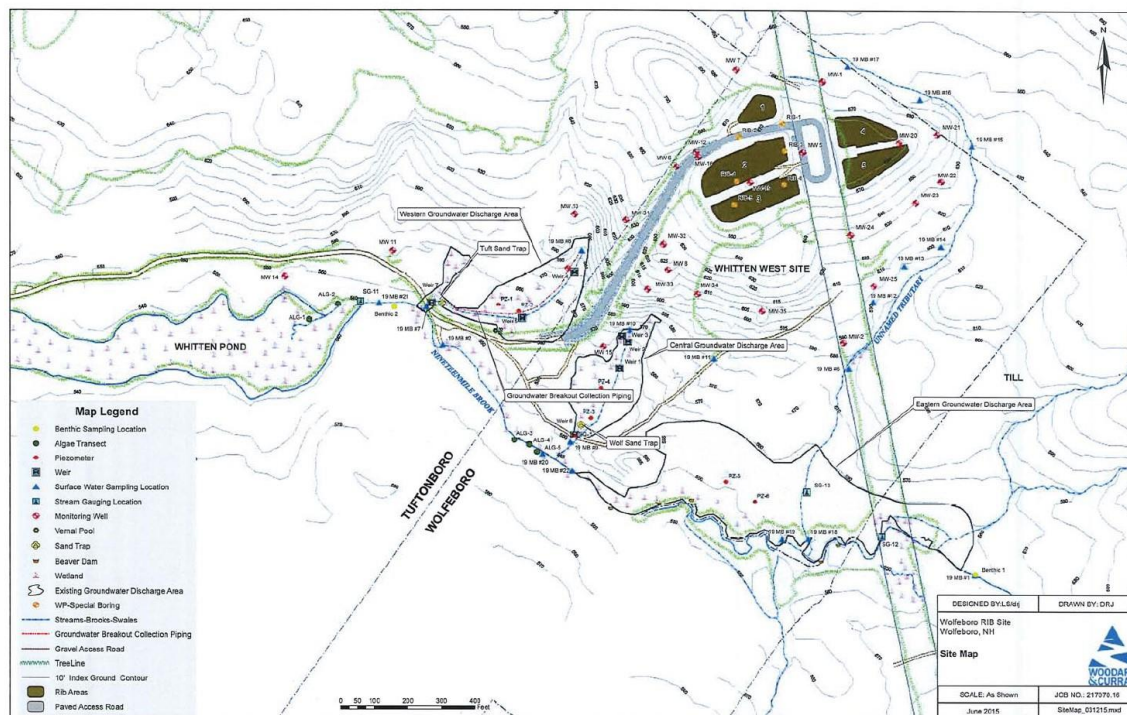


Figure 3. Site map of Wolfeboro Groundwater Discharge Permit study area (from Wolfeboro, 2015)

Surface water chemistry at Nineteen Mile Brook

The Wolfeboro RIB Site project file had water chemistry data for the period July 2007 through August 2017 at the time of our research. Stations 19MB-1 (an upstream reference station), 19MB-4 (downstream of the Project influence at the Rte 109 crossing), and 19MB-21 (downstream of the Project influence above Whitten Pond) have the most comprehensive surface water quality records for the Project and have sampling requirements under the current and previous permits. Other water quality monitoring stations in the Western Groundwater Discharge Area (19MB-7, 19MB-8) and the Central Groundwater Discharge Area (19MB-9, 19MB-10) have extensive records as well and are monitored routinely. Other stations in the Project area have more sporadic records and were included in our analysis as much as possible. Multiple water chemistry parameters were monitored at each of the stations, including nutrients, which are the primary pollutants of concern from wastewater treatment facility discharges. Our review of data focused primarily on nutrients including total phosphorus and nitrate, although other parameters including chloride were also reviewed for patterns, trends, and water quality exceedances.

Total phosphorus

Total phosphorus (TP), which is typically the limiting nutrient in freshwaters, was monitored extensively at the Project site and was the surface water quality parameter we were most focused on. In New Hampshire, state surface water quality standards are identified in Env WQ-1700. There are no numerical water quality standards for phosphorus in NH; however, Env-Wq 1703.14 states that “Class B waters shall contain no phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring” and also states that “There shall be no new or increased discharge containing phosphorus or nitrogen to tributaries of lakes or ponds that would contribute to cultural eutrophication or growth of weeds or algae in such lakes and ponds.” EPA has provided guidelines for nutrient criteria in the absence of state water quality standards based on aggregate ecoregions throughout the US (EPA, 2001). For Aggregate Ecoregion VIII, which includes northern New England and Nineteen Mile Brook, the recommended phosphorus limit is 0.010 mg/L for rivers and streams. While this guideline is not an enforceable limit, it does provide guidance for assessing the state of rivers and streams.

In the available water quality data for Nineteen Mile Brook, there were routine exceedances of the 0.010 mg/L TP threshold throughout the watershed and throughout the period of record from 2007 – 2017 (see Figures 4 & 5). In the data reviewed there were 483 samples out of a total of 756 samples reviewed (64%) that exceeded the 0.01 mg/L TP threshold from 2007 – 2017. The available data also show that total phosphorus was variable throughout the Site and that high levels of TP were documented at the control reach (Station 19MB-1) outside the influence of the discharge and also at multiple stations in the timeframe pre-dating the operation of the discharge. These results suggests that TP sources in Nineteen Mile Brook are not confined to the RIB discharge area and that upstream watershed sources of TP (e.g. as documented at Station 19MB-1) are routinely in exceedance of the EPA guideline. The data reviewed indicate a highly variable pattern with an overall decreasing trend in TP levels throughout the watershed. Total phosphorus values in the watershed did not show strong evidence of spatial patterns of distribution, although there were some minor patterns evident. On average, TP concentrations were slightly higher in the Central and Western Groundwater Discharge Area stations compared to stations along the main stem of Nineteen Mile Brook. This suggests some evidence of minor TP effects from the RIB discharge in the Groundwater Discharge Areas, although the averages are only marginally higher and should not be considered significant. These results are expected as the wastewater entering the RIB structures is treated to reduce TP into the range of 0.1 – 0.6 mg/L (Wolfeboro, 2015) and the groundwater infiltration should serve to further reduce TP levels as phosphorus is readily attenuated in groundwater (in contrast with nitrogen which is highly mobile).

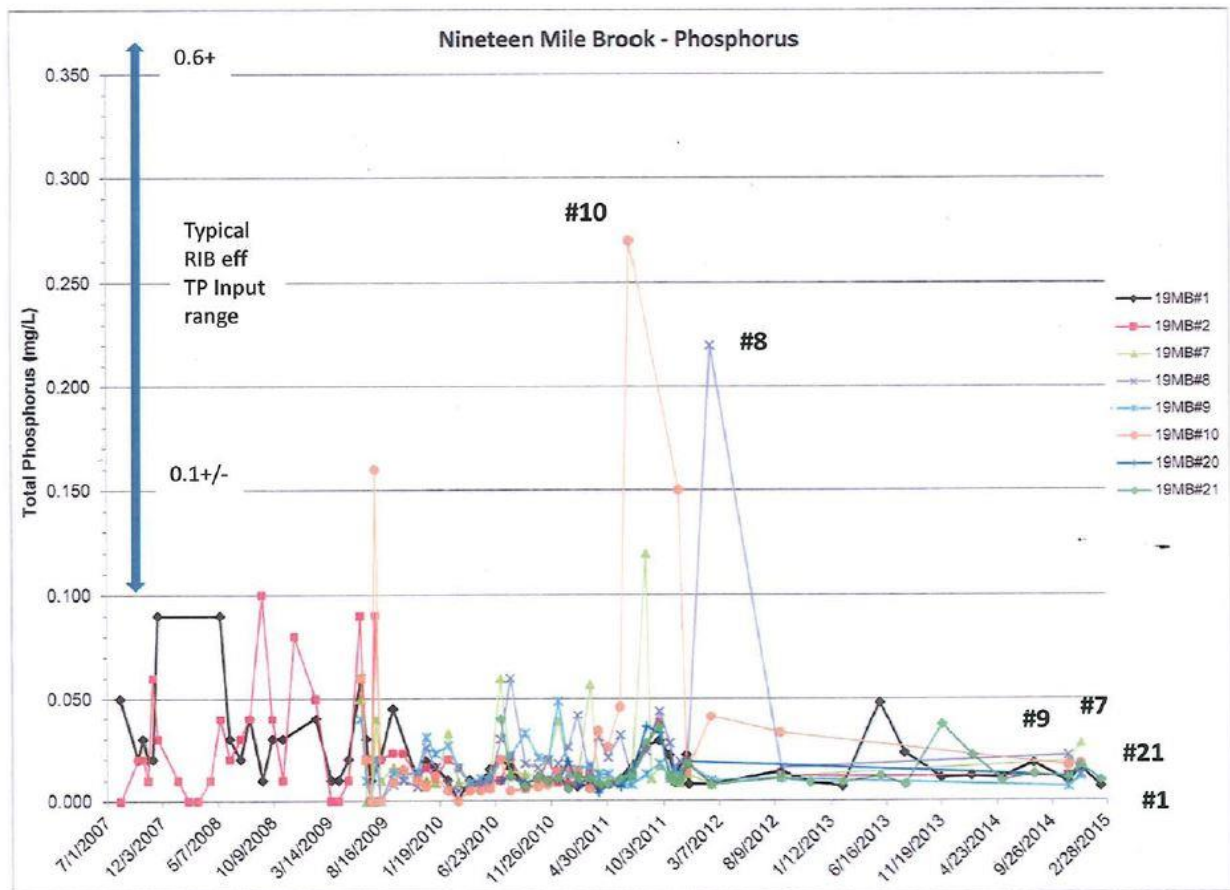


Figure 4. Total phosphorus at all GWP monitoring stations except 19MB-4 for 2007 – 2015 (from Wolfeboro, 2015)

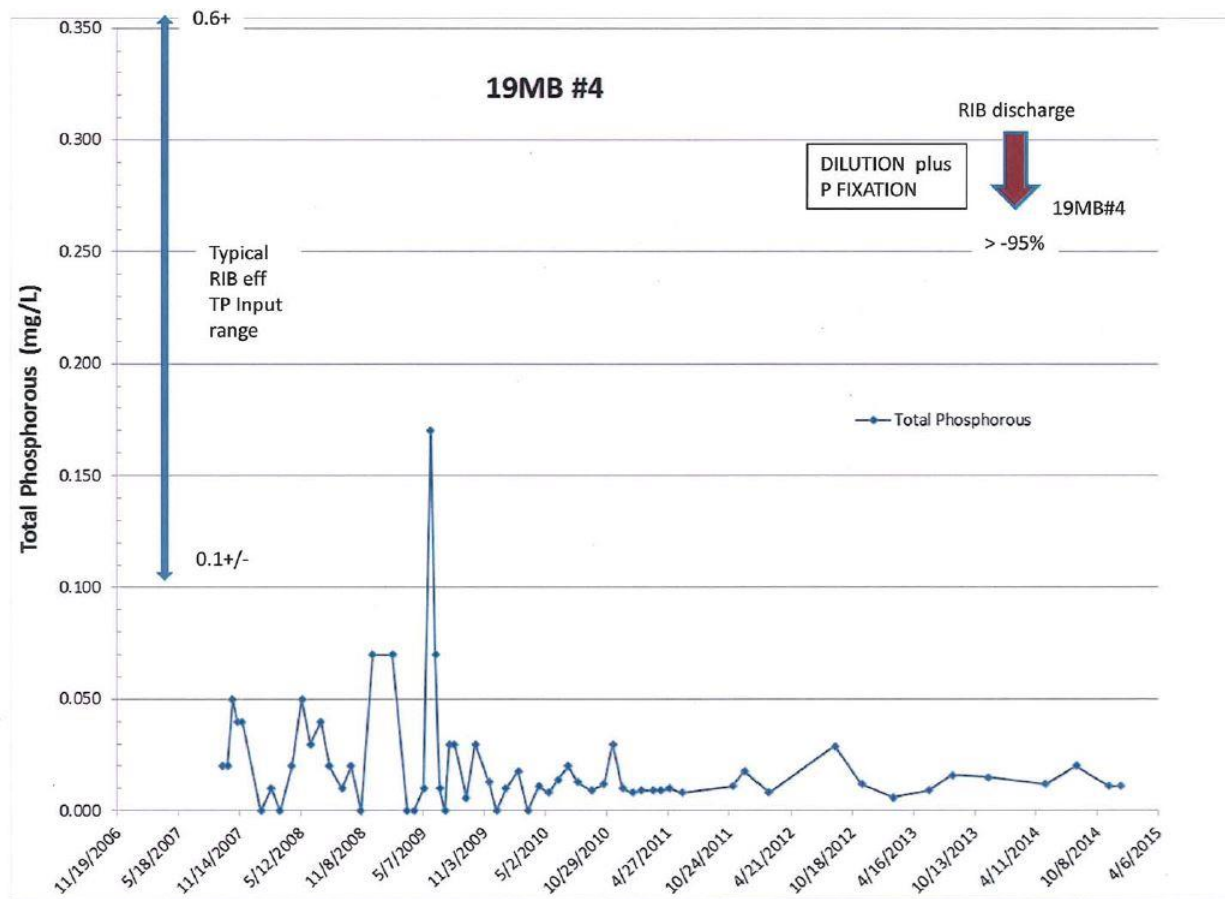


Figure 5. Total phosphorus at GWP monitoring station 19MB-4 for 2007 – 2015 (from Wolfeboro, 2015)

Total nitrogen

There are also extensive nitrogen data for the period of record throughout the Nineteen Mile Brook watershed, primarily as nitrate, the most common form of nitrogen in surface waters. Like phosphorus, there are no numerical surface water standards for total nitrogen or nitrate in New Hampshire. Env-Wq 1703.14 states that “Class B waters shall contain no phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring” and also states that “There shall be no new or increased discharge containing phosphorus or nitrogen to tributaries of lakes or ponds that would contribute to cultural eutrophication or growth of weeds or algae in such lakes and ponds.” The EPA guideline for total nitrogen for Aggregate Ecoregion VIII, which includes northern New England and Nineteen Mile Brook, is 0.38 mg/L for rivers and streams (EPA, 2001).

In the available water quality data for Nineteen Mile Brook, nitrate values were highly variable, with values at stations along the main stem of Nineteen Mile Brook generally below the 0.38 mg/L total nitrogen threshold, while nitrate values in the Western and Central Groundwater Discharge Areas (Stations 19MB-7 – 19MB-10) tended to be much higher – typically in the 0.5 – 2.5 mg/L range (see Figures 6 & 7). The available data show that nitrate levels had generally increased in the watershed since 2007 and particularly since the RIB discharge commenced in 2009. The data also show strong spatial patterns of distribution of nitrate in the Nineteen Mile Brook watershed. The main stem on

Nineteen Mile Brook had the highest nitrate levels near Station 19MB-21, below the groundwater discharge areas, and the lowest nitrate levels at Station 19MB-01, the background station above the influence of the RIB discharge. The most consistently high levels of nitrate were measured in samples from the uppermost stations in the Western and Central Groundwater Discharge Areas (19MB-08 and 19MB-10, respectively). The median nitrate value for all samples from Station 19MB-08 was 1.1 mg/L, while at Station 19MB-10 it was 1.8 mg/L. These values were over an order of magnitude greater than the median nitrate value at Station 19MB-01 (background station) of 0.07 mg/L. Clearly, nitrate levels in Nineteen Mile Brook increased with commencement of operations of the RIB discharge and increased most significantly in the surface water tributaries receiving groundwater discharges in the Western and Central Groundwater Discharge Areas. This result is expected as nitrate is highly mobile in groundwater and high values would be expected in the discharge areas.

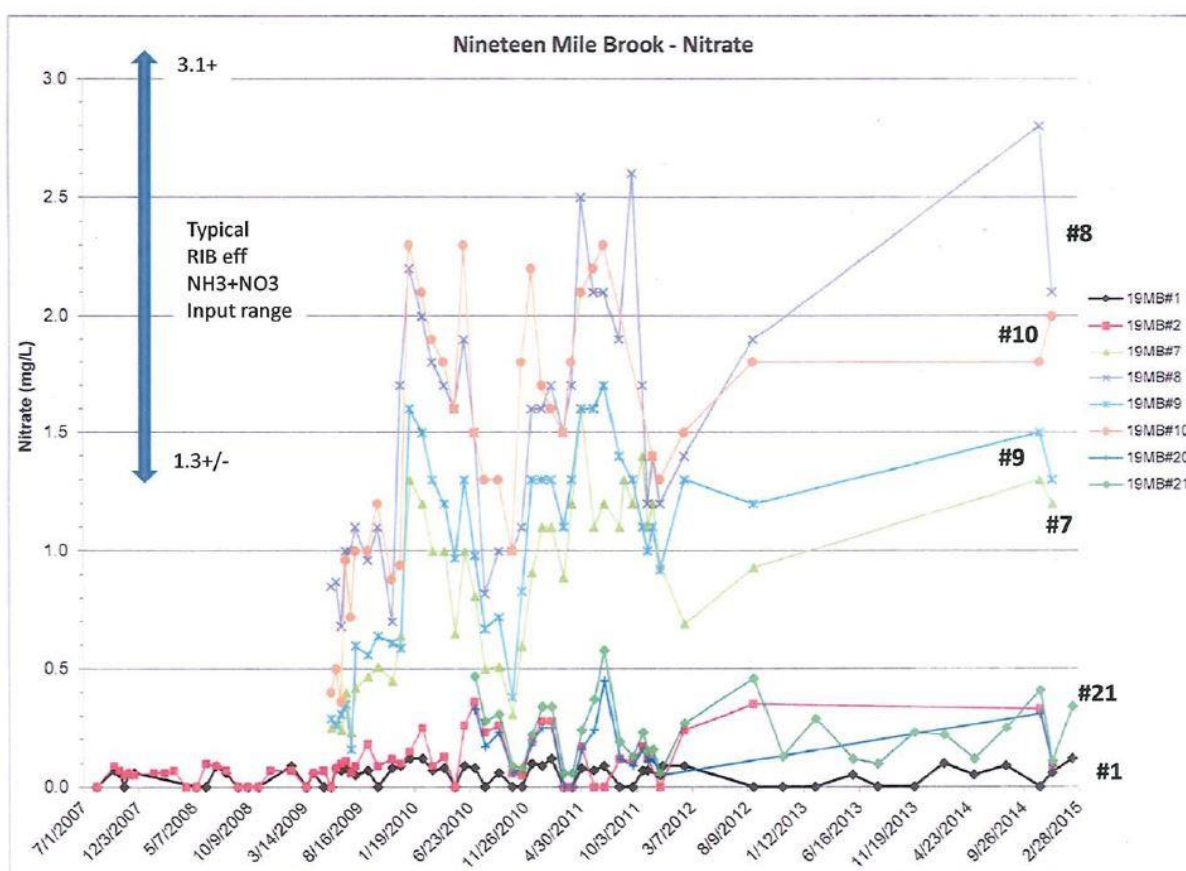


Figure 6. Nitrate at all GWP monitoring stations except 19MB-4 for 2007 – 2015 (from Wolfeboro, 2015)

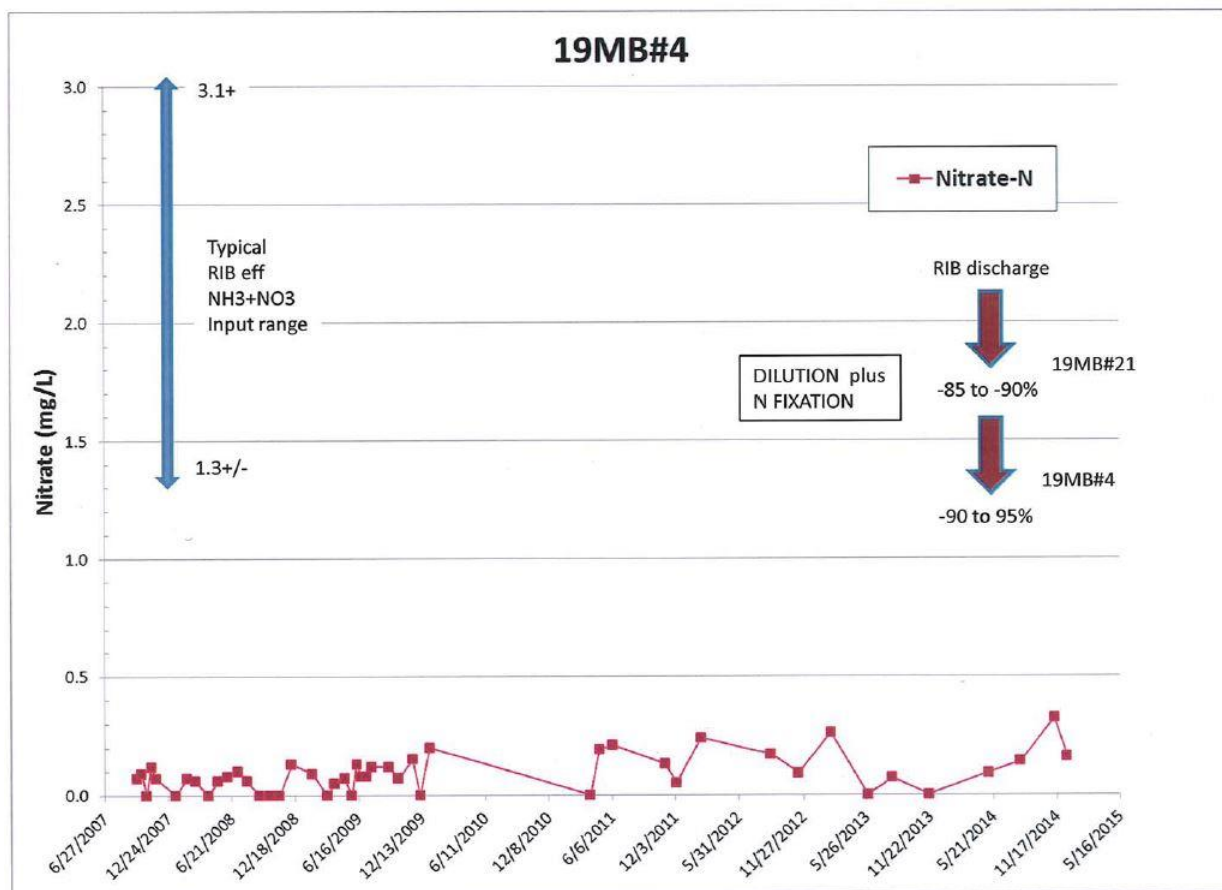


Figure 7. Nitrate at GWP monitoring station 19MB-4 for 2007 – 2015 (from Wolfeboro, 2015)

Chloride

Chloride is another parameter of concern for wastewater discharges to surface waters, including indirect discharges via groundwater infiltration, due to the conservative nature of chloride (i.e. there is generally no natural attenuation of chlorides in surface water or groundwater). Extensive chloride data were collected as part of the Project's permit compliance monitoring. It is evident from the surface water chloride data that natural chloride levels are low in Nineteen Mile Brook with consistent measurements around 5 mg/L chloride at the background station 19MB-01, upstream of the discharge. Since commencement of operation of the RIB discharge in 2009, chloride levels downstream of the discharge areas have increased considerably above background levels, with typical readings in the 10-40 mg/L range (see Figures 8 & 9). Monitoring stations on the main stem of Nineteen Mile Brook have had chloride detected at 2-10 times the concentration of background samples (as high as 60+ mg/L) and monitoring stations in the Western and Central Groundwater Discharge Areas have had chloride detected at 10-30 times the concentration of background samples (as high as 150 mg/L). In New Hampshire, state surface water quality standards are identified in Env WQ-1700. Chloride has an acute freshwater standard of 860 mg/L and a chronic freshwater standard of 230 mg/L, for the protection of aquatic life. There was no evidence of an exceedance of either standard based on the readily available chloride data reviewed as part of this study.

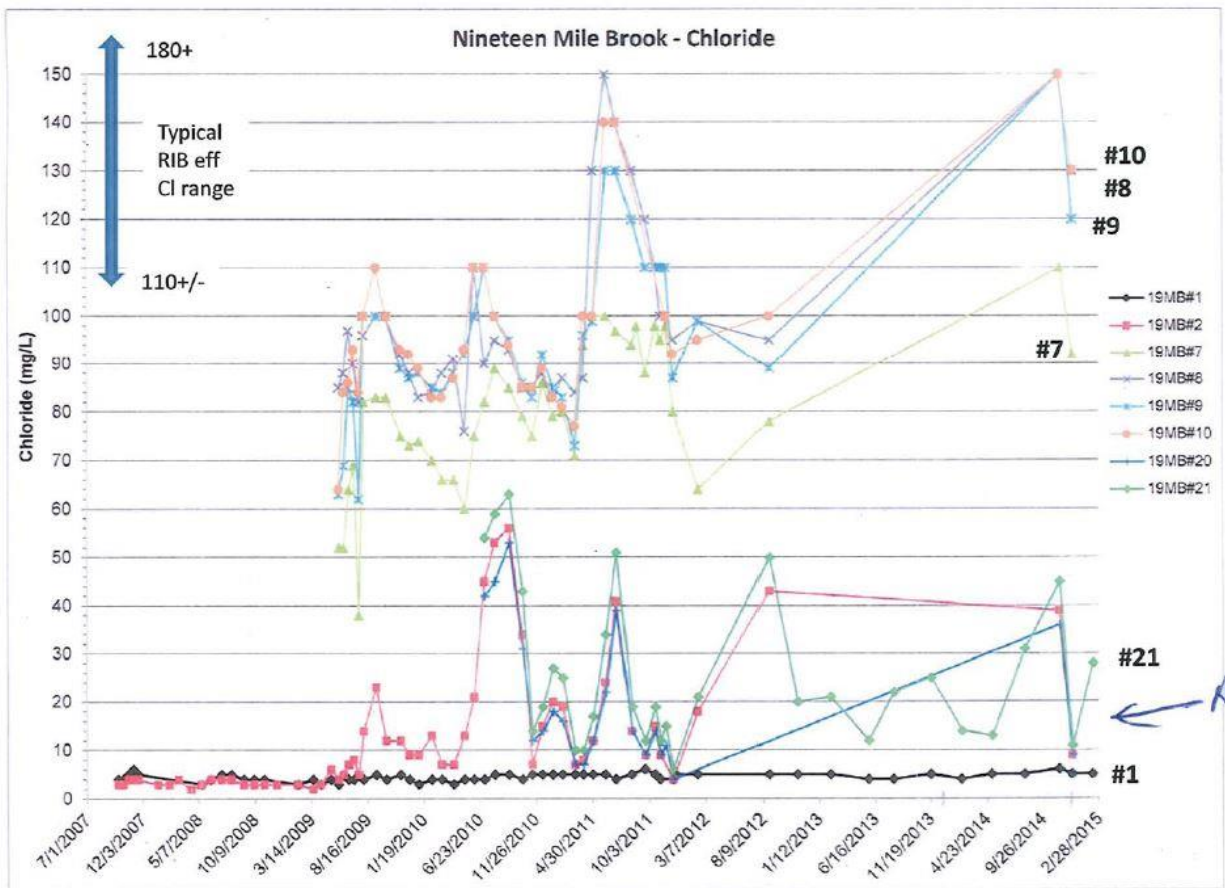


Figure 8. Chloride at all GWP monitoring stations except 19MB-4 for 2007 – 2015 (from Wolfeboro, 2015)

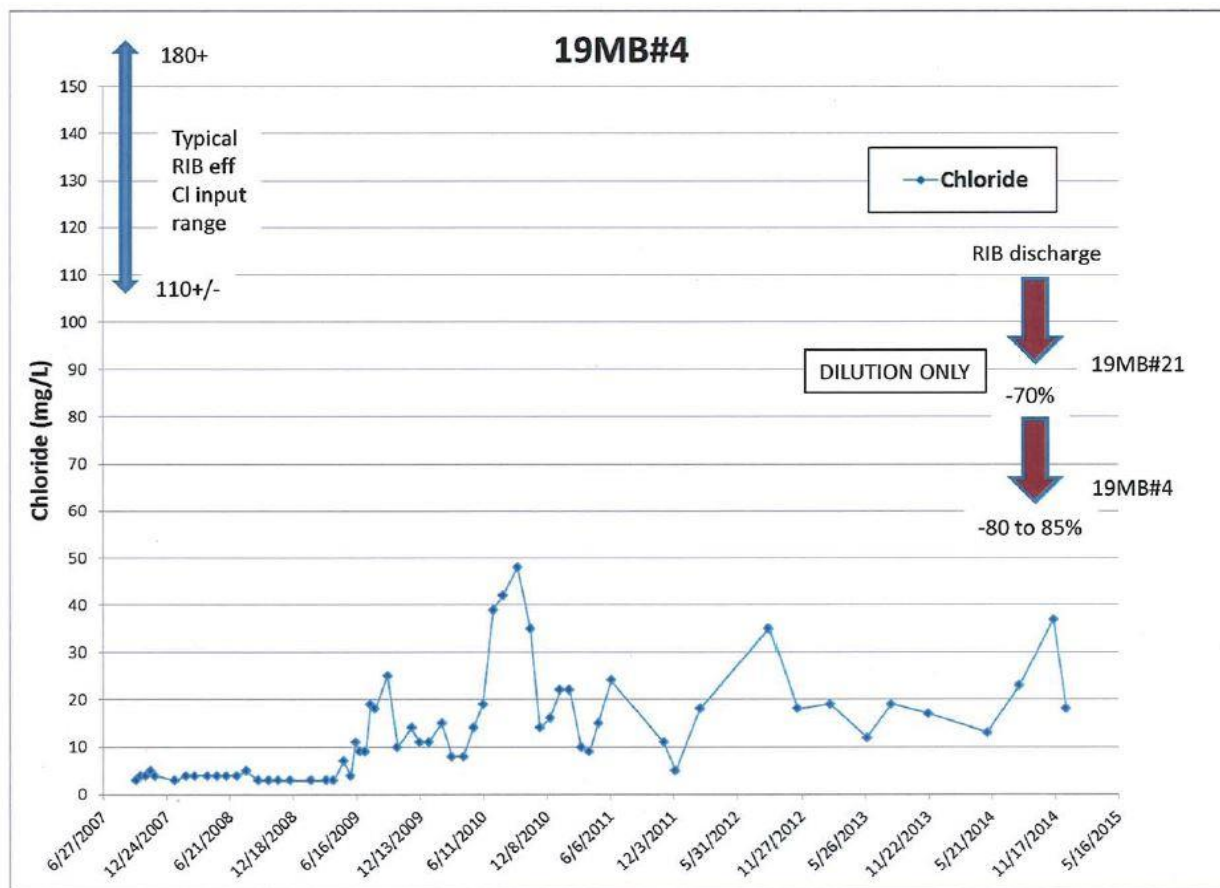


Figure 9. Chloride at GWP monitoring station 19MB-4 for 2007 – 2015 (from Wolfeboro, 2015)

RBP Habitat Assessment

Aquatic and riparian habitat in Nineteen Mile Brook was evaluated in our 2008 baseline study at Nineteen Mile Brook and again in 2013 and 2015 per the Project Groundwater Discharge Permit requirement using US EPA's Rapid Bioassessment Protocols (RBP; Barbour et al. 1999). Ten metrics are evaluated on a numerical scale of 0 to 20 (highest quality) for each sampling reach. The ratings are then totaled and compared to a reference (upstream) condition to provide a final habitat ranking; scores increase as habitat quality increases. Total habitat scores range from 0 to 200; therefore, in general, scores 150 to 200 indicate excellent habitat quality, scores 100 to 149 indicate good habitat quality, scores 50 to 99 indicate fair habitat quality, and scores 0 to 49 indicate poor habitat quality (Barbour et al., 1999). Changes in aquatic and riparian habitat could result in changes in water quality and documenting changes over time is important for evaluating the overall ecological integrity of a stream. Table 2 presents a summary of the available RBP habitat assessment data. As can be seen in the table, the stations where RBP habitat assessments have taken place on Nineteen Mile Brook generally indicate "Excellent" habitat value, with the exception being Station 19MB-21A, which, in 2013, was ranked as having "Good" habitat.

Table 2. Wolfeboro Groundwater Discharge Permit RBP Habitat scores by year and location

	2008				2013		2015	
	Downstream Station - near mouth of Nineteen Mile Brook	Downstream Station - downstream of Whitten Pond	Downstream Station - upstream of Whitten Pond	Reference Station - Near 19MB-01	Downstream Station	Reference Station	Downstream Station	Reference Station
Station	RBP-4	RBP-3	RBP-2	RBP-1	21A	19MB1	21A	19MB1
Total RBP Score	158	154	151	159	136	155	155	175
Habitat Value	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Excellent	Excellent

Benthic Macroinvertebrates

In our 2008 Nineteen Mile Brook baseline study, we evaluated the in-stream macroinvertebrate community as part of the overall determination of water quality in the brook. Macroinvertebrates are variably sensitive to water quality and the abundance of various taxa can indicate high quality streams versus impaired streams and can be useful in tracking changes in water quality over time. In the 2008 study we sampled macroinvertebrates at four locations on the main stem of Nineteen Mile Brook – Station 4 was near the mouth of the brook, Station 3 was below Whitten Pond, Station 2 was above Whitten Pond, and Station 1 was upstream of the proposed discharge areas. We used a kick-net method of sampling the benthic community which is a different method from later benthic sampling under the 2012 and 2017 Groundwater Discharge Permits which used a deployed artificial substrate sampler (“rock basket”). The differences in sampling methods don’t allow for statistically rigorous direct comparison. However we can qualitatively review the results from both methods and generally evaluate indications of impairment from the available data.

The macroinvertebrate data from the 2008 Baseline Study indicated moderate impairment at Station 4, slight impairment at Station 3, and no impairment at Station 2, all relative to reference Station 1, which had an overall “good” water quality rating. NHDES evaluated the 2013 and 2014 macroinvertebrate data submitted as part of the Groundwater Discharge Permit requirements and determined an Index of Biotic Integrity, which is the summation of a number of macroinvertebrate statistical metrics. For the 2013 macroinvertebrate data, the upstream reference station 19MB-01 had an IBI score of 66.55 which “passed” the threshold of 65.44, while the downstream station 19MB-21 had an IBI score of 53.63 which “failed” to meet the threshold score of 65.49. In 2014, both 19MB-01 and 19MB-21 failed to meet the threshold IBI scores, with scores at 62.49 and 60.88, respectively. These results may indicate impairment, although we were unable to formally develop all of the indices to provide a more comprehensive evaluation within the scope of this project. An informal (not statistically rigorous) evaluation of one metric, the Hilsenhoff Biotic Index, indicate “fair” to “excellent” HBI values at stations 19MB-21A and 19MB-01 (median value was “very good” at both stations) as determined from the 2013, 2014, and 2015 macroinvertebrate data. Multiple indices also indicate a pattern of slightly higher water quality in the reference station as compared to the downstream station affected by the RIB discharge, although this is an informal evaluation. The 2019 baseline study included a repeat of the methods used in the 2008 study and allows a better and more statistically rigorous comparison of changes in the macroinvertebrate community over the interim period.

3.0 Aquatic Habitat Assessment

In August 2019 several concurrent field studies were completed at Nineteen Mile Brook utilizing the EPA RBP method for evaluating aquatic habitat, macroinvertebrate communities, and fish communities. Four stream stations were used for these studies, identified as RBP-1 through RBP-4 (See Figure 1), and are the same four locations identified previously in the 2008 baseline study. The study sites included:

- An upstream reference site (“Site RBP-1” upstream of the rapid infiltration basin site);
- A site where impacts from the infiltration site are expected to be greatest (“Site RBP-2” immediately downstream of the RIB site but upstream of Whitten Pond);
- A site downstream of Whitten Pond (“Site RBP-3”); and
- A site downstream in an open lowland area (“Site RBP-4”).

Aquatic habitat was surveyed according to the US Environmental Protection Agencies Rapid Bioassessment Protocols (Barbour et al. 1999) using the low-gradient habitat assessment. This was the same assessment technique conducted previously during the 2008 baseline study. Habitat was evaluated along each study reach with the downstream end of a reach at the Station location (GPS point) and the upstream end of the reach located approximately 150 m upstream of the station location, as is appropriate for a stream of this size. The low-gradient RBP habitat assessment consisted of ten metrics evaluated on a numerical scale of 0 to 20 with scores of 0-5 considered Poor, 6-10 Marginal, 7-15 Suboptimal, and 16-20 Optimal. Total habitat scores for each reach may range from 0-200 with scores at the upper range (150-200) indicative of excellent habitat quality and scores at the lower end (0-49) indicative of poor habitat quality.

Metrics used for the visual-based habitat assessment of low-gradient streams are described in Barbour et al. 1999 and summarized below:

- **Epifaunal Substrate/Available Cover:** Includes the relative quantity and variety of natural structures in the stream, such as cobble, large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna.
- **Pool Substrate Characterization:** Evaluates the type and condition of bottom substrates found in pools.
- **Pool Variability:** Rates the overall mixture of pool types found in streams, according to size and depth.
- **Sediment Deposition:** Measures the amount of sediment that has accumulated in the pools and the changes that have occurred to the stream bottom as a result of deposition.
- **Channel Flow Status:** The degree to which the channel is filled with water.
- **Channel Alteration:** A measure of large-scale changes in the shape of the stream channel.

- **Channel Sinuosity:** Evaluating the meandering or sinuosity of the stream.
- **Bank Stability:** Measuring whether or not the stream banks are eroded (or have the potential for erosion).
- **Bank Vegetative Protection:** The amount of vegetative protection afforded to the stream bank and near-stream portion of the riparian zone.
- **Riparian Vegetative Zone Width:** Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone.

The 2019 sampling effort used Global Positioning System (GPS) coordinates collected for the 2008 baseline study to relocate the sampling stations with high accuracy and identify potential changes in habitat. Visual habitat assessment locations for the 2019 study were also recorded with a GPS. Recorded data were maintained on field data sheets and are provided as part of this study report. Photographs were taken of sites where sampling was conducted. In addition, any areas observed to be stressed during the assessment (as in the presence of invasive species or defoliation), were also photo-documented.

3.1 Aquatic Habitat Assessment Results

Figure 1 presents the locations of the four sampling sites relative to the rapid infiltration site and Lake Winnepesaukee. Site coordinates for the 2019 habitat assessment locations and the metric scoring are provided in Table 3. All sites were composed of a stream reach approximately 150 meters in length, with the downstream end of each reach indicated in Table 3 and shown in Figure 1. Aquatic habitat assessment at each site was conducted per the RBP protocols in Barbour et al., 1999 as presented in Section 3.0. A summary of each sampling Site and an assessment of the visual survey are provided below. Copies of all data sheets are attached in Appendix B.

Site RBP-1 (also referred to as Site 1) was accessed on August 14, 2019 and is located upstream of any influence of the subsurface rapid infiltration discharge, and upstream of the powerline crossing. This site was selected as a reference site in 2008 for future biological impact assessments once the subsurface rapid infiltration discharge became operational. The visual assessment of Site 1 identified two habitat types present. In the lower and upper ends of the reach, the habitat was characterized as a low-gradient stream with predominantly sand substrate (See Appendix A, Figure 2). The middle reach included a higher gradient habitat with step falls and pools dominated by sand, boulder, and cobble (Appendix A, Figure 3). The site reach was forested and shaded by shoreline canopy cover. Both banks were lined with shrubs and herbaceous vegetation. In stream, there were areas of large woody debris (LWD) and organic substrate components were primarily composed of CPOM (coarse particulate organic matter; 25%) with smaller amount so FPOM (fine particulate organic matter; 5%). The average reach depth was approximately 1 foot and current velocities ranged from 0.9 fps (feet per second) in the low-gradient area to 1.8 fps in the high-gradient region. The water temperature collected at this site was 16.4°C with dissolved oxygen levels at 9.6 mg/L (Table 3). No indications of habitat degradation or pollution were evident during the survey. RBP metric scoring was 159 of 200, indicating excellent habitat value for aquatic biota. Most metrics scored Optimal or Suboptimal with only the Pool Variability metric scoring as Marginal.

Site RBP-2 (also referred to as Site 2) was accessed August 13, 2019 and is the closest to the RIB discharge area, where biological impacts would theoretically be greatest. This low/moderate gradient reach was characterized by riffles and pools with predominantly sand and cobble substrate (Appendix A, Figure 4). Similar to Site 1, the reach was well shaded by canopy cover along the shoreline and lined with herbaceous and woody vegetation. Patches of LWD in the form of fallen logs and snags were noted throughout the reach with small amounts of CPOM and FPOM present. Average thalweg depth at Site 2 was 0.7 feet with a channel velocity of approximately 0.4 fps. The water temperature as measured at the time of sampling was 15.2°C with dissolved oxygen levels of 10.0 mg/L (Table 3). Outside of the snowmobile bridge crossing at the downstream end of the reach, there were no outwardly visible indications of habitat disturbance or degradation from pollution evident during the survey. The RBP metric scoring for this site was 163 of 200, indicating excellent habitat value for aquatic biota. This scores similarly to the upstream reference reach suggesting that there is no habitat degradation when compared to the upstream reference location.

Site RBP-3 (also referred to as Site 3) was accessed August 13, 2019 and located downstream of Whitten Pond and included a foot bridge crossing approximately one third of the way down and a road crossing/culvert at the lower end. A concrete pipe in the river was identified during the survey upstream of a small tributary stream about halfway through the reach. The upstream end of the reach was bounded by a rock dam that impounded Whitten Pond (Appendix A, Figure 5). The stream reach was characterized by areas of high/moderate gradient riffles at the upstream end and low gradient, pool dominated habitat in the downstream portion (Appendix A, Figure 6). The substrate included some cobble in the upper reach with smaller components (gravel, sand, and silt) becoming more prevalent as the gradient decreased and lower velocity flows allowed them to settle out. The reach was partially shaded by canopy trees and woody vegetation lining the banks and some woody debris in the form of snags and CPOM (15%). Aquatic vegetation was present along approximately 60% of this reach. The average depth at the thalweg was 1 foot with current velocities of 0.5 fps (Table 3). The water temperature, at the time of sampling, was 17.3°C with dissolved oxygen levels at 9.8 mg/L. Signs of human disturbance as described above were prevalent at this site although there were no outward signs of habitat degradation from pollution at this site. RBP metrics for this site scored 154 out of 200, indicating this site provides excellent habitat value for aquatic biota. The score is 97% similar to the upstream reference reach, indicating no apparent degradation in habitat compared to the upstream reference location.

Table 3. Habitat characteristics of sampling stations in Nineteen Mile Brook, Tuftonboro, NH - August 13 & 14, 2019.

STATION	LATITUDE	LONGITUDE	HABITAT ASSESSMENT					
			SUBSTRATE/ COVER	POOL SUBSTRATE CHARACTERIZATION	POOL VARIABILITY	SEDIMENT DEPOSITION	CHANNEL FLOW STATUS	CHANNEL ALTERATION
1 (ref)	43° 38.805'	71° 13.763'	19	14	10	14	11	20
2	43° 37.900'	71° 14.076'	19	15	17	13	14	20
3	43° 37.960'	71° 14.653'	17	16	14	13	15	18
4	43° 38.182'	71° 15.244'	17	13	13	12	19	20

STATION	HABITAT ASSESSMENT				TOTAL SCORE	% COMP TO REF. STA.	HABITAT VALUE
	CHANNEL SINUOSITY	BANK STABILITY	VEGETATIVE PROTECTION	RIPARIAN VEG. ZONE WIDTH			
1 (ref)	18	17	20	16	159		EXCELLENT
2	8	20	20	17	163	103	EXCELLENT
3	14	16	18	13	154	97	EXCELLENT
4	19	20	20	20	173	109	EXCELLENT

STATION	SUBSTRATE % COMPOSITION				DETRITUS		
	Boulder	COBBLE	GRAVEL	SAND	Silt	CPOM	FPOM
1 (ref)	45	20		35		25	5
2	5	50	5	30	5	10	10
3		10	40	40	10	15	
4				50	50	5	5

STATION	WATER QUALITY					
	TEMPERATURE (°C)	DISSOLVED OXYGEN (mg/l)	SPEC. COND. (µS/cm)	pH	VELOCITY (fps)	DEPTH (ft)
1 (ref)	16.4	9.6	50.0	7.15	0.92	1
2	15.2	10.0	248	8	0.44	0.66
3	17.3	9.8	218	7.99	0.53	1
4	17.8	9.3	86.0	8.03	0.58	1.6

Site RBP-4 (also referred to as Site 4) was accessed August 14, 2019 and is the station furthest downstream of the rapid infiltration site and located more than halfway down the main stem of Nineteen Mile Brook. The stream at this location is low gradient with multiple braided channels and ponded sections impounded by beaver dams (Appendix A, Figure 7). This site had an average depth of 1.6 feet in the thalweg and a current velocity of 0.6 fps. Sand and silt were the substrates present at this site and little LWD, CPOM, or FPOM. Aquatic vegetation was present along the entirety of this site in the form of rooted emergent, submergent, and floating plants as well as attached algae. The stream was mostly open, the banks vegetated by herbaceous and woody vegetation but lacking tree canopy cover. Water temperature at the time of sampling measured 17.8°C with dissolved oxygen levels of 9.3 mg/L. The stream at this site runs through an open alder and grass vegetated swamp and does not show any outward signs of human disturbance or habitat degradation due to pollution. The RBP metrics for this site were high (173 of 200) indicating the aquatic habitat at this location is excellent for macrobiota. This scoring is somewhat higher than the value provided for the reference site (173 versus 159), although both sites are considered to have excellent habitat and therefore no aquatic habitat degradation is evident at this site.

4.0 Macroinvertebrate Community Assessment

Benthic macroinvertebrate samples were collected on August 13 and 14, 2019 at the aquatic habitat assessment sites (Sites RBP-1 through RBP-4, Figure 1). Benthic macroinvertebrate samples were collected following procedures provided in the NH Department of Environmental Services Biomonitoring Protocols (NHDES, 2013a) and EPA's RBP Multihabitat Approach Sampling Protocol (Barbour et al., 1999). Benthic macroinvertebrate samples were collected using a 595 µm mesh d-frame net. Approximately 3 m² of substrate and aquatic vegetation were sampled from each site by kicking the substrate or using the d-frame net to jab into bank, snag, and submerged macrophyte habitats to dislodge organisms. The amount of material from each habitat type was proportional to the percent composition of that habitat type at the site. The contents of all net samples within a single site were composited to provide one sample from each location.

Physical water quality characteristics were measured at each site including: water temperature, dissolved oxygen, percent oxygen saturation, specific conductance, pH, and general turbidity. These metrics were collected prior to macroinvertebrate sample collection.

Macroinvertebrate samples were preserved and analyzed at Normandeau's benthic laboratory following the fixed-count subsampling procedures described in Barbour et al. (1999). Each sample was evenly distributed in a gridded white enamel pan. Randomly selected grids were individually sorted until a minimum of 200 organisms were removed from each sample. Once sorting was initiated in a grid, all animals were removed from that grid. Therefore in some cases, more than 200 organisms were identified from a single sample. Organisms removed during the sorting process were identified to the genus and species taxonomic level, except for damaged organisms and organisms where larval development was insufficient to allow for genus and species identification.

Benthic data analysis for the RBP uses seven biological metrics to assess the data. These metrics (as described in Barbour et al. (1999) are:

- **Taxa Richness** – Taxonomic richness (taxa richness) is the number of different types (taxa) of benthic macroinvertebrates present in a sample, and is a measure of the diversity within a sample.
- **Biotic Index** – The biotic index is a ranking based on literature-reported values of the relative sensitivity of a taxon to organic pollution stress caused primarily by the presence of oxygen-demanding substances in the water.
- **Ratio of Scrapers to Filtering Collectors** – Scrapers are benthic macroinvertebrates that feed on algae and bacteria growing on the substrate (periphyton). Filtering collectors feed on fine particulate material that is suspended in the water. The predominance of either functional feeding group reflects an abundance of their food source, and the two feeding groups are usually compared as a ratio. The more this ratio differs from a value of 1.0, the greater the imbalance in the proportion of these two food resources.
- **Ratio of Ephemeroptera, Plecoptera, and Trichoptera (EPT) to Chironomidae abundance** – Non-biting midges in the insect family Chironomidae are generally abundant in the benthic macroinvertebrate community and tolerant of environmental stress. The ratio of abundance of the sensitive EPT taxa to the abundance of the tolerant Chironomidae is a measure of community balance.
- **Percent Contribution of the Dominant Family** – The percent contribution of the most abundant taxon to the total number of organisms found in a sample is a measure of balance in the benthic community. If the dominant taxon accounts for a large percentage of the individuals present, it is an indication of stress because the community is dominated by one taxon, whereas unstressed communities typically exhibit a more evenly balanced abundance among several taxa.
- **EPT Index** – Three groups of benthic insects are considered particularly sensitive to pollution, and the number of distinct taxa among them generally increases with increasing water quality. These groups (orders) are Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are collectively referred to as the EPT taxa. The EPT Index is calculated by counting the number of EPT taxa represented in each sample, similar to calculating taxa richness. Low values for this metric indicates potentially stressful conditions.
- **Community Loss Index** – The community loss index measures the loss of benthic taxa in samples from an experimental Site compared to those found at the reference Site. It is calculated as the number of taxa found at the reference Site minus the number of taxa common at both Sites, divided by the number of taxa present at the experimental Site.

Table 4. US EPA table RBP III - macroinvertebrate scoring criteria (from Plafkin et al., 1989)

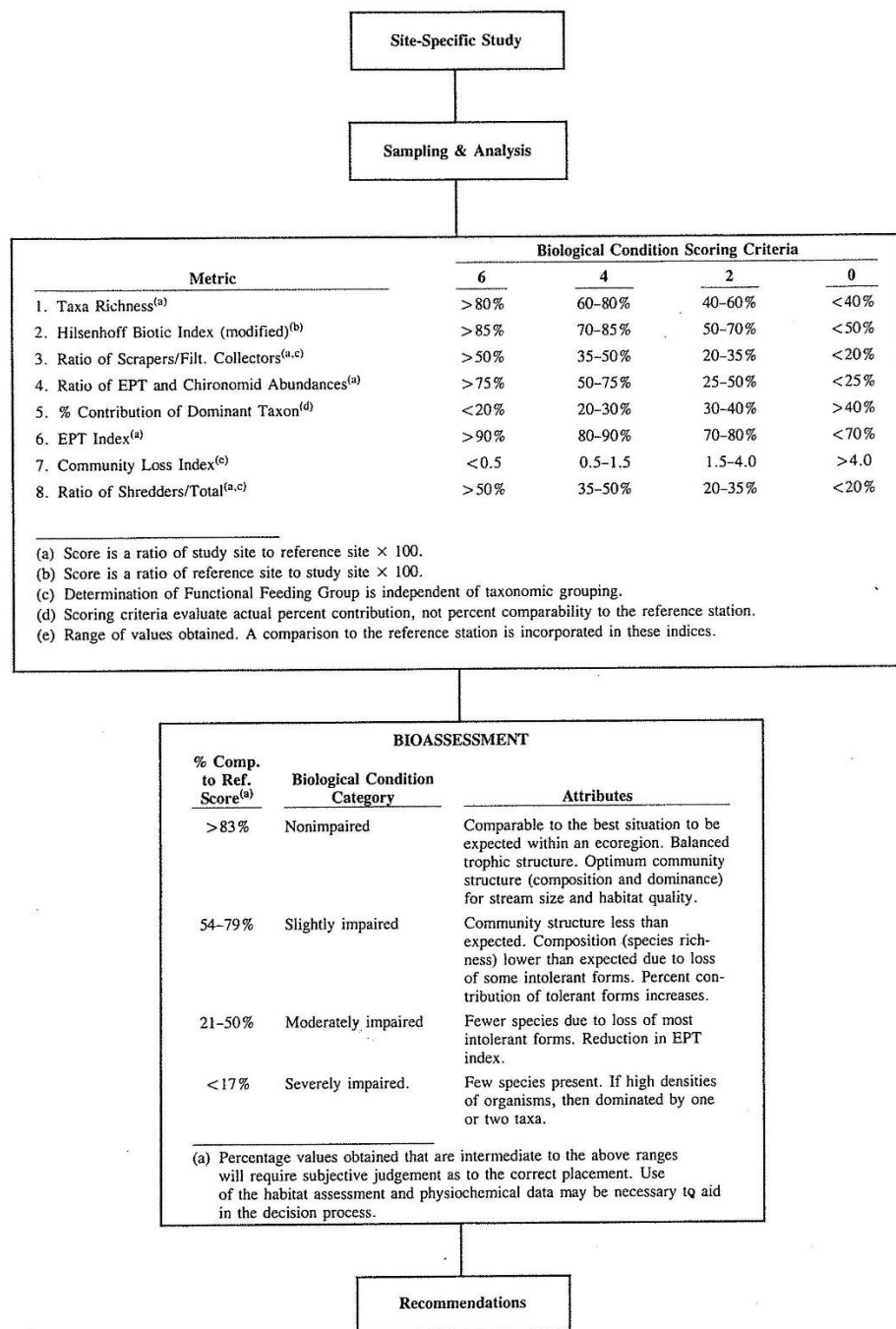


Figure 6.3-4. Flowchart of bioassessment approach advocated for Rapid Bioassessment Protocol III.

These biological metrics integrate aquatic community and functional feeding group characteristics to produce a single evaluation of biotic integrity. Each metric result for the experimental sites (sites downstream of the rapid infiltration discharge) were assigned a score based on the percent comparability to the same metric value from the reference site (i.e., the location upstream of the rapid infiltration discharge site). Exceptions to this were the metrics for Percent Contribution of the Dominant Taxon and Community Loss Index, where actual values were used to determine the scores. Scores were totaled for each site and compared to the total metric score for the reference site. The reference site automatically receives an optimal score of 6 for each metric except for percent contribution of the dominant taxon, which may be less than optimal. The percent comparison between the total scores provided a final evaluation of biological condition (bioassessment) and was compared to values from the 2008 Normandeau baseline study (Normandeau, 2008). This scoring process, reproduced from Plafkin et al. (1989), is presented in Table 4.

4.1 Macroinvertebrate Community Assessment Results

The benthic macroinvertebrate communities sampled in August 2019 at four sites in Nineteen Mile Brook were generally found to be in good to excellent condition. The results of the 2019 taxonomic identification and IBI metric analysis by site are presented in Table 5.

A total of 52 species of macroinvertebrates were collected at the reference site (Site 1), the highest count among the four sites sampled in 2019. During sampling, large numbers of freshwater mussels were observed at this location. Based on a small number of mussels that were captured within the benthic sample, it is likely they are eastern pearlshell mussels (*Margaritifera margaritifera*), listed by the State of New Hampshire as a Species of Greatest Conservation Need. The dominant taxon (14.9%) was *Polypedium aviceps*, a midge species with a tolerance value of 6. The metric scores from this location were all set at 6, for a total of 42 and Site 1 (as noted) was used as a standard of comparison with the downstream sites, to evaluate potential impacts due to the RIB discharge.

Site 2 is the location adjacent to the RIB discharge; where a number of mussels were observed that are likely the eastern pearlshell. A single specimen was found in the benthic sample from this site. A total of 45 taxa were identified and the dominant was *Oulimnus latiusculus*, a riffle beetle that accounted for 16.7% of the total. Four of seven metric values from Site 2 surpassed those from Site 1. A Hilsenhoff Index of 4.38 indicated “very good” water quality. Thirteen EPT taxa were found, approximately twice the number upstream – and a Scraper/filtering Collector Ratio of 1:1.5 at Site 1 improved to 1.4:1. An EPT/ Chironomidae ratio of 1:2.1 was noticeably lower than the ratio of 1:3.5 from Site 1. The metric scores were all 6, producing an Index of Biotic Integrity (IBI) total of 42, identical to the reference site. Comparison with the 2019 results from the reference location gives a narrative rating of “non-impaired”.

Table 5. Macroinvertebrate taxonomic identification and IBI metric summary

Sample Type:		Kick Net (NH DES and US EPA - RBP III: 200- specimen subsample)										
Sample Date3:		August 13-14, 2019										
Taxon:	Common Name	SC	FC	Tol.	Sta. 1 (Ref.)		Sta. 2		Sta. 3		Sta. 4	
					No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Nematoda	round worm			5	2	1.0%						
Tricladida												
Planariidae												
<i>Dugesia tigrina</i>	flatworm			6			1	0.5%	1	0.5%		
Lumbriculida												
Lumbriculidae												
<i>Stylodrilus heringianus</i>	earthworm			5	2	1.0%	15	7.4%	1	0.5%	2	1.0%
Tubificida												
Enchytraeidae	earthworm			10	1	0.5%						
Gastropoda												
Lymnaeidae												
<i>Galba sp.</i>	pond snail	SC		6					1	0.5%		
Physidae												
<i>Physella sp.</i>	pouch snail	SC		8							4	2.0%
Planorbidae												
<i>Ferissia rivularis</i>	limpet snail	SC		6							9	4.4%
<i>Helisoma anceps</i>	rams' horn snail	SC		6					2	1.0%		
Bivalvia												
Margaritiferidae												
<i>Margaritifera margaritifera</i>	Eastern pearl shell	FC		6	2	1.0%	1	0.5%				
Sphaeriidae												
<i>Pisidium sp.</i>	pill clam	FC		6	5	2.4%	6	3.0%				
Amphipoda												
Gammaridae												
<i>Gammarus</i>	sides wimmer			4					30	14.4%	39	19.0%
Hyalellidae												
<i>Hyalella azteca</i>	sides wimmer			8					1	0.5%		
Decapoda												
Cambaridae												
<i>Orconectes sp.</i>	crayfish			6							1	0.5%
Hydrachnidia	water mite			6							1	0.5%
Ephemeroptera												
Baetidae												
<i>Acerpenna sp.</i>	mayfly			5			5	2.5%	4	1.9%	80	39.0%
<i>Baetis sp.</i>	mayfly			4	7	3.4%	4	2.0%	2	1.0%		
Ephemerellidae												
<i>Eurylophella sp.</i>	mayfly			3	1	0.5%	1	0.5%				
Heptageniidae												
<i>Maccaffertium sp.</i>	mayfly	SC		4			1	0.5%	30	14.4%	2	1.0%
Leptophlebiidae												
<i>Paraleptophlebia</i>	mayfly			1					1	0.5%		

(continued)

Table 5. (continued) Macroinvertebrate taxonomic identification and IBI metric summary

Taxon:	Common Name	SC	Tol.	Sta. 1 (Ref.)		Sta. 2		Sta. 3		Sta. 4	
		FC		No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Odonata											
Aeschnidae											
<i>Boyeria vinosa</i>	dragonfly		2	1	0.5%	2	1.0%				
Calopterygidae											
<i>Calopteryx sp.</i>	damselfly		5	1	0.5%	9	4.4%	4	1.9%	3	1.5%
Cordulegastridae											
<i>Cordulegaster maculata</i>	dragonfly		3	5	2.4%						
Gomphidae											
<i>Gomphus sp.</i>	dragonfly		5	1	0.5%						
<i>Lanthus sp.</i>	dragonfly		5			1	0.5%				
Plecoptera											
Chloroperlidae											
<i>Sweltsa sp.</i>	stonefly		0			1	0.5%				
Leuctridae											
<i>Leuctra sp.</i>	stonefly		0	8	3.8%	6	3.0%				
Perlodidae											
<i>Isoperla sp.</i>	stonefly		2	3	1.4%	1	0.5%				
Hemiptera											
Belostomidae											
<i>Belostoma sp.</i>	giant water bug		5					1	0.5%		
Gerridae											
<i>Rheumatobates sp.</i>	water strider		5	1	0.5%						
Veliidae											
<i>Microvelia sp.</i>	water treader		5	2	1.0%			3	1.4%	2	1.0%
<i>Rhagovelia obesa</i>	water treader		5			1	0.5%	3	1.4%		
Megaloptera											
Corydalidae											
<i>Nigronia</i>	fishfly		0	3	1.4%	3	1.5%	1	0.5%		
Trichoptera											
Hydropsychidae											
<i>Cheumatopsyche</i>	caddisfly	FC	5			4	2.0%	24	11.5%	6	2.9%
<i>Diplectrona modesta</i>	caddisfly	FC	0			4	2.0%				
<i>Hydropsyche</i>	caddisfly	FC	4	8	3.8%	1	0.5%	26	12.5%		
Leptoceridae											
<i>Oecetis sp.</i>	caddisfly		8			1	0.5%				
Goeridae											
<i>Goera sp.</i>	caddisfly	SC	0					1	0.5%		
Limnephilidae											
<i>Pycnopsyche sp.</i>	caddisfly		4			1	0.5%			2	1.0%
Lepidostomatidae											
<i>Lepidostoma sp.</i>	caddisfly		1	1	0.5%						
Philopotamidae											
<i>Dolophilodes sp.</i>	caddisfly	FC	0			4	2.0%				
Rhyacophilidae											
<i>Rhyacophila sp.</i>	caddisfly		2	4	1.9%						
Lepidostoma											
Pyralidae											
<i>Paraponyx sp.</i>	aquatic moth		5					1	0.5%	4	2.0%

(continued)

Table 5. (continued) Macroinvertebrate taxonomic identification and IBI metric summary

Taxon:	Common Name	SC	Tol.	Sta. 1 (Ref.) No.	Pct.	Sta. 2 No.	Pct.	Sta. 3 No.	Pct.	Sta. 4 No.	Pct.
Coleoptera											
Elmidae											
<i>Oulimnius</i>	riffle beetle	SC	4	5	2.4%	34	16.7%	13	6.3%	1	0.5%
<i>Promoresia tardella</i>	riffle beetle	SC	2	11	5.3%	11	5.4%	1	0.5%		
<i>Stenelmis crenata</i> gr.	riffle beetle	SC	5	1	0.5%	1	0.5%	5	2.4%	1	0.5%
Psephenidae											
<i>Ectopria nervosa</i>	riffle beetle	SC	5	1	0.5%	1	0.5%				
Diptera											
Cecidomyiidae	gall gnat		5	1	0.5%						
Ceratopogonidae											
<i>Mallochohelea</i> sp.	sand fly		6	1	0.5%						
<i>Palpomyia</i> gr.	sand fly		6	2	1.0%	1	0.5%				
Chironomidae											
<i>Alotanypus aris</i>	midge		9	3	1.4%						
<i>Brillia parva</i>	midge		5	2	1.0%	1	0.5%				
<i>Cryptochironomus</i> <i>fulvus</i> gr.	midge		8	1	0.5%						
<i>Eukiefferiella</i> <i>devonica</i> gr.	midge		8	2	1.0%	5	2.5%				
<i>Microtendipes</i> <i>pedellus</i> gr.	midge	FC	6							1	0.5%
<i>Microtendipes</i> <i>rydalensis</i>	midge	FC	6	2	1.0%	1	0.5%				
<i>Micropsectra</i> sp.	midge		7	6	2.9%	3	1.5%	8	3.8%		
<i>Paracladopelma</i> <i>loganae</i>	midge		7	2	1.0%						
<i>Parametriocnemus</i> sp.	midge		5	30	14.4%	13	6.4%				
<i>Paratanytarsus</i> sp.	midge	FC	6							1	0.5%
<i>Polypedilum</i>	midge		6	31	14.9%	22	10.8%	20	9.6%	4	2.0%
<i>Polypedilum</i>	midge		6	3	1.4%	2	1.0%	3	1.4%	3	1.5%
<i>Polypedilum laetum</i>	midge		6	2	1.0%						
<i>Pseudorthocladius</i> sp.	midge		0			2	1.0%				
<i>Psilometriocnemus</i> sp.	midge		4	1	0.5%						
<i>Procladius</i> sp.	midge		9							1	0.5%
<i>Rheosmittia</i> sp.	midge		5	3	1.4%						
<i>Rheotanytarsus</i> <i>exiguus</i> gr.	midge	FC	6	1	0.5%	9	4.4%	3	1.4%	7	3.4%
<i>Stempellinella</i> sp.	midge		2	1	0.5%	3	1.5%			1	0.5%
<i>Tanytarsus</i> sp.	midge	FC	6	6	2.9%	2	1.0%				
<i>Thienemanniella</i> sp.	midge		6	3	1.4%	8	3.9%				
<i>Thienemannimyia</i> gr.	midge		3	5	2.4%			3	1.4%	1	0.5%
<i>Tribelos jacundum</i>	midge		5							2	1.0%
<i>Trissopelopia</i> <i>ogemawi</i>	midge		4			1	0.5%				
<i>Tvetenia bavarica</i> gr.	midge		5	4	1.9%			2	1.0%		
<i>Zavrelimyia</i> sp.	midge		8	5	2.4%						

(continued)

Table 5. (continued) Macroinvertebrate taxonomic identification and IBI metric summary

Taxon:	Common Name	SC	FC	Tol.	Sta. 1 (Ref.) No. Pct.	Sta. 2 No. Pct.	Sta. 3 No. Pct.	Sta. 4 No. Pct.
Dixidae								
<i>Dixa sp.</i>	meniscus midge	FC	1		1 0.5%			
Empididae								
<i>Chelifera sp.</i>	dance fly		6		3 1.4%	2 1.0%		
Simuliidae								
<i>Simulium sp.</i>	black fly	FC	4		2 1.0%	2 1.0%	11 5.3%	27 13.2%
Tabanidae								
<i>Chrysops sp.</i>	deer fly		6		4 1.9%			
Tipulidae								
<i>Antocha sp.</i>	crane fly		3			1 0.5%		
<i>Dicranota sp.</i>	crane fly		3		4 1.9%	4 2.0%	2 1.0%	
<i>Pseudolimnophila sp.</i>	crane fly		2		1 0.5%			
<i>Tipula sp.</i>	crane fly		4			1 0.5%		
Total Specimens					208 100.0%	203 100.0%	208 100.0%	205 100.0%

Metric:	Value	Score (2)	Value	Score (2)	Value	Score (2)	Value	Score (2)
Total Taxa (Richness)	52	6	45	6	30	2	25	2
Hilsenhoff Biotic Index (1)	4.76	6	4.39	6	4.59	6	4.85	6
Scraper / Filtering Collector Ratio (1)	1 : 1.5	6	1.4 : 1	6	1 : 1.2	6	1 : 2.5	6
EPT Index	7	6	13	6	7	6	4	0
EPT / Chironomidae Ratio	1 : 3.5	6	1 : 2.1	6	2.3 : 1	6	4.3 : 1	6
Percent Dominant Taxon (3)	15%	6	17%	6	14%	6	39%	2
Community Loss Index	-	6	0.49	6	1.2	4	1.6	2
Total Score: Index of Biotic Integrity	42		42		36		24	
Percent Similarity to the Reference Score	-		100.0%		85.7%		57.1%	
Biological Condition	Reference		Non-impaired		Non-impaired		Slightly Impaired	

Notes:	1) Tolerance Values and Functional Groups from Maine DEP (2016) and New York State DEP (2018).
	2) Criteria for metric scoring taken from US EPA (1989).
	3) Dominant Taxon at each station shown in bold print.

Site 3 is downstream of the RIB discharge and also downstream of Whitten Pond. Codominant at this site were: *Gammarus fasciatus* (tol. = 4), an amphipod (14.4%) and a mayfly *Maccaffertium sp.* (tol. = 4) (14.4%). The amphipod *Gammarus fasciatus* is commonly found in slower, sandy/silty conditions associated with aquatic vegetation. Their relative abundance suggests a biotic response to a habitat shift that occurs in Nineteen Mile Brook between the upper to lower Sites. Five of seven metrics received scores of 6. A decline in Richness from 52 to 30 taxa produced a metric score of 2 - and a Community Loss Index of 1.2 resulted in a score of 4. The Index of Biotic Integrity (the total) was 36; that was 85.7% of the reference score of 42. So, the Biological Condition at this site was described as “non-impaired”.

Site 4 was the furthest downstream site sampled on Nineteen Mile Brook in a more open low—gradient area and, continuing the observed trend, showed lower metric values when compared with upstream sites. The dominant taxon here was a mayfly in the genus *Acerpenna* (tol. = 5), a marginal form found in backwater areas that represented 39.0% of the sample total. *Gammarus fasciatus* ranked second in

abundance (19.0%). Four of seven metrics received scores of 0 or 2 and the IBI total was 24 - 57% of Site 1. Therefore, the Biological Condition for this site was considered “slightly impaired”.

5.0 Fish Community Assessment

The fish community was assessed at Sites 1 – 4 concurrent with RBP habitat assessment and macroinvertebrate collection and was consistent with the 2008 baseline study. Fish were collected on August 13 and 14, 2019 using a Haltech B-2000 backpack electrofishing unit. For each site in Nineteen Mile Brook, a single pass was made through a 150 meter reach working in an upstream direction, as described in the NHDES Biomonitoring Program Protocols (NHDES, 2013b). In Whitten Pond, representative shoreline areas were sampled. Shocking distance and sampling time were recorded on field data sheets, along with species counts, total lengths and weights of collected fish, and information on external parasites, disease, or other morphological abnormalities. Fish data were analyzed using analytical metrics provided in the RBP first edition (Plafkin et al., 1989) and included Species Richness and Composition Metrics (RBP Metrics 1-6), Trophic Composition Metrics (RBP Metrics 7-9), and Fish Abundance and Condition Metrics (RBP Metrics 10-12) to evaluate overall stream quality for supporting aquatic biota. These metrics are summarized below and interpreted as presented in Table 6:

Species Richness and Composition Metrics –The following metrics assess the species richness component of diversity and the health of resident taxonomic groupings and habitat guilds of fishes.

- RBP Metric 1. Total Number of Fish Species – This number decreases with increased degradation; hybrids and introduced species are not included.
- RBP Metric 2. Number of Benthic Insectivores – These species (e.g., tessellated darter) are sensitive to degradation resulting from siltation and benthic oxygen depletion because they feed and reproduce in benthic habitats. Many smaller species live within the rubble interstices, are weak swimmers, and spend their entire lives in an area of 100-400 m².
- RBP Metric 3. Number of Water Column Species – These pool species (e.g., spottail shiner) decrease with increased degradation of pools and instream cover. Most of these fish feed on drifting and surface invertebrates and are active swimmers.
- RBP Metric 4. Number of Sucker Species – These species (e.g., white sucker) are sensitive to physical and chemical habitat degradation and commonly comprise most of the fish biomass in streams. These are long-lived species and provide a multiyear integration of physiochemical conditions.
- RBP Metric 5. Number of Intolerant Species – This metric distinguishes high and moderate quality sites using species that are intolerant of various chemical and physical perturbations. Intolerant species (e.g., rainbow trout) are typically the first to disappear following a disturbance. Species classified as intolerant should only represent the 5-10% most susceptible species; otherwise this becomes a less discriminating metric.
- RBP Metric 6. Proportion (%) Individuals as White Sucker – This metric is the reverse of Metric 5. It distinguishes low from moderate quality waters. These species show increased distribution or

abundance despite historical degradation of surface waters, and they shift from incidental to dominant in disturbed sites.

Trophic Composition Metrics -The following metrics evaluate the quality of the energy base and trophic dynamics of the fish assemblage. The trophic composition metrics offer a means to evaluate the shift toward more generalized foraging that typically occurs with increased degradation of the physicochemical habitat.

- RBP Metric 7. Proportion (%) of Individuals as Omnivores – The percent of omnivores (e.g., golden shiner) in the community increases as the physical and chemical habitat deteriorates. Omnivores are defined as species that consistently feed on substantial proportions of plant and animal material.
- RBP Metric 8. Proportion (%) of Individuals as Insectivores – Insectivores, primarily insectivores (e.g., tessellated darter) are the dominant trophic of most North American surface waters. As the invertebrate food source decreases in abundance and diversity due to habitat degradation (e.g., anthropogenic stressors), there is a shift from insectivorous to omnivorous fish species. This metric evaluates the midrange of biological conditions.
- RBP Metric 9. Proportion (%) of Individuals as Top Carnivores – The top carnivore metric discriminates between systems with high and moderate integrity. Top carnivores (e.g., largemouth bass) are species that feed, as adults, predominantly on fish, other vertebrates, or crayfish.

Fish Abundance and Condition Metrics - these metrics indirectly evaluate population recruitment, mortality, condition, and abundance.

- RBP Metric 10. Density of Individuals – This metric evaluates population abundance and varies with region and stream size for small streams. It is expressed as catch per unit effort, either by area, distance or time sampled. Generally, sites with lower integrity support fewer individuals, but in some nutrient poor regions, enrichment increases the number of individuals.
- RBP Metric 11. Proportion (%) of Individuals as Hybrids – This metric is an estimate of reproductive isolation or the suitability of the habitat for reproduction. Generally as environmental degradation increases the percent of hybrids also increases, but the proportion of simple lithophilids decreases. However, minnow hybrids are found in some high quality streams, hybrids are often absent from highly impacted sites, and hybridization is rare and difficult to detect.
- RBP Metric 12. Proportion of Individuals with Disease, Tumors, Fin Damage and Skeletal Anomalies – This metric depicts the health and condition of individual fish. These conditions occur infrequently or are absent from minimally impacted reference sites but occur frequently below point sources and in areas where toxic chemicals are concentrated. They are excellent measures of subacute effects of chemical pollution and the aesthetic value of game and nongame fish.

Table 6. RBP Fish IBI metric scoring and interpretation (from Plafkin et al., 1989)

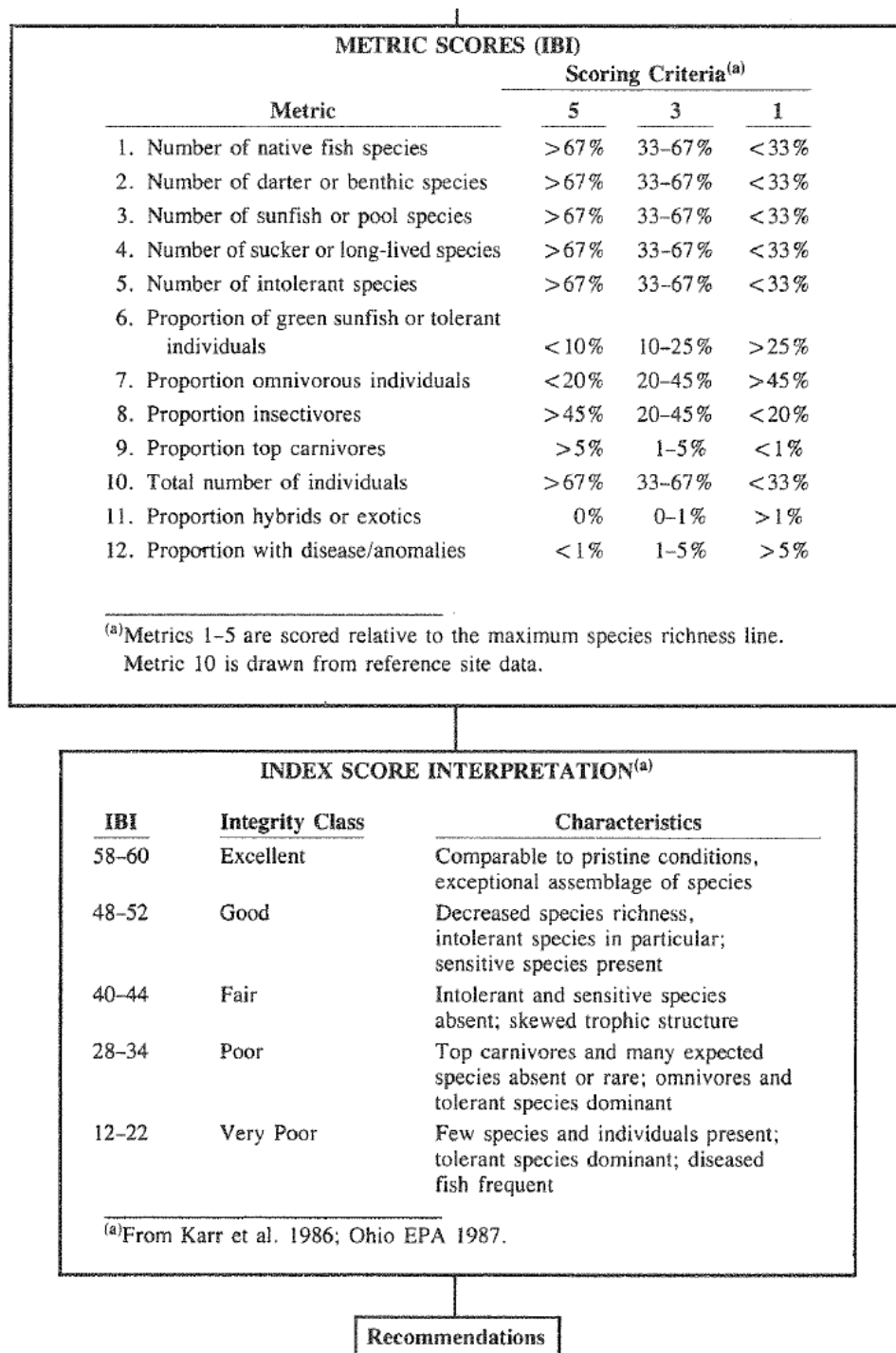


Figure 7.2-2. Flowchart of bioassessment approach advocated for Rapid Bioassessment Protocol V.

Similar to the macroinvertebrate sampling, metrics are scored and totaled to create an IBI for each station. The scores from the stations at or downstream of the rapid infiltration site discharge are then compared with the reference station to determine the degree of impairment. The scoring process, from Plafkin et al. (1989), is presented as Table 6.

5.1 Fish Community Assessment Results

The fish collected on August 13 – 14, 2019 indicate overall good biological conditions throughout the study area and represent a diverse range of species composition and abundance, sizes, and age classes. The fish communities showed measurable differences between stations, as expected for the varied habitats represented in the study area. A summary of the species and numbers captured at RBP Sites 1-4 are presented in Table 7 and discussed in detail below.

The reference site (Site 1) and Site 2 (the location of the rapid infiltration site discharge) both had similar fish communities. Brook trout (*salvelinus fontinalis*) were the only fish captured at each site. Sixty brook trout were captured at Site 1 representing multiple age classes (sizes ranging from 75 mm to 157 mm TL; Appendix A, Figure 8). Sixty seven brook trout were collected at Site 2 representing multiple age classes (ranging in size from 63 mm to 199 mm TL). The presence of brook trout as the dominant species is typical of a small coldwater stream in NH. Multiple age classes present in the fish population further indicates natural reproduction and multiple-year survival rates. These population characteristics require supportive spawning and rearing habitat with high water quality and are evidence of an overall high quality stream environment. Nineteen Mile Brook is stocked annually with hatchery-reared trout; however, it is unlikely that the fish caught in this study were hatchery-reared. Nineteen Mile Brook is stocked with “1 year+” hatchery fish that would be larger than most wild trout (> 180 mm) and hatchery fish often have fin deformations due to the confined hatchery conditions. The majority of trout caught for this study were well under 180mm in length and showed no evidence of fin deformations and, therefore, were most likely wild trout.

Fifty three fish representing five species were captured during sampling at Site 3 (downstream of Whitten Pond). Warmwater and coolwater species were numerically dominant at this location with golden shiner (*notemigonus crysoleucas*) the most commonly encountered species (n=20) followed by eastern creek chubsucker (*erimyzon oblongus*), (n=11; Appendix A, Figure 9). Brook trout (n=9), a coldwater species, were present here representing multiple age classes (lengths ranging from 82 mm to 170 mm). Chain pickerel (*esox niger*) and pumpkinseed (*lepomis gibossus*) were also captured at this location (Appendix A, Figure 10). This site represents a transitional stream environment with warm and coldwater species dominant and our data show this site supports a high quality fish community and further indicates high value habitat and high water quality.

Fifty two fish representing six species were captured at Site 4 (nearest the brook mouth). Similar to Site 3, golden shiner (n=20) and eastern creek chubsucker (n=16) were the most commonly encountered species at this site followed by chain pickerel (n=12). A single bluegill (*lepomis macrochirus*) was the only representative of this species in the study. Brook trout (n=2) and pumpkinseed (n=2) were also present here. Unlike at upstream locations, brook trout at Site 4 were represented by only 2 individuals at lengths of 202 mm and 268 mm TL. The lack of more age classes suggests this location may not be as suitable as upstream sites for coldwater species. However, the fish community present were typical of a warmwater stream in NH and indicate high quality habitat and good water quality.

Table 7. 2019 Fish Collection and Metric Analysis Results from Nineteen Mile Brook

SPECIES	REF STA 1	STA 2	STA 3	STA 4
Brook Trout (<i>Salvelinus fontinalis</i>)	60	67	9	2
Chain Pickerel (<i>Esox niger</i>)			7	12
Golden Shiner (<i>Notemigonus crysoleucas</i>)			20	20
Pumpkinseed			5	2
Eastern Creek Chubsucker			11	16
Bluegill			1	
Total individuals per sample	60	67	53	52
species richness	1	1	6	6

METRIC	Metric Value			
	REF STA 1	STA 2	STA 3	STA 4
1. Number of Native Fish Species	1	1	5	5
2. Number of Benthic Insectivore Species	0	0	0	0
3. Number of Water Column Species	1	1	5	4
4 Number of Sucker Species	0	0	1	1
5. Number of Intolerant Species	1	1	2	2
6. % White Sucker	0	0	0	0
7. % Omnivores	0.0%	0.0%	0.0%	0.0%
8. % Insectivores	0.0%	0.0%	0.0%	0.0%
9. % Top Carnivores	100.0%	100.0%	30.2%	26.9%
10. Density of Individuals	0.40	0.45	0.35	0.35
11. % Hybrids	0	0	0	0
12. % Anomalies	0	0	0	0

METRIC	Metric Value Percent Comp. to Ref. Site			
	REF STA 1	STA 2	STA 3	STA 4
1. Number of Native Fish Species	-	100%	500%	500%
2. Number of Benthic and Insectivore Species	-	100%	100%	100%
3. Number of Water Column Species	-	100%	500%	400%
4 Number of Sucker Species	-	100%	100%	100%
5. Number of Intolerant Species	-	100%	200%	200%
6. % White Sucker	-	100%	100%	100%
7. % Omnivores	-	100%	100%	100%
8. % Insectivores	-	100%	100%	100%
9. % Top Carnivores	-	100%	30%	27%
10. Density of Individuals	-	112%	88%	87%
11. % Hybrids	-	100%	100%	100%
12. % Anomalies	-	100%	100%	100%

(continued)

Table 7. (continued) 2019 Fish Collection and Metric Analysis Results from Nineteen Mile Brook

METRIC	Score			
	REF STA 1	STA 2	STA 3	STA 4
1. Number of Native Fish Species	5	5	5	5
2. Number of Benthic and Insectivore Species	5	5	5	5
3. Number of Water Column Species	5	5	5	5
4. Number of Sucker Species	5	5	5	5
5. Number of Intolerant Species	5	5	5	5
6. % White Sucker	5	5	5	5
7. % Omnivores	5	5	5	5
8. % Insectivores	5	5	5	5
9. % Top Carnivores	5	5	5	5
10. Density of Individuals	5	5	5	5
11. % Hybrids	5	5	5	5
12. % Anomalies	5	5	5	5
Total	60	60	60	60
BIOLOGICAL CONDITION	GOOD	GOOD	GOOD	GOOD

Whitten Pond was not sampled. It was determined that backpack electrofishing would be ineffective based on the size of the area. Additionally, the soft sediment would make safe movement difficult while sampling. No fish were captured here in 2008, making a comparison unproductive.

Obvious differences in aquatic habitat occur over a gradient from upstream to downstream within the study area in Nineteen Mile Brook. Observations of aquatic habitat indicate that Site 1 (the reference reach) is most similar to Site 2 (e.g. both are closed canopy, pool-riffle reaches) as compared with Sites 3 or 4. Site 2 is also within the discharge area and allows for a useful comparison between similar habitats both in a reference state (Site 1) and directly within RIB discharge area (Site 2). Therefore, an additional coldwater fisheries IBI comparison (NHDES, 2007) was made between these two sites to determine whether there were measurable differences in the biological integrity between the sites.

Sites 1 and 2 are indicative of small coldwater streams common in this part of New Hampshire. According to The Nature Conservancy Aquatic Habitat 7 Classes Map (Data Basin, 2019), these two upstream sites have drainage areas of less than 3.81 mi² and sampling shows they are dominated by a single coldwater species (brook trout). We used a predictive model to determine whether the NHDES coldwater IBI is a viable analysis given the physical stream characteristics. Based on the predictive model results, the upper sites of Nineteen Mile Brook do not meet the criteria to be considered under the coldwater IBI (Table 8; latitude below 43.75, elevation lower than 775 ft). However, based on the species richness (less than 4 species in community), species present (brook trout) and the drainage size (< 15 mi²), we determined it would be informative to run both sites through the NH coldwater IBI to provide an additional quantitative comparison between the sites. Both Site 1 and Site 2 had coldwater IBI scores of 45 (Table 9), which is above the threshold level of 30 required to consider a stream capable of supporting coldwater aquatic life use. Despite the inability to meet the qualifying predictive model parameters, the conditions within the upper portion of the stream have the requisite IBI attributes of a healthy coldwater NH stream. The coldwater IBI results show that the RIB discharge area (Site 2) and

the reference area (Site 1) are equivalent in terms of coldwater fish biological integrity, and further indicate no impairment to the fish community in the vicinity of the wastewater discharge.

Table 8. NHDES IBI Predictive Model Assessment for Cold and Transitional Water Streams

Predictive Model for Using Coldwater IBI	
Stream expected to support coldwater fish species?	Yes
Is stream > 43.75° Latitude with watershed <15 mi ²	No
CT River Basin and with watershed <15 mi ²	No
Rest of State: > 775' Elevation and watershed <15 mi ²	No
Result: Should Use Transitional Water IBI	

Table 9. NHDES Coldwater IBI Metric Analysis and Scoring

Metric	Score		
	Response	Site 1	Site 2
Percent Coldwater Individuals	100%	7.5	7.5
Percent Generalist Feeder	0%	7.5	7.5
Percent Top Carnivore	100%	7.5	7.5
Percent Eastern Brook Trout	100%	7.5	7.5
Eastern Brook Trout Age Class (Multiple?)	Yes	7.5	7.5
Number of Tolerant Species	0%	7.5	7.5
CW- IBI Score (Threshold 30)		45	45

6.0 Rare, Threatened and Endangered Species

Wildlife resources were reviewed during the 2019 baseline study and all species identified were compared to state and federal lists for rare, threatened, and endangered (RTE) or otherwise protected or listed species. In addition, the listed species were reviewed to determine whether there were known or likely listed species not identified during field studies that could be present in the study area. No state or federally protected RTE species were identified during the 2008 or 2019 baseline field studies. One species of fish (brook trout) and one species of freshwater mussel (eastern pearlshell) were present and positively identified in the 2019 baseline study; both have a status in New Hampshire of “Greatest Conservation Need” in the New Hampshire Wildlife Action Plan (NHFGD, 2015), as discussed below.

6.1 General Wildlife Resources

The 2019 Nineteen Mile Brook study was focused on water quality and biotic indicators (i.e., fish, macroinvertebrates) that are directly dependent on the water quality of aquatic habitats, and did not include any field assessment of wildlife. However, to provide continuity with the 2008 report, the following review of wildlife resources known to be or potentially present in the study area is presented.

This review is based on the 2008 study and existing publically available information regarding the presence and status of wildlife species in New Hampshire, and was conducted by the same biologist who conducted the 2008 study.

The species observed during the 2008 field survey were the types of wildlife commonly associated with the habitat types present in the study area. To the extent that the habitats present within the study area are similar to the habitat that was present in 2008, the species currently present are expected to be comparable and essentially unchanged since the 2008 study. At the time of the 2008 study, none of the species observed or expected to be present in the study area were state or federally listed as threatened or endangered. Since 2008, special status species lists have been updated, and based on this update, some special status species are now expected to be present in the study area. These species are listed in Table 10, and briefly discussed below.

Federally Listed Species

In 2007, white-nose syndrome (WNS), a lethal disease that affects cave-hibernating bats, was first identified in New York State. Since then, WNS has spread across the eastern and central United States, causing affected species to decline by up to 99%. In response, the northern long-eared bat (NLEB), formerly one of the most common bats in North America, was listed as federally threatened in 2015. Prior to the onset of WNS, NLEBs commonly occurred in forested habitats throughout New Hampshire in summer, roosting in tree hollows and under loose bark by day and feeding under the forest canopy at night. Acoustic bat surveys indicate that this species continues to persist at very low level in New Hampshire. Forested habitats associated with Nineteen Mile Brook provide suitable habitat for this species, and it is potentially present in the study area in the summer time. No suitable winter hibernation habitats (caves, abandoned mines) are present. No other federally listed wildlife species are expected to be present in the study area.

State Listed Species

New Hampshire updated its Wildlife Action Plan (NH WAP) in 2015 (NHFGD, 2015). As part of this update, the State list of Special Concern (SC), Threatened, and Endangered species was also updated, and a list of Species of Greatest Conservation Need (SGCN) was adopted. In response to WNS and other threats, NLEB, little brown bat, and eastern tri-colored bat were listed as endangered, and three other bat species (eastern red bat, silver-haired, and hoary bat) were added to the SC list. All these bat species use forested habitats in the summer time, commonly foraging over water and along forested edges, and are potentially present in the Study Area. Wood turtles were also added to the SC list. As noted in the 2008 report, the Study Area provides high quality habitat for wood turtles, and although none were observed during the 2008 surveys, this species is likely to be present. The 2008 survey confirmed the presence of scarlet tanager, listed as a SGCN. Other SGCN species likely to be present, based on known distribution and habitat present are spotted turtle, big brown bat and four song birds, Eastern towhee, purple finch, veery, and wood thrush.

Table 10. Special Status species known or likely to be present in the Study Area

Species	Scientific Name	Status*	Habitat Requirements
Northern Long-eared Bat	<i>Myotis septentrionalis</i>	FT, SE	Forest
Little Brown Bat	<i>Myotis lucifugus</i>	SE	Forest edges, ponds, streams
Eastern Tri-colored Bat	<i>Perimyotis subflavus</i>	SE	Forest edges, ponds, streams
Eastern Red Bat	<i>Lasiurus borealis</i>	SC	Forest edges, ponds, streams
Silver-haired Bat	<i>Lasionycteris noctivagans</i>	SC	Forest edges, ponds, streams
Hoary Bat	<i>Lasiurus cinereus</i>	SC	Forest edges, ponds, streams
Wood Turtle	<i>Glyptemys insculpta</i>	SC	Slow flowing sandy-bottomed streams, surrounding alder thickets and uplands
Spotted Turtle	<i>Clemmys guttata</i>	SGCN	Forested and shrubby wetlands, vernal pools, and surrounding uplands
Big Brown Bat	<i>Eptesicus fuscus</i>	SGCN	Forest edges, ponds, streams
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	SGCN	Shrubby thickets
Purple Finch	<i>Haemorhous purpureus</i>	SGCN	Forest, especially with conifers
Scarlet Tanager	<i>Piranga olivacea</i>	SGCN	Forest, deciduous and mixed
Veery	<i>Catharus fuscescens</i>	SGCN	Shrubby riparian habitats
Wood Thrush	<i>Hylocichla mustelina</i>	SGCN	Forest, deciduous and mixed

*FT = Federally Threatened, SE = State Endangered, SC = Species of Special Concern, SGCN = Species of Greatest Conservation Need

6.2 Fish and Freshwater Mussel Resources

The State of New Hampshire Wildlife Action Plan (NHFGD, 2015) includes a list of wildlife and habitats that are in need of conservation and as discussed in 6.2, above, and include Species of Concern (SC), State Threatened (ST) or Federally Threatened (FT), or State Endangered (SE) or Federally Endangered (FE) species, as well as other species that likely require protection and are included in the NH WAP as Species of Greatest Conservation Need (SGCN). While State or Federally Threatened or Endangered species are legally protected, State listed Species of Concern and Species of Greatest Conservation Need carry no legal status, but are considered uncommon, or vulnerable and warrant inclusion in the NH WAP.

The NH WAP includes one fish species identified during the 2019 field studies (brook trout, SGCN) as well as one mussel species (eastern pearlshell, SGCN). Other species in the NH WAP are known or may likely be found regionally in the vicinity of Nineteen Mile Brook but were not observed in the 2008 or 2019 surveys. No state or federally protected RTE species of wildlife were identified in Nineteen Mile Brook during the 2008 or 2019 baseline field studies.

Fish

The NH WAP (NH, 2015) includes several fish species that could potentially be found in the general region of the study area, including: lake whitefish (SC, SGCN); burbot (SC, SGCN); brook trout (SCGN); lake trout (SGCN); American eel (SC, SCGN); and bridled shiner (T,SGCN). Brook trout were prevalent at

the study area, especially in the upper reaches, as discussed in Section 5.0, but other state listed species were not identified as discussed below.

Lake trout and lake whitefish are primarily lake dwelling species and would not typically be found in a small low gradient stream such as Nineteen Mile Brook. Burbot, while occupying deep cold oligotrophic lakes and rivers in NH, are known to spawn in flowing portions of streams during December- March (Scarola, 1987). While there are portions of Nineteen Mile Brook that meet this description, no juvenile burbot were captured in the survey and it is likely that the rock dam at Whitten Pond would be a substantial barrier for any fish attempting to move upstream. American eel are known to be present in Lake Winnepesaukee and could potentially be present in Nineteen Mile Brook.

Bridle shiner are a State Threatened fish species in NH that occupy lakes, ponds, backwaters of rivers and slow moving streams with substantial submerged aquatic vegetation present, similar to the lower portions of Nineteen Mile Brook (NHFG, 2019a). Although the distribution map in the NH WAP identifies the region including Nineteen Mile Brook within their known range, no bridle shiners have been documented here. Eastern creek chubsucker, a species captured during the 2019 survey, have similar habitat requirements and are frequently observed in areas where bridle shiner surveys occur (NHFG 2019b).

Freshwater Mussels

Several freshwater mussels, identified as the eastern pearlshell (*margaritifera margaritifera*), were collected during the macroinvertebrate sample collections at two stations on Nineteenmile Brook (Sites RBP-1 and RBP-2). Eastern pearlshell are listed in the NH WAP as Species of Greatest Conservation Need in the State of New Hampshire and do not have state or federal protection (RTE) status. These individuals were not the target of the original investigations, but were incidentally collected as part of the jab-sweep methodology used for the macroinvertebrate sample collection. While the original study was not designed to evaluate freshwater mussel populations, health, or distributions, these opportunistic collections can confirm the presence of at least one species of freshwater mussel at these locations on Nineteen Mile Brook.

A total of three individual mussels were captured from two separate sample locations upstream (RBP-1) and adjacent to the RIB discharge area (RBP-2). Two individuals were captured from Station RBP-1 upstream of the discharge area and one individual was captured at Station RBP-2 immediately adjacent to the RIB discharge area. Individual mussels appeared to be in good condition with approximate ages ranging from 14-22 exterior annuli (a method for approximating ages of adult mussels). The shells were in good condition with less than 15 percent erosion of the periostracum (an outer coating that protects the mussel).

Eastern pearlshell mussels are typically found in coldwater streams with trout communities and their presence has been confirmed at the study site. Freshwater mussels are often patchily distributed and require a complex life cycle that involves fish and, consequently, no biological metrics or biotic integrity indices have been developed specifically for freshwater mussels to assess stream health. Rather, metrics using fish and macroinvertebrate communities are conventionally used as presented in Sections 4 and 5. The high quality habitat, excellent biological indicators documented at the study site, and the confirmed presence of eastern pearlshell indicate a supportive environment in Nineteen Mile Brook for this Species of Greatest Conservation Need.

7.0 Water Quality

Surface water quality was monitored during the 2019 baseline studies at four sites (see Figure 1) that were also utilized for water quality monitoring during the 2008 baseline studies. The four sites included a reference station (NMB-01) located upstream of the RIB wastewater discharge area, a station located within the RIB discharge area (NMB-02), a station in Whitten Pond below the discharge (WP-01), and a station in a “recovery” area at the Route 109A bridge (NMB-03). The water quality field program commenced in May 2019 and concluded in September 2019 to include a range of stream conditions and operating conditions from the RIB wastewater discharge.

The 2019 sampling program included monthly collection of water samples for laboratory analysis of nutrients and chloride at each of the four stations, as well as monthly collection of water temperature, dissolved oxygen (DO), pH, and conductivity data, and continuous monitoring of water temperature and conductivity throughout the field season. The monthly discrete sampling was consistent with the 2008 water quality monitoring program and provides information on potential impacts from the wastewater discharge that are commonly associated with pollution and impairment in receiving waters. Treated wastewater is permit-limited for the concentration of nutrients and other parameters that are discharged to the environment. Confirmatory monthly sampling of nutrients can show impacts as well as compliance with permit conditions. Testing of chloride is also useful, as chloride is a common wastewater component and is conservative in the environment; therefore, chloride concentrations can show the relative effects of the discharge in the stream, especially at low flows when the proportion of groundwater contributions to streamflow increase. Continuous monitoring of conductivity in the stream was not part of the 2008 baseline studies but was included in 2019 as this was an information gap identified in the Nineteen Mile Brook water quality data record (i.e. there were no continuous monitoring data records identified in the Wolfeboro Groundwater Discharge Permit file review). Specific conductance measurements are correlated with chloride concentrations in streams in NH and the conductivity monitoring record allows us to provide an estimate of continuous chloride concentrations in Nineteen Mile Brook throughout a field season. Continuous monitoring allows water quality to be assessed at the event scale, i.e. to see if there are short duration changes that might not be represented by periodic measurements.

The instrumentation used in the study included a YSI 6920 V2 water quality sonde for collection of temperature, DO, pH, and conductivity measurements. This instrument was calibrated according to manufacturer protocols prior to use each field day. Continuous monitoring temperature and conductivity data were collected with four Onset Hobo Conductivity Loggers. The Onset instruments were not field calibrated (they are factory calibrated), but were quality controlled (QC) prior to use by checking instrument performance with conductivity calibration standards. Side-by-side comparison readings at each stream site were also made with the YSI and Onset instruments on field days as a further QC check. In addition to continuous temperature/conductivity monitoring, we also collected stream stage elevations at the NMB-02 site in the RIB discharge area using a pair of Onset Hobo Water Level Loggers (one deployed in the stream and one as an atmospheric pressure reference). While the stream stage measurements were not included in our proposal, we felt the stream stage information would be useful for assessing flow conditions during the study. Instrument data were downloaded during monthly field visits with an Onset Hobo Waterproof Shuttle as recommended by the manufacturer.

During the September 25, 2019 water quality site visit, the final site visit of the season, an instrument error was discovered that affected all of the deployed Onset Hobo instruments at this site and one instrument (NMB-03) was lost during a flood event at the Rte. 109A road crossing (likely caused by beaver activity). None of the Onset Hobo instruments retrieved had collected any data following the August 29, 2018 site visit. The cause of the error was determined to be a critical error in the Onset Hobo Waterproof Shuttle that was used to communicate with the instrumentation. The Shuttle device is the means of communicating with Onset Hobo instrumentation in the field and allows for data downloads and simultaneously resets the data collection settings (i.e. to the previously used time interval and parameter collection settings). At the time of the August 29 field visit the shuttle device indicated a successful transfer of the data files and a successful resetting of the deployment settings. However, the shuttle had a malfunction at the time that was not indicated during use and resulted in corrupted header files on the instrumentation that delayed the start of each instrument indefinitely. The error was not (and could not be) discovered until the next site visit one month later when the instruments were retrieved and connected to the shuttle device. The result of this error is that continuous water temperature/conductance at the three stations (and very likely at NMB-03, although lost during the flood event) and stream stage at NMB-02 were not recorded from August 29, 2018 through September 25, 2019. While the data loss is unfortunate and irreconcilable, we have reviewed the data that were successfully collected as well as regional flow conditions (as indicated by nearest USGS gaging station on the Bearcamp River at South Tamworth, NH USGS gage 1064801) and are confident that the range of conditions expected for the study were represented in the remaining data collected.

7.1 Water Quality Sampling Results

Nutrients and chloride

We collected monthly water samples for laboratory analysis of nutrients and chloride from May through September, 2019 as presented below. Nutrient samples were analyzed for nitrate-nitrogen and total phosphorus. Nitrogen in typical RIB effluent is expected to be in the range of 1.3 - 3.1 mg/L (ammonia + nitrate, Wolfeboro, 2015) and is limited in the most recent groundwater discharge permit to ≤ 10 mg/L for total nitrogen. Most nitrogen in the RIB effluent will be in the form of nitrate – nitrogen so we can compare nitrate levels between stations and against the permit limit and expected range. Total phosphorus in wastewater effluent is not limited in the most recent groundwater discharge permit (NHDES, 2017) but according to the Town of Wolfeboro (Wolfeboro, 2015) is expected to be in the range of 0.1 – 0.6 mg/L in typical RIB effluent. As discussed previously in Section 2, there are no numerical water quality standards for phosphorus or nitrogen in NH; however, Env-Wq 1703.14 states that “Class B waters shall contain no phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring” and also states that “There shall be no new or increased discharge containing phosphorus or nitrogen to tributaries of lakes or ponds that would contribute to cultural eutrophication or growth of weeds or algae in such lakes and ponds.” The NH 2018 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM) Indicator 8b identifies trophic classes for lakes, ponds, and reservoirs for evaluating nutrients. The NH CALM Indicator 8b identifies oligotrophic lakes as having a median total phosphorus (TP) concentration of <0.008 mg/L; mesotrophic lakes as having TP concentrations ≤ 0.012 mg/L; and eutrophic lakes as having a median TP concentration of ≤ 0.028 mg/L. EPA has also provided guidelines for nutrient criteria in the absence of state water quality standards based on aggregate ecoregions throughout the US. For Aggregate Ecoregion VIII, which includes northern New England and Nineteen Mile Brook, the recommended

phosphorus limit is 0.010 mg/L and the recommended nitrogen limit is 0.38 mg/L for rivers and streams. While not an enforceable standard, these guidelines are useful evaluating the results of our in stream monitoring. Chloride concentration in the RIB effluent is not limited in the most recent Wolfeboro Groundwater Discharge Permit (NHDES, 2017), however the typical RIB effluent concentration of chloride is expected to be in the range of 110 – 180 mg/L (Wolfeboro, 2015) and NH water quality standards (Env-Wq 1700) have chronic (230 mg/L) and acute (860 mg/L) exceedance criteria for chlorides in freshwater for the protection of aquatic life.

The results of the monthly sample collection and laboratory analysis are presented in Table 11, below. Nitrate samples collected show that the lowest nitrogen levels were documented at the reference station NMB-01 with a highest reported nitrogen value at that site of 0.059 mg/L; other nitrogen values were lower or below laboratory reporting limits (and therefore an unknown). Laboratory reporting limits are the lowest reportable levels (statistically determined) for a given analytical test at a specific laboratory and can vary with sample matrix and treatment procedures (e.g. sample dilutions). For this study the laboratory reporting limits for nitrate varied from 0.05 – 1.0 mg/L. The measured (i.e., reported) nitrogen values in the reference reach were very low, well below the EPA guidelines value of 0.38 mg/L and well below the expected RIB effluent concentration of 1.3 – 3.1 mg/L total nitrogen (primarily as nitrate nitrogen). The samples collected at the three sites within and below the RIB discharge area documented higher nitrogen levels compared to the reference station, with the highest levels in the discharge area (NMB-02) and in the recovery reach (NMB-03). Nitrogen levels at NMB-02 were documented at 0.4 – 1.5 mg/L, with one sample below the laboratory reporting limit (<1 mg/L). These values are considerably higher than the nitrogen values measured at the reference reach, are higher than the EPA guidance value of 0.38 mg/L, and within or below the lower range of the expected RIB effluent nitrogen concentrations. Nitrogen levels in Whitten Pond tended to be considerably lower than at NMB-02 but higher than the reference station (NMB-01). Nitrogen levels also tended to be higher at the downstream station NMB-03 compared to NMB-01 and WP-01 but lower than NMB-02.

Total phosphorus samples indicated a more variable pattern as compared to nitrate at this site. While nitrate tends to be highly mobile in groundwater, and therefore we expect to see higher concentrations of nitrate near a subsurface wastewater discharge, phosphorus tends not to be mobile in groundwater and is easily attenuated by groundwater infiltration. Therefore, we expect to see a variable pattern of phosphorus throughout the site and any high levels of phosphorus in the wastewater discharge area could indicate performance issues with the RIB discharge such as preferential flow paths through the infiltration media and/or erosion and deposition of sediments in the stream. Background levels of phosphorus, as indicated by samples collected at NMB-01 varied from 0.01 – 0.19 mg/L while samples collected at the three downstream stations varied from <0.01 – 0.55 mg/L. The mean TP concentration at NMB-01 was 0.11 mg/L compared to 0.16 mg/L at the downstream stations, a relative percent difference of about 40%. These results indicate that TP levels during this study were higher on average at the three stations at or below the RIB discharge area as compared to background levels at NMB-01, however average TP levels are higher than the EPA guidelines value of 0.01 mg/L at all stations, including the reference station. Therefore, elevated levels of phosphorus in Nineteen Mile Brook are likely to be the result of multiple sources that may include the RIB discharge as well as a significant fraction of upstream (watershed) sources or instream (nutrient cycling) sources as indicated by the high TP levels at the reference station.

Chloride samples collected at Nineteen Mile Brook in 2019 show a strong spatial pattern of variation by site with low background chloride levels in the reference reach (NMB-01) and an increase by half an order of magnitude or more at the discharge site (NMB-02). Chloride values were also higher at Whitten Pond (WP-01) and NMB-03 than at NMB-01, but were lower than at NMB-02. Chloride values for samples collected at NMB-01 varied from <6 – 10 mg/L, which are very low and well below the NH chronic chloride standard of 230 mg/L. Chloride samples collected at NMB-02 varied from 18 – 86 mg/L; chloride samples collected at WP-01 varied from 6 – 32 mg/L; and chloride samples at NMB-03 varied from 18 – 62 mg/L. All of the chloride samples collected had chloride values below the NH water quality standards of 230 mg/L (chronic) and 860 mg/L (acute). This pattern of low background chloride levels and a marked increase in and below the RIB wastewater discharge area is expected as chloride is a component of treated wastewater effluent and is not typically assimilated by groundwater infiltration or through surface water interactions (e.g. uptake by plants or chemical transformations).

Comparison with nutrient data collected for Wolfeboro GWP

An extensive water quality record exists for Nineteen Mile Brook due to the requirement for sampling under Wolfeboro's groundwater discharge permit, as discussed in Section 2. We compared our data collected for the 2008 and 2019 baseline studies to the previously available Wolfeboro data (2007-2017) and updated 2017-2019 data provided by Wolfeboro in 2020 (Wolfeboro, 2020). We compared the stream sites that were located in closest proximity to make comparisons between the studies: GWP site 19MB#1 is located near our site NMB-01 and is the reference reach; in the RIB discharge area GWP site 19MB#21 is located near our site NMB-02; and at a downstream location GWP site 19MB#4 is located near our site NMB-03. Combined Wolfeboro GWP site data and data from this study are shown in Figures 10 and 11 and are summarized in Table 12.

The Wolfeboro GWP data show a slight downward trend in TP concentration throughout the site from 2007 – 2019; and samples collected by NAI for the 2008 study have comparable TP concentrations to the GWP data collected during the same timeframe. However, samples collected by NAI in 2019 have considerably higher concentrations of TP (by nearly an order of magnitude) at all sites (Figure 10; Table 12). There is no obvious explanation for why TP concentrations were consistently higher in our 2019 study than in the 13 years of data collected by Wolfeboro. It is worth noting TP was elevated at the reference reach in the NAI 2019 study (as compared to Wolfeboro 2007 – 2019 data) and was comparable to TP increases at downstream stations in our 2019 data and so it should not be concluded that this result is due to the RIB discharge. Another discrepancy between the data collected in our 2019 study and the Wolfeboro GWP dataset is the average values by station. In the Wolfeboro dataset the highest average TP concentrations were at the reference reach 19MB#1 (Table 12), not in the discharge or downstream stations. In contrast our TP data from the 2019 study indicate the highest average TP concentrations were at the discharge area NMB-02 (Table 12), with lower concentrations at the reference reach. Again, there is no obvious explanation for this discrepancy, although it could partially be explained by the small number of samples collected in the 2019 study (five monthly samples were collected).

Table 11. Monthly water quality measurements and laboratory analytical results

5/15/2019								
Station	Chloride (mg/L)	Nitrate - N (mg/L)	Total Phosphorus (mg/L)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	Specific Conductance (uS/cm)	pH (s.u.)
NMB-01	<6	<1	0.16	7.76	11.82	99.3	63	6.78
NMB-02	18	<1	0.38	7.24	11.88	98.6	120	6.48
WP-02	18	<1	0.55	9.62	13.06	115.4	84	6.59
NMB-03	18	<1	0.17	9.23	12.49	108.7	89	6.76
6/19/2019								
Station	Chloride (mg/L)	Nitrate - N (mg/L)	Total Phosphorus (mg/L)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	Specific Conductance (uS/cm)	pH (s.u.)
NMB-01	8	<0.05	0.19	15.09	9.83	97.6	50	6.63
NMB-02	32	0.4	0.21	14.23	9.96	97	155	6.71
WP-02	24	0.2	0.21	18.24	11.33	120.4	126	111
NMB-03	28	0.2	0.14	16.12	8.98	91.2	137	6.87
7/26/2019								
Station	Chloride (mg/L)	Nitrate - N (mg/L)	Total Phosphorus (mg/L)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	Specific Conductance (uS/cm)	pH (s.u.)
NMB-01	8	0.059	0.062	16.66	9.87	101.3	51	6.99
NMB-02	44	0.65	0.064	15.74	10.08	101.5	221	6.93
WP-02	24	0.097	0.057	24.82	14.04	165.1	122	7.62
NMB-03	34	0.32	0.064	20.80	9.35	104.6	167	7.2
8/29/2019								
Station	Chloride (mg/L)	Nitrate - N (mg/L)	Total Phosphorus (mg/L)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	Specific Conductance (uS/cm)	pH (s.u.)
NMB-01	10	<0.1	0.01	16.51	9.69	99.2	48	6.4
NMB-02	44	0.51	0.01	15.82	9.55	96.4	185	6.71
WP-02	32	0.12	0.04	24.29	12.03	143.4	152	7.06
NMB-03	36	0.25	<0.01	18.98	9.81	105.7	150	6.79
9/25/2019								
Station	Chloride (mg/L)	Nitrate - N (mg/L)	Total Phosphorus (mg/L)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	Specific Conductance (uS/cm)	pH (s.u.)
NMB-01	6	0.025	0.11	11.86	11.49	106.3	54	6.78
NMB-02	86	1.5	0.14	11.77	10.65	98.5	408	7.05
WP-02	6	<0.1	0.086	17.57	13.28	139.1	65	7.41
NMB-03	62	0.47	0.12	15.54	9.75	98.1	304	7.08

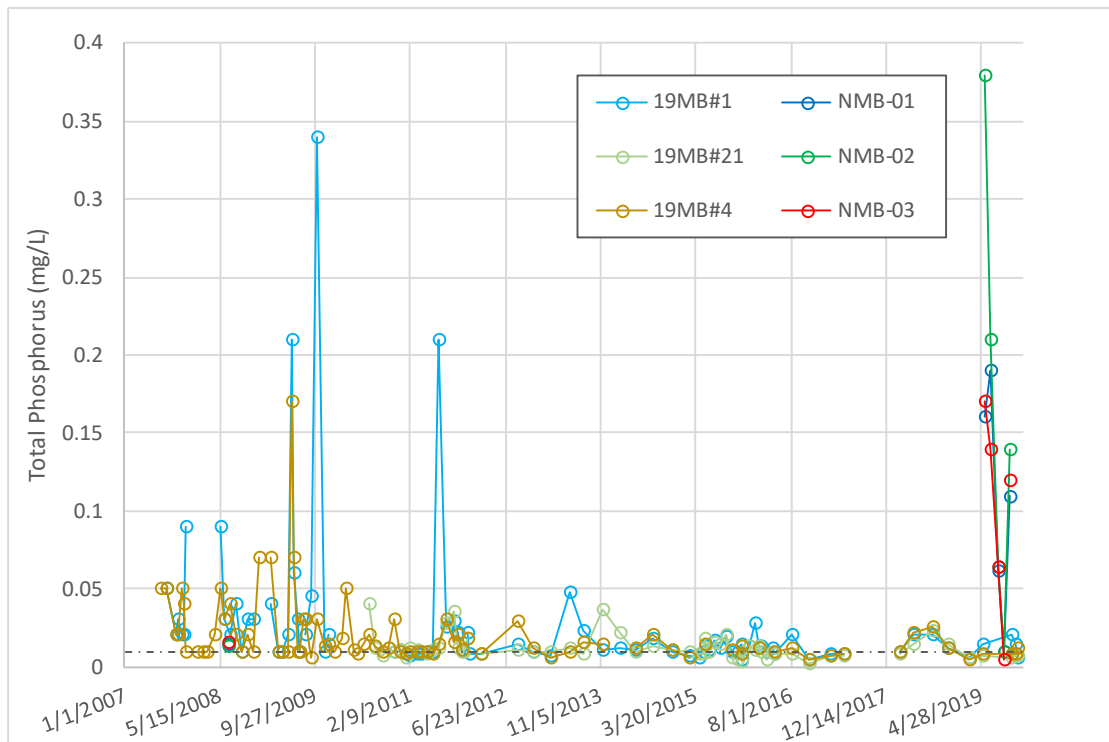


Figure 10. Wolfeboro GWP total phosphorus data (19 MB#1; 19MB#21; 19MB#4, 2007 – 2019); NAI total phosphorus data (NMB-01; NMB-02; NMB-03, 2008 & 2019)

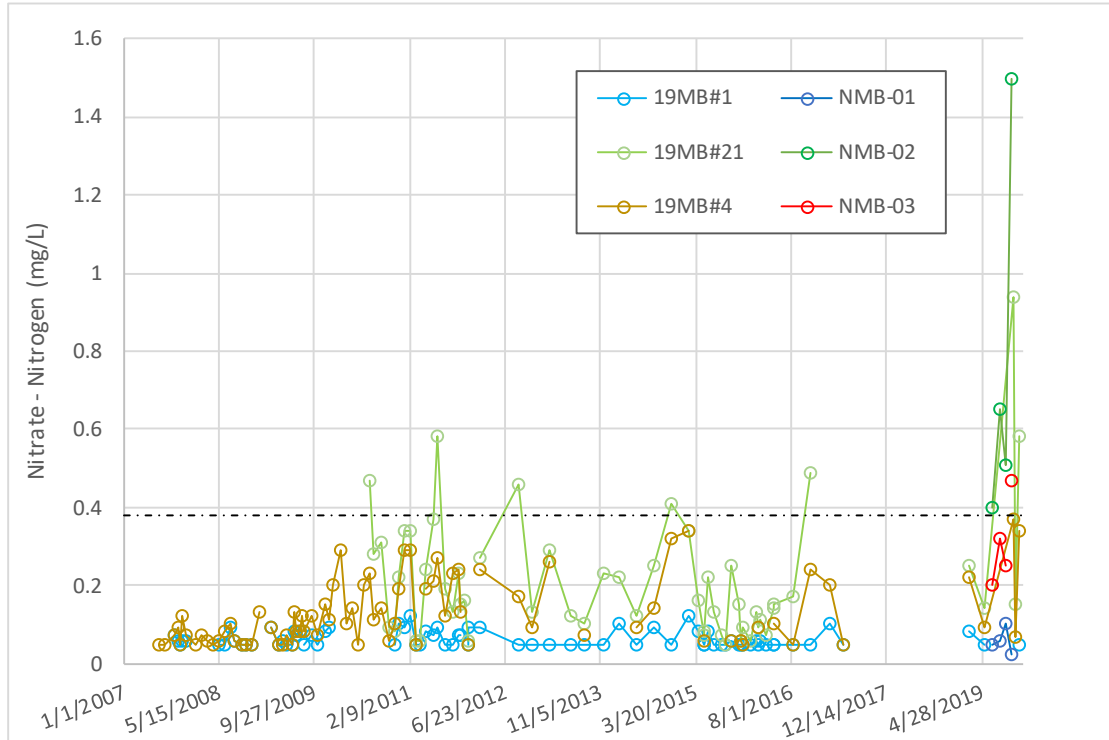


Figure 11. Wolfeboro GWP Nitrate - Nitrogen data (19 MB#1; 19MB#21; 19MB#4, 2007 – 2019); NAI Nitrate - Nitrogen data (NMB-01; NMB-02; NMB-03, 2008 & 2019)

Table 12. Comparison of median total phosphorus, nitrate-nitrogen, and chloride concentrations by site and study.

Total Phosphorus (median of all study samples, mg/L)				
	Reference Reach	Discharge Area	Whitten Pond	Downstream Reach
Study	NMB-01	NMB-02	WP-01	NMB-03
NAI 2008	0.015	0.013	0.018	0.016
Wolfeboro 2007-2019	0.013	0.010	-	0.012
NAI 2019	0.110	0.140	0.086	0.120
Nitrate - Nitrogen (median of all study samples, mg/L)				
	Reference Reach	Discharge Area	Whitten Pond	Downstream Reach
Study	NMB-01	NMB-02	WP-01	NMB-03
NAI 2008	<0.5	<0.5	<0.5	<0.5
Wolfeboro 2007-2019	0.050	0.150	-	0.100
NAI 2019	0.042	0.580	0.120	0.285
Chloride (median of all study samples, mg/L)				
	Reference Reach	Discharge Area	Whitten Pond	Downstream Reach
Study	NMB-01	NMB-02	WP-01	NMB-03
NAI 2008	4	4	4	4
Wolfeboro 2007-2019	-	-	-	-
NAI 2019	8	44	24	34

Nitrate – nitrogen data collected during the NAI 2019 study were also on average higher than the Wolfeboro GWP permit 2007 – 2019 data that were reviewed (Figure 11 and Table 12). Our 2019 data indicate nitrate concentrations in the discharge area and downstream reach were several times greater than the average values reported in the GWP permit data for 2007 - 2019, while nitrate values at the reference reach were actually lower in the 2019 samples than the average concentrations reported for the GWP permit in 2007-2019. This result could indicate that nitrate concentrations have increased in the discharge area and downstream stations since 2017, since nitrate levels in the reference reach are comparable to (or lower than) the 2007 – 2019 data. However, this result is equivocal and could be explained by the low number of samples collected in 2019 (5 monthly samples) versus the 2007-2019 GWP dataset and/or due to random inherent variability.

Field measurements of temperature, dissolved oxygen, pH, and conductivity

Concurrent with water sample collection we also measured water quality parameters at each sampling station with a YSI 6920 data sonde, as presented in Table 11. Measurements were taken at each site for water temperature, dissolved oxygen, pH, and conductivity/specific conductance. Dissolved oxygen levels were high at all sites and all site visits. The highest DO levels were in Whitten Pond (WP-01) and

showed evidence of supersaturation >100% during each of the five site visits. Whitten Pond was observed to be very shallow and full of aquatic plants and algae. This observation combined with measured total phosphorus levels of 0.04 mg/L – 0.55 mg/L, and supersaturated oxygen levels indicate that Whitten Pond is likely in a eutrophic state (nutrient enriched). Oxygen levels at NMB-03 below Whitten Pond showed more typical levels of 91.2 – 108.7 % saturation. All dissolved oxygen measurements exceeded the state standards for Class B waters of 75% saturation and 5 mg/L. pH levels measured during site visits indicated typical pH conditions and only two measurements (pH of 6.4 at NMB-01 and 6.48 at NMB-02) did not meet the state pH standard for Class B waters of 6.5 – 8.0. The location of one pH measurement below the state standard at NMB-01 likely indicates an upstream source of the lower pH. Specific conductance measurements show results that mirror the chloride data collected from the four sites – with low background values at station NMB-01 and markedly higher levels at the downstream stations, particularly at NMB-02 in the RIB discharge area. Water temperatures measured during site visits are shown for reference but are highly variable on a daily cycle and it is difficult to compare single measurements between sites. Further discussion of temperature and specific conductance are presented with the continuous water quality data in Section 7.2.

7.2 Water temperature and specific conductance continuous monitoring

Onset Hobo Conductivity Loggers were installed at the four water quality sampling stations (NMB-01, NMB-02, WP-01, NMB-03) and collected continuous temperature and conductivity data throughout the study with valid data from May 15, 2019 through August 29, 2019. Instrument data were not collected from August 29, 2019 through the end of the study on September 25, 2019 due to instrument failures and physical loss of the instrument at NMB-03, as discussed previously in Section 7.1. The conductivity data collected were temperature corrected to specific conductance using the equation:

$$\text{Specific conductance} = \text{conductivity} / (1 + 0.0191 * (\text{temperature} - 25))$$

Specific conductance data were also converted to an estimate of chloride concentration based on a linear regression developed from the chloride samples collected and analyzed for this study (n=19 valid chloride measurements) and the specific conductance readings of those samples as shown in Figure 12. Continuous temperature at each station is shown in Figure 13 (as a 24 hour rolling average to dampen large daily changes), specific conductance is shown in Figure 14 and estimated chloride concentrations are shown in Figure 15. Stream stage at NMB-02 and daily discharge from RIB structures are also shown in Figures 13 – 15 for reference.

Continuous monitoring of temperature and conductivity at Nineteen Mile Brook in 2019 fills a data gap identified during the Wolfeboro Groundwater Discharge Permit file review portion of this study as discussed in Section 2. While there is an abundance of water quality data collected at the site associated with permit compliance and from the 2008 baseline studies, there has been no continuous monitoring with deployed instrumentation prior to this 2019 study (that we are aware of). Continuous monitoring allows for an evaluation of water quality trends with time at daily, event scale, and seasonal timeframes. Given the variability of flows associated with the RIB discharges (wastewater is pumped intermittently and not always daily to the RIBs), a record of continuous water quality data can help identify changes in the affected water body that may not be represented by periodic sampling.

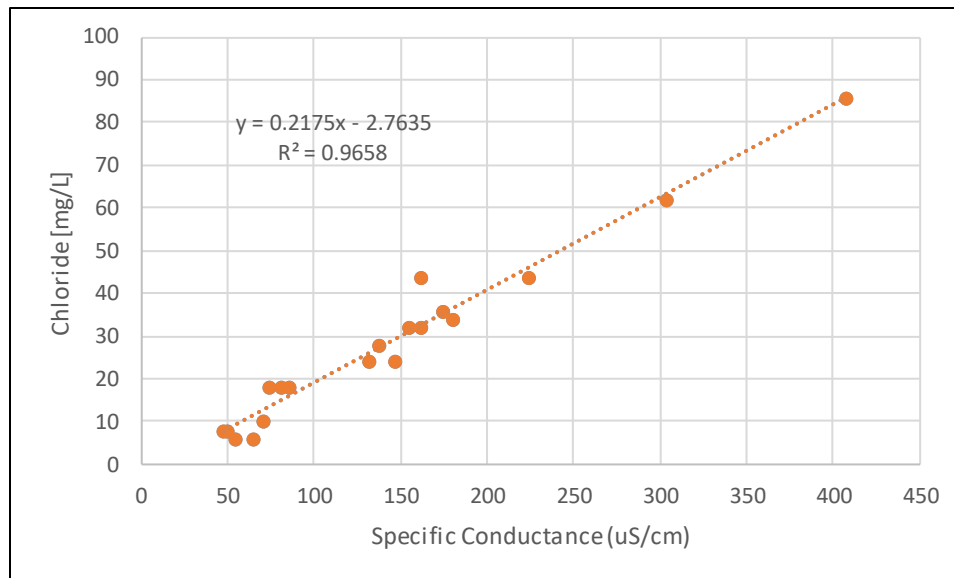


Figure 12. Chloride-specific conductance regression

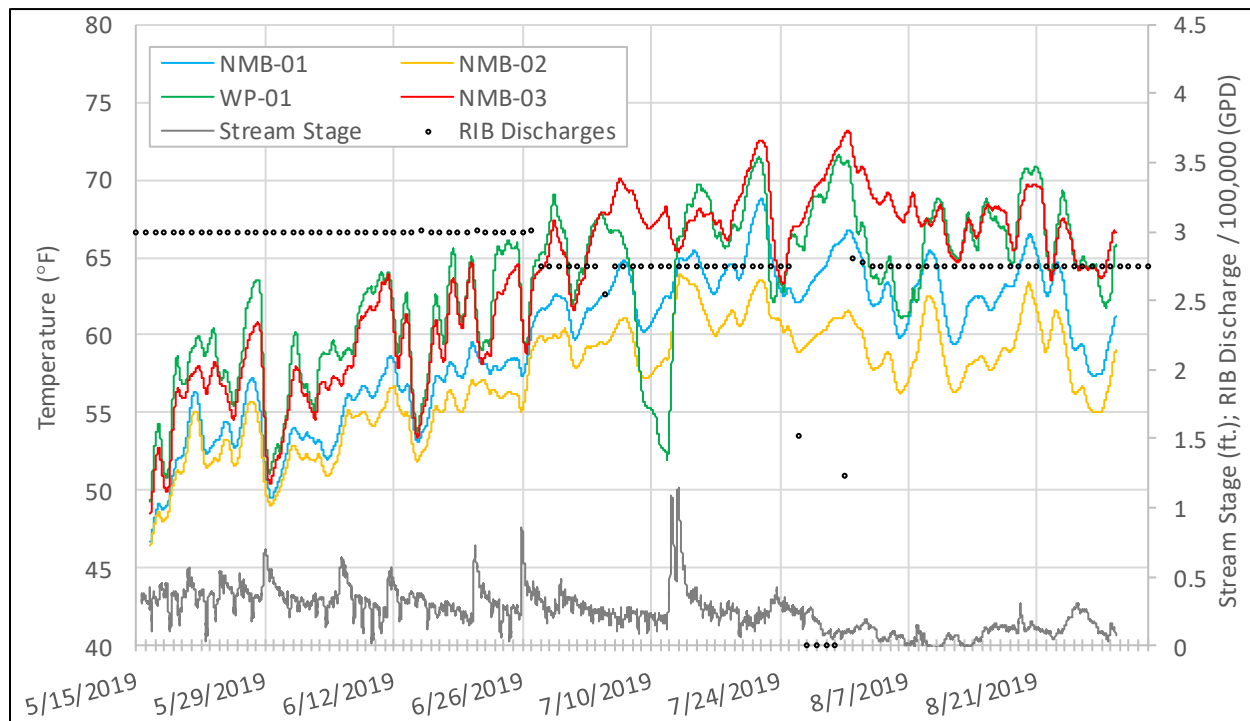


Figure 13. Water temperature at all sites as a 24 hour rolling average, stream stage at NMB-02, and RIB discharges

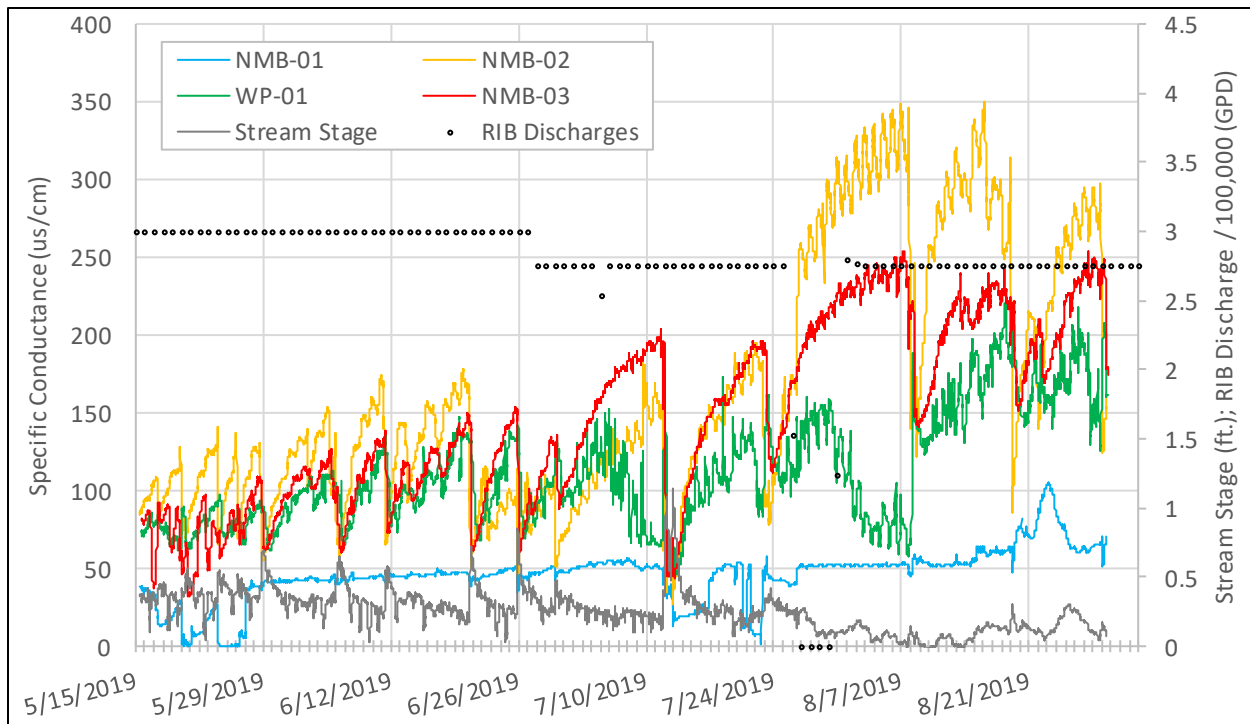


Figure 14. Specific conductance at all sites, stream stage at NMB-02, and RIB discharges

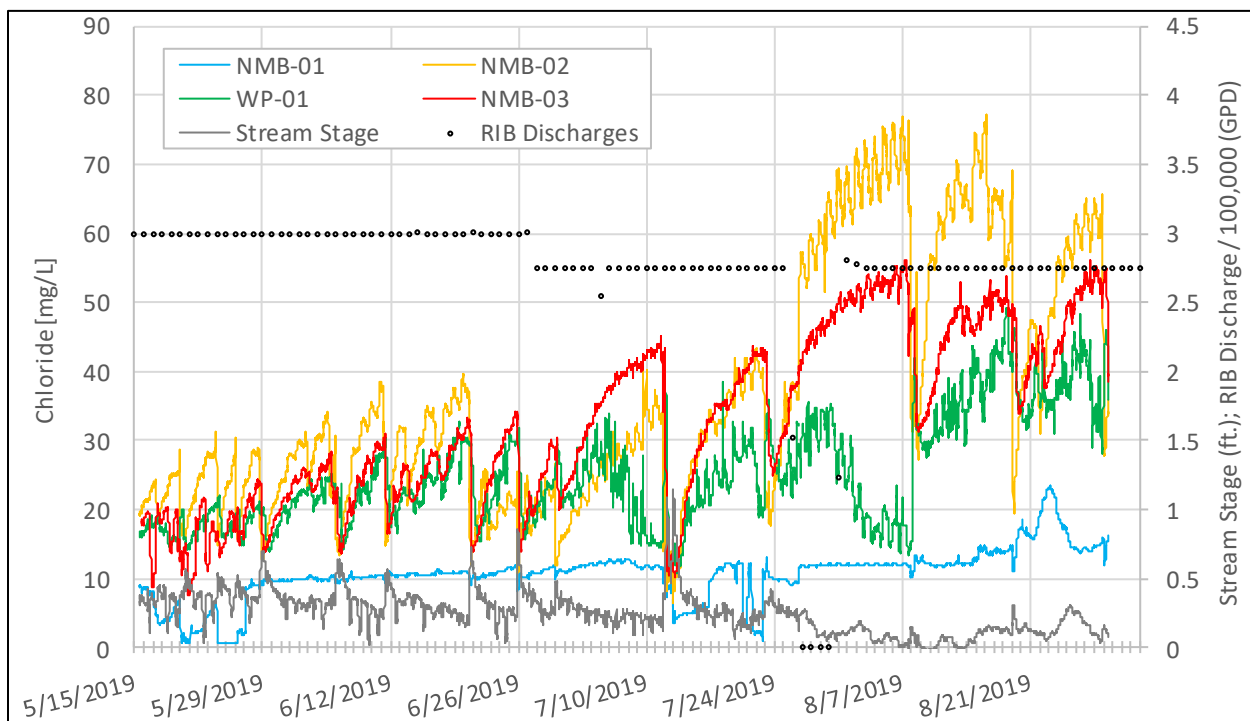


Figure 15. Estimated chloride at all sites, stream stage at NMB-02, and RIB discharges

Our data show that water temperatures at Nineteen Mile Brook varied seasonally and daily, and in general were lower at the upper two sites (NMB-01 and NMB-02) compared to the lower two sites (WP-

01 and NMB-03) as presented in Table 13. This result is expected as the upper sites were characterized by a closed canopy which limits daily solar heating in the stream and the same reaches have been identified as excellent coldwater brook trout habitat (Section 5.0). Temperatures at NMB-02 in the RIB discharge area were consistently lower than at the reference reach, particularly during the high temperature/low flow periods of the study in July and August, and could indicate a cooling effect from the increased proportion of groundwater discharged to that reach. This result is equivocal, however, and there could be other hydrologic causes (e.g. natural groundwater discharges, hyporheic exchange, etc.) for lower temperatures at this reach. Temperatures tended to be warmer at WP-01 and NMB-03 compared to the upper two reaches, likely caused by the heating effects of the slow, shallow water in Whitten Pond and the more open canopy in the lower reaches of the brook. RIB discharges occurred daily during the study period with flows generally between 275,000 and 300,000 GPD. No discharges from the RIBs occurred from July 27 – 30, 2019. There were no obvious changes in water temperature or stream stage during the period with no RIB discharges or due to changes in discharge volume.

Table 13. Maximum, minimum, and mean temperature, specific conductance, and estimated chloride by station for May – August continuous monitoring period

Station	Max/ Min/ Mean Temperature (°C)			Max/ Min/ Mean Specific Conductance (uS/cm)			Max/ Min/ Mean Estimated Chloride (mg/L)		
NMB-01	71.2	45.3	59.7	104.6	0.0	45.3	23	1	11
NMB-02	65.9	44.9	57.2	350.5	26.7	163.8	77	6	36
WP-02	79.1	46.4	63.2	222.2	44.9	112.2	49	10	25
NMB-03	78.0	46.0	63.7	254.4	31.4	147.1	56	8	33

Specific conductance in Nineteen Mile Brook varied considerably from the reference station (NMB-01) to the downstream stations, with the highest overall specific conductance values at NMB-02 and were on average a factor of 3.5+ times higher than at NMB-01. Specific conductance values decreased at the stations below NMB-02 and were lowest in Whitten Pond (WP-01), although still much higher than at NMB-01. While specific conductance tended to be relatively steady at NMB-01 (with the exception of periods of almost zero readings, likely caused by the instrument location going dry) with an overall seasonal increase, specific conductance at the downstream stations varied on a daily basis, showed large changes at the event scale, and large seasonal variations. Specific conductance was highest during low flow periods in August, with the highest levels measured at NMB-02, likely due to the increasing proportion of wastewater effluent-sourced groundwater as stream levels dropped overall. Multiple events were characterized by marked temporary decreases in conductivity at the downstream sites. While some low conductivity events coincided with higher flows (higher stream stage), particularly in the first half of the study period, temporary low conductivity periods in the latter half of the study period did not coincide with significant stream stage increases and cannot be explained by that driver alone (we had assumed that high flow events would decrease instream conductivity as the flow source shifts from groundwater to surface runoff). RIB discharges were fairly uniform during the study period and therefore it is difficult to determine any effects from changes in RIB operations. There was one four day period during the study with no RIB discharges (July 27 – 30); however, there were no obvious effects on conductivity or stream stage in the discharge area or downstream stations.

Estimated chloride at each of the stations, as derived from the specific conductance data, followed identical patterns as the specific conductance data from which it was derived and is presented to review estimate chloride concentrations with respect to state standards. Estimated chloride during the May – August continuous monitoring period varied from 1 – 77 mg/L and was highest on average at NMB-02 with a mean estimated concentration of 36 mg/L for the study period. Estimated chloride values, while high for a typical low-order stream in this region, were well below the NH chronic (230 mg/L) and acute (860 mg/L) values for chloride.

Specific conductance and estimated chloride values increased with decreasing streamflow throughout the study site, likely due to the shift in source composition at baseflows (i.e. increasingly from groundwater). The period from August 29 through September 25 that is missing from the continuous monitoring record was a very dry period and likely had continued periods of high specific conductance/chloride values in the stations at and below NMB-02. For comparison, see streamflow at the Bearcamp River at North Tamworth and stream stage at NMB-02 in Figure 16. Flows in late September were comparably low to flows in mid-August at the Bearcamp River, a surrogate for regional flow levels. At Nineteen Mile Brook specific conductance/ chloride may have been at a seasonal high in late September as evidenced by the grab sample from NMB-02 on September 25 that had a laboratory measured chloride value of 86 mg/L and a specific conductance reading in the field of 408 uS/cm. These levels were higher than any other readings measured during the study. While September data were not collected during the continuous monitoring study, and the highest measurements for specific conductance and chloride were measured at the end of that month, we think it is unlikely that levels in the stream were ever much higher than 400 uS/cm specific conductance and 86 mg/L chloride in this study period. Regionally, streamflow reached an absolute seasonal minimum in August (at Bearcamp River), not in September. Therefore we think it is reasonable to conclude that chloride levels in the stream never approached the state water quality standards of 230 mg/l (chronic) and 860 mg/L (acute) as this would be 2.5+ times greater than any measurement during our study, including the grab sample collected at the end of the September dry period. Therefore, while the missing data from our study are unfortunate, we don't feel that our results would change appreciably had the data been collected as planned.

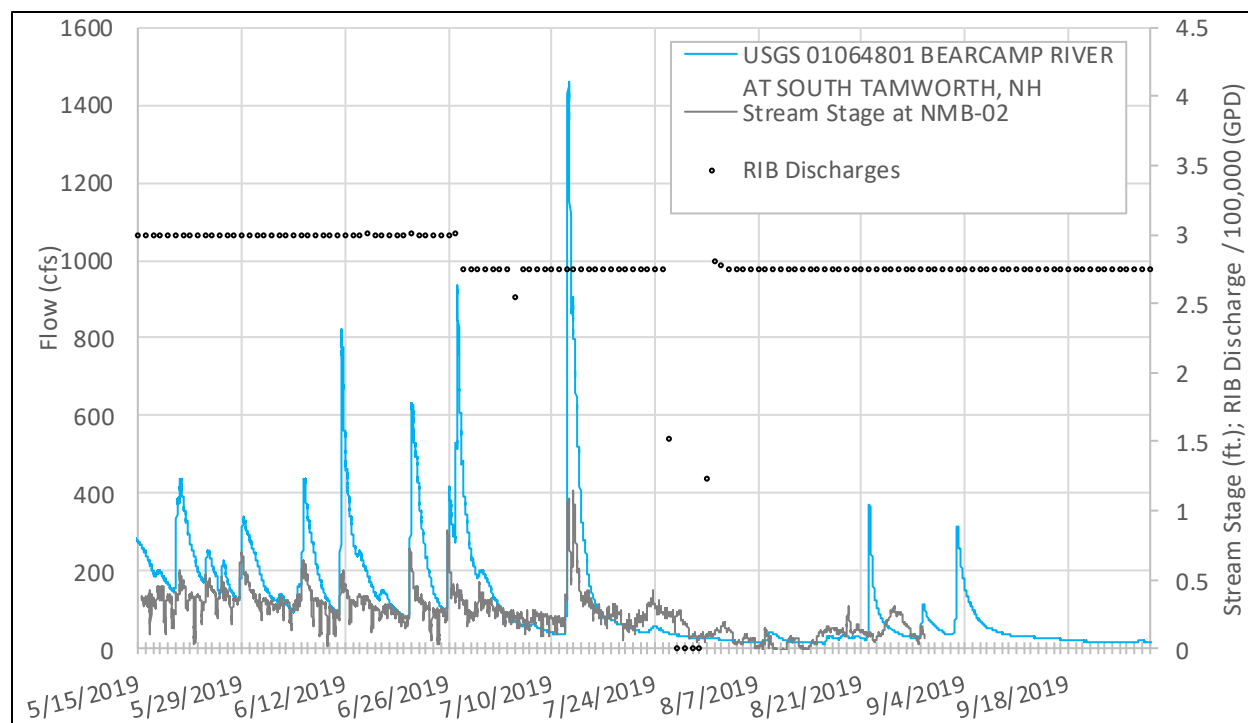


Figure 16. River flow at Bearcamp River at South Tamworth, NH (USGS gage 01064801), stream stage at NMB-02, and RIB discharges

8.0 Comparison of Results from 2008 and 2019 Baseline Studies

Baseline environmental studies completed in 2019 along portions of Nineteen Mile Brook allow a quantitative assessment of water quality and overall ecological health in the brook after ten years of operating the Wolfeboro Rapid Infiltration Basin wastewater discharge. In 2008, many of the same studies were completed prior to commencement of operations of the wastewater discharge and these repeated efforts allow for direct comparison over the ten year interval and provide critical information to the current ecological state in the stream. The studies completed allow a holistic assessment with documentation of short timescale measurements in the continuous water quality study and long term cumulative effects assessment in the habitat, fish, and macroinvertebrate studies. These studies individually and together are designed to identify any current signs of impairment, ecological stress, or exceedance of water quality standards, as well as any degradation over time. Given the high quality of the brook as measured in the 2008 baseline studies, as well as the uncertainty surrounding the potential impacts resulting from a new source of treated wastewater being discharged indirectly to the brook, and the subsequent number of critical operating issues associated with the RIB wastewater discharge, including an administrative order by consent issued for violating the groundwater discharge permit conditions, it was and remains prudent to independently evaluate the stream to determine both ambient conditions and any potential effects resulting from the wastewater discharge.

Stream habitat was assessed at the same stations on Nineteen Mile Brook using the RBP methods in both the 2008 and 2019 baseline studies. Habitat degradation due to human activity or pollution (or any other source) would be evident in the RBP evaluations completed eleven years apart. All sites in the

study area scored an “Excellent” RBP value for habitat in both 2008 and 2019 (see Table 13). The Site 1 and Site 3 2019 metrics were the same as the 2008 scores while Sites 2 and 4 scored higher in 2019 than in 2008. Based on the habitat scores comparison between 2008 and 2019, there does not appear to be any long term degradation of habitat in Nineteen Mile Brook and the stream habitat remains to be in excellent quality.

Analysis of macroinvertebrate samples collected in 2019 also showed a trend of improvement over time or stability (i.e. no change in analytical metrics) within Nineteen Mile Brook since completion of the 2008 baseline studies (see Table 13). At the reference station (Site 1) the metric scores calculated from the 2019 data were generally similar to those from the 2008 metric analysis; except for the richness metric that increased from 32 taxa in 2008 to 52 taxa in 2019. At Site 2, in the RIB discharge area, the IBI scores were 40 in 2008 and 42 in 2019. These values indicate no impairment compared to the reference station and also a slight increase in the IBI score (macroinvertebrate community improvement) during the eleven year interval between studies. Site 3 had an IBI score of 28 in 2008 (“slightly impaired”) and an IBI score of 36 in 2019 (“non-impaired”). This indicates the macroinvertebrate community improved at Site 3 from 2008 to 2019. Site 4 had an IBI score of 20 in 2008 (“moderately impaired”) and a score of 24 (“slightly impaired”) in 2019. Therefore, Site 4 also showed a slight improvement in the macroinvertebrate community between 2008 and 2019.

As part of the 2019 fisheries study, we compared the fish communities in the downstream sites with the reference site following the methodology utilized in the 2008 report. Based on that approach, all four sites in 2019 scored a 48 of 60, indicating a good quality fish community. These results are similar to those reported in 2008. The presence of multiple age classes of brook trout in 3 of the 4 sampling locations suggest that this stream has provided year round coldwater fish habitat for several consecutive years and there is no evidence of impairment to the fish community.

Water quality data were collected in both the 2008 and 2019 studies and included repeated measurements of water temperature, dissolved oxygen, pH, and conductivity as well as laboratory analysis of water samples for nutrients and chlorides. Dissolved oxygen levels, one of the most important water quality indicators, were generally comparable and in all cases were greater than NH water quality standards in both the 2008 and 2019 studies. In the 2008 study we saw DO levels that were on average lower, especially in Whitten Pond, than were measured in 2019. This result, particularly the supersaturated (daytime measurements) oxygen levels in Whitten Pond, and the higher levels of phosphorus measured in 2019 versus 2008 (however, only one round of laboratory data were reported in 2008), and the observed aquatic plants and algae in Whitten Pond, could indicate that Whitten Pond has become eutrophic (nutrient enriched) since 2008.

Table 14. Comparison of summarized 2008 and 2019 study data

METRIC	2008 Values				2019 Values			
	REF STA 1	STA 2	STA 3	STA 4	REF STA 1	STA 2	STA 3	STA 4
Habitat								
RBP Habitat Score	159	151	154	158	159	163	154	173
% Similarity to Reference Reach	-	95%	97%	99%	-	103%	97%	109%
Habitat Value	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Macroinvertebrates								
Macroinvertebrate Index of Biotic Integrity	42	40	28	20	42	42	36	24
% Similarity to Reference Reach	-	95.2%	66.7%	47.6%	-	100.0%	85.7%	57.1%
Impairment Status	Reference	Non-impaired	Slightly impaired	Moderately impaired	Reference	Non-impaired	Non-impaired	Slightly impaired
Fish								
Species count								
<i>Brook Trout</i>	9	16	3	3	60	67	9	2
<i>Chain Pickerel</i>			1	3			7	12
<i>Golden Shiner</i>	1		1	1			20	20
<i>Pumpkinseed</i>							5	2
<i>Eastern Creek Chubsucker</i>							11	16
<i>White Sucker</i>			1				1	
<i>Bluegill</i>								
Total individuals per sample	10	16	6	7	60	67	53	52
RBP Fish Metrics								
Total Score	60	60	60	60	60	60	60	60
Biological Condition	Good	Good	Good	Good	Good	Good	Good	Good
Water Quality								
	2008 Values				2019 Values			
	NMB-01	NMB-02	WP-01	NMB-03	NMB-01	NMB-02	WP-01	NMB-03
Median value								
Chloride (mg/L)	4	4	4	4	8	44	24	34
Total Phosphorus (mg/L)	0.015	0.013	0.018	0.016	0.110	0.140	0.086	0.120
Nitrate- Nitrogen (mg/L)	<0.5	<0.5	<0.5	<0.5	0.05	0.58	0.12	0.29
Dissolved Oxygen (mg/L)	8.85	8.80	8.75	8.50	9.87	10.08	13.06	9.75
Dissolved Oxygen (% saturation)	92.8	91.6	90.5	85.0	99.3	98.5	139.1	104.6
pH (s.u.)	7.0	6.9	7.0	6.9	6.8	6.7	7.4	6.9
Specific Conductance (uS/cm)	41	39	41	42	51	185	122	150
Temperature (°C)	14.6	14.4	18.0	16.3	15.1	14.2	18.2	16.1

Total phosphorus values in 2008 ranged from 0.015 to 0.018 mg/L at the site, which are in the “eutrophic” range of 0.012 – 0.028 mg/L as identified in the 2018 NH Consolidated Assessment and Listing Methodology (CALM) Indicator 8b numeric thresholds for lakes, ponds, reservoirs, and impoundments. Current levels of total phosphorus were measured at 0.040 – 0.550 in Whitten Pond during the 2019 study. Therefore, we can conclude that phosphorus levels were elevated in 2008 prior to operation of the RIBs and background levels of phosphorus remain elevated, as was presented in the Wolfeboro Groundwater Discharge Site file review portion of this study and confirmed with the 2019 study results. Nitrate levels have increased since the 2008 study at the RIB wastewater discharge site (NMB-02) and the two other downstream sites (WP-01 and NMB-03). Nitrate levels in the 2008 study were reported at <0.5 mg/L. In 2019, we report nitrate levels at 0.025 – 0.059 mg/L in the reference reach (NMB-01) and at 0.4 – 1.5 mg/L in the discharge reach (NMB-02). Therefore, nitrate levels have increased markedly in the discharge area and downstream reaches compared to the reference reach between the 2008 and 2019 studies. While nitrogen is not typically a limiting nutrient in freshwater systems, nitrate concentrations are limited in permitted wastewater discharges and the measurable increase in receiving water nitrate demonstrates a likely effect of the wastewater discharge.

Another water quality change that has been documented between the 2008 and 2019 baseline studies has been the increase in specific conductance and chloride in the study area. While the reference reach (NMB-01) has been characterized by relatively little change in conductivity or chloride concentration, i.e. specific conductance in the 40s or 50s uS/cm and chloride concentrations of ≤ 10 mg/L between the 2008 and 2019 studies, the downstream sites have showed significant increases in specific conductance and chloride concentration. In the 2008 study, specific conductance values in the study area were consistently in the 30s and 40s uS/cm range, whereas in the 2019 study specific conductance measurements were typically in the 100 – 200 uS/cm range at the downstream sites (NMB-02, WP-01, NMB-03). Likewise, chloride concentration increased from 4 mg/L based on four samples analyzed in 2008 to typical values in the 20-40 mg/L range at the downstream sites in 2019. These results indicate a several-fold increase in chloride concentration/specific conductance in the three lower stations since completion of the 2008 study.

9.0 Summary and Conclusions

In 2008 Normandeau completed baseline studies in Nineteen Mile Brook to evaluate the overall quality of the brook prior to construction and operation of a Rapid Infiltration Basin wastewater discharge located adjacent to the brook. The RIB system was designed to infiltrate wastewater into groundwater with Nineteen Mile Brook as the indirect receiving water for the entirety of the wastewater discharge. In 2008, we concluded that Nineteen Mile Brook was a high quality stream as determined from multiple types of assessments including high water quality, excellent habitat, and high quality fish and macroinvertebrate communities with no evidence of impairment to the stream. The 2019 baseline studies repeated the RBP habitat, fish, and macroinvertebrate studies completed in 2008 and expanded on the water quality study to include continuous monitoring of water temperature and conductance for a spring/summer field season. The 2019 studies were completed following ten years of operation of the Wolfeboro RIB wastewater discharge and allow for a quantitative assessment of changes over time to the stream.

Aquatic Habitat

Aquatic habitat was assessed using the RBP methods (Barbour et al., 1999) at all four sampling sites during a series of stream surveys in August 2019. The aquatic environment and surrounding terrestrial habitats were found to have changed minimally during the eleven year interval between baseline studies. The stream habitats evaluated in 2019 were all ranked as excellent for supporting fish and benthic macroinvertebrates. The similar habitat scoring in 2008 and 2019 suggests no evidence of current habitat degradation occurring over the 11 years between sampling.

Benthic Macroinvertebrate Communities

The composition and abundance of benthic macroinvertebrate communities in a stream setting is dependent on many factors including the stream setting, habitat, and water quality; therefore, by evaluating the macroinvertebrate community at a given location, a great deal of information can be determined about the supporting environment (Barbour et al., 1999). Because of their limited in-stream movement and/or sessile (stationary) life history, macroinvertebrates are well suited for making comparisons between sites - such as upstream and downstream differences around an area of interest (e.g. a wastewater discharge). Additionally, they are a good indicator of environmental variations over time due to the long life histories of certain species (>1 yr), measurable responses of sensitive species to environmental stressors, and changes to composition and abundance of sensitive species (Barbour et al., 1999).

Based on the RBP metrics analysis completed for the 2019 field studies, Sites 2 and 3 were ranked 'non-impaired' as compared to the reference reach, and Site 4 was ranked 'slightly impaired' relative to the reference reach. The slight impairment at Site 4 is likely due to stream habitat changes (and accompanying macroinvertebrate community changes) occurring over the upstream to downstream gradient and not due to substantial impacts associated with pollution or habitat degradation. This conclusion is based on the fact that Site 4 was located in a considerably different stream environment compared with the reference reach and because impairments were not documented at the other two downstream locations, most importantly Site 2 which was located within the wastewater discharge area. RBP metric scores also showed improvement at all sites relative to the 2008 analysis. Based on the documented improvement or stability of the biological condition at the study sites, as determined from comprehensive macroinvertebrate metrics analysis, there does not appear to be any evidence of biological community degradation at the study site between 2008 and 2019.

Fish Communities

Similar to macroinvertebrates, Barbour et al. (1999) presents the advantages of using fish to evaluate the biological condition of streams. Fish are good indicators of long term environmental variation (>several years) due to their mobility and relatively long life. They are also at the top of the aquatic food web and, as a potential human food source, are important for assessing contamination. Overall, the IBI scores, when compared to the upstream reference site, indicated a good quality fish community. The two lower sites do not share the same physical characteristics as the two upstream locations and these differences make it difficult to make comparisons between those sites. Greater drainage area size in the lower brook sites, a fish community with representatives of mainly cool and warmwater species, and a more impounded condition differed from the smaller (<3.86 sq mi) drainage area, coldwater fish community, and faster small stream conditions in the upper two sites. Brook trout were present at all

sites although multiple life stages were observed only in the upper 3 sites. The reduction in brook trout over the downstream gradient is likely a function of the water body becoming less supportive of coldwater species in the lower reaches. The ponding of the stream by human activity (dams) and wildlife (beavers) as well as the loss of cooling provided by a closed canopy over the stream are likely effecting the water temperature (which was higher at Sites 3 and 4 relative to Sites 1 and 2). The elevated water temperature during the warmer part of the year likely leads to marginal conditions for persistence of brook trout. The upper sites were indicative of small coldwater streams found in NH and, despite not meeting the criteria for using the NHDES coldwater IBI, both sites scored highly, indicating these sites are representative of a high quality, small coldwater stream. Similar to the macroinvertebrate metric analysis, changes in the fish community are likely due to the changing habitat conditions across the upstream to downstream gradient rather than pollution. Based on a comparison with 2008 electrofishing results and various IBI indices, the fish community in Nineteen Mile Brook appears to be relatively stable over the past 11 years and does not show evidence of being impacted by habitat degradation or pollution.

Water Quality

The physical and chemical characteristics of Nineteen Mile Brook were determined during our 2019 water quality study, which included monthly collection of water samples for laboratory testing of nutrients and chlorides, monthly measurements of water temperature, dissolved oxygen, pH, and conductivity, and continuous monitoring of water temperature and conductivity with deployed instruments. Our results show that in Nineteen Mile Brook nutrient levels as indicated by total phosphorus and nitrate nitrogen tend to be high relative to what is expected for a typical undeveloped stream in New Hampshire and have likely increased since the 2008 study.

Total phosphorus is the primary nutrient of concern in freshwater systems as it is typically the primary limiting nutrient and excess amounts can lead to water quality degradation and eutrophication (Carpenter, 2005). TP concentrations were high at all four sampling locations in Nineteen Mile Brook in 2019, with the highest average levels in the RIB discharge area. These results are in contrast to the water quality data available in the Wolfeboro GWP file for 2007 – 2019, which show lower levels of TP (on average about a factor of 10 lower) compared to our 2019 data. There is no obvious explanation for this apparent increase and Wolfeboro GWP data from May, October, and November, 2019 show typical TP levels at less than 0.02 mg/L. Given that TP levels at the reference station and the downstream stations were all elevated in 2019 compared to the 2007 – 2019 GWP data reviewed, it is unlikely that the TP source is (exclusively) the RIB discharge. If RIB discharges, breakouts, bank erosion, construction related soil disturbance or other RIB related activities were the primary source of increased TP levels then there would be no associated increase in TP at the control station, which is upstream of the RIB site. Our data from 2019 indicate the highest TP levels were in the RIB discharge area and were on average 27% higher than the reference reach and could indicate an effect from operations or activities at the RIB facility. However, this result is in contrast to the Wolfeboro GWP data from 2007 – 2019 that indicate the highest average TP levels were at the reference reach, not the discharge area. Given the range of phosphorus data reviewed and the lack of distinct patterns in the data, it is difficult to determine what if any effect the RIB operations or associated activities (e.g. construction) and events (e.g. erosion) have on total phosphorus levels in Nineteen Mile Brook. In summary, total phosphorus levels in the brook from 2007 – 2019 were routinely elevated, were consistently higher than water

quality criteria, and in our 2019 study were much greater than has been documented in other studies at all sites, including at the reference reach that is not affected by RIB operations.

Nitrogen is typically the limiting nutrient in marine systems and is not a limiting nutrient in most freshwater systems (Vitousek et al., 1997, Schindler et al., 2008). Excess amounts of nitrogen would not typically lead to direct negative effects in a freshwater stream, lake, or pond and is regulated in wastewater discharges primarily to address watershed loading goals. Nitrate has increased in Nineteen Mile Brook since the 2008 study and nitrate concentrations at and below the discharge area have increased several-fold relative to the reference reach. Nitrate is conservative in groundwater (not easily attenuated) and the increase in nitrate since 2008 at and below the RIB discharge most likely is a direct effect of the RIB discharge. While nitrate levels are elevated in the lower reaches of Nineteen Mile Brook and routinely exceed water quality criteria, the levels were well below the RIB discharge permitted effluent limits and the effects on Nineteen Mile Brook or downstream waters (Lake Winnepesaukee) are likely minimal.

Whitten Pond shows evidence of eutrophication based on the elevated TP levels in the pond, daytime oxygen supersaturation in the pond, and the observed abundance of aquatic plants and algae in the pond. While it seems evident that eutrophication in the pond has increased since 2008, when TP levels were lower and oxygen readings in the pond were more typical, we think it is unlikely to be a direct effect of the RIB wastewater discharge. Rather, high TP levels appear to be a watershed issue as evident with the high levels of TP measured in the reference reach (NMB-01) and as is common with many small streams in NH. In NH, eutrophic ponds are classified as having median TP concentrations of 0.012 – 0.028 mg/L. The data we reviewed from 2007 - 2019 as well as the 2019 data collected for this study indicate TP levels throughout Nineteen Mile Brook and Whitten Pond are routinely in the eutrophic range, including the reference station which is upstream of the RIB operations. Therefore, it is likely that Whitten Pond was trending toward eutrophication before construction and operation of the RIB facility and will continue that trend without a reduction in TP loads. While it is likely that construction and operation of the RIB facility has added a new source of phosphorus loading to Nineteen Mile Brook and Whitten Pond (through wastewater discharges and through hillside soil erosion, streambank erosion and deposition in the stream, and other events and activities), the quantity and effects of that load are beyond the scope of this study. Even if the RIB contribution to the TP load in Nineteen Mile Brook were reduced to zero, current background TP levels in the brook are consistently in the eutrophic range and water quality in Whitten Pond would not be expected to improve as a result. Consequently, phosphorus loading in Nineteen Mile Brook needs to be addressed as a watershed issue with a goal of reducing the total load, regardless of source.

Conductivity and chloride, as measured with laboratory samples and continuous monitoring in 2019, have increased since the 2008 baseline study, with the greatest increases at and below the RIB wastewater discharge. While the relative increase in conductivity/chloride has been several-fold, there have been no documented exceedances of the NH water quality standards for chloride of 230 mg/L (chronic) and 860 mg/L (acute). NH antidegradation rules (Env-Wq 1700) exist to ensure that certain activities (including wastewater discharges) will not eliminate any existing or designated uses of waterbodies and will not impact the water quality needed to maintain and protect those uses. While our water quality data show that increases in conductivity/chloride and nitrate in Nineteen Mile Brook have been documented since commencement of operation of the RIB wastewater discharge, most significantly in the area where wastewater discharges to the brook, numerical water quality standards

have not been exceeded and the existing and designated uses appear to be unaffected by the increases of these parameters (as evidenced by the excellent habitat conditions and healthy fish and macroinvertebrate communities).

Summary

In conclusion, our comprehensive 2019 baseline study on Nineteen Mile Brook shows that there have been some negative changes to the brook since completion of the 2008 baseline study including increased conductivity/chlorides and nitrates at and below the discharge area of the Wolfeboro RIB wastewater system. However, these increases have not exceeded any applicable water quality standards and are an expected result of the wastewater discharge. Total phosphorus levels were also higher in our 2019 study than in the 2008 study and were well above water quality criteria. This result may indicate a trend or could be part of the inherent variability of nutrient concentrations at this site and it is not possible to make a definitive conclusion without further information. Whitten Pond showed evidence in 2019 of being eutrophic (nutrient enriched) which was not documented in our 2008 baseline study. This apparent degradation of Whitten Pond is likely a watershed issue as high levels of total phosphorus were documented throughout the site including an upstream reference reach in 2019. Within the free flowing reaches of Nineteen Mile Brook the increase in nutrients and conductivity/chloride has had no measurable effect on the biological community as the habitat, fish community, and benthic macroinvertebrate community indicate excellent overall stream conditions and have either been of comparable or improved quality compared with the 2008 baseline studies. Overall, based on the habitat, macroinvertebrate community, and fish community sampling conducted in 2019, the stream appears to be healthy and capable of providing high quality habitat for aquatic macrobiota. The 2019 results are generally similar to those found in 2008 indicating that while there have been changes in some water quality parameters, with the potential exception of Whitten Pond, there has been no substantial degradation to the stream biological communities during the eleven year interim between studies.

10.0 Recommendations

This 2019 baseline study is a repeat of our efforts in 2008 to provide a comprehensive review of the overall quality of Nineteen Mile Brook after ten years of operations at the Wolfeboro Rapid Infiltration Basin facility adjacent to the brook. Based on our findings we offer the following recommendations for additional monitoring at Nineteen Mile Brook.

- The Nineteen Mile Brook aquatic habitat, fish community, and benthic macroinvertebrate communities have been documented to be healthy and of comparable or improved quality over the eleven year interval between studies. Continued biomonitoring in Nineteen Mile Brook is warranted (i.e. to document any potential degradation of the brook); however, because these communities appear to be stable and of high quality it should not be necessary to repeat biomonitoring more often than every five to ten years unless there is a significant change in the watershed or new evidence of impairment.
- The greatest changes to Nineteen Mile Brook in the eleven years between studies have been increases in conductivity/chloride and nitrogen levels in the RIB discharge area and downstream stations. There is also evidence of increased phosphorus levels at all sites in 2019, although this

result is not evident in the 2007-2019 data collected by Wolfeboro as part of their GWP monitoring, and could indicate a recent trend or could be inherent variability. Because of the documented increases in concentrations, we recommend continued routine monitoring of nutrients and chlorides/conductivity, including continuous monitoring of conductivity during the growing season when streamflow is lowest and potential impacts are greatest.

- Whitten Pond potentially shows signs of impairment in the form of high TP levels, supersaturated dissolved oxygen conditions, and apparent excessive aquatic plant and algae growth; therefore, further studies at Whitten Pond are probably warranted. Continuous monitoring of dissolved oxygen in the pond, nutrient sampling, and chlorophyll a sampling over a growing season (May – September), as well as an analysis of the phytoplankton community during the growing season would confirm the trophic state of the pond and identify whether the pond has become impaired.
- Elevated levels of total phosphorus in Nineteen Mile Brook have been documented at all sites and indicate a potential watershed scale nutrient issue. Without a reduction in phosphorus loads, it is unlikely that Whitten Pond or other vulnerable areas on Nineteen Mile Brook can avoid the effects of eutrophication. A watershed study and/or management plan may be the most effective way to identify and address the sources of nutrients (specifically phosphorus) that are potentially degrading water quality in portions of Nineteen Mile Brook.

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Appendices

Appendix A RBP Survey Photos August 2019



Figure 1. Aquatic habitat/assessment sampling Sites



Figure 2. Low Gradient Sandy Habitat in Site 4, August 2019.



Figure 3. Higher Gradient Cobble/Bedrock Habitat in Site 4, August 2019



Figure 4. Low/Moderate Gradient Sand/Cobble/Gravel Habitat in Site 3, August 2019



Figure 5. Upper end of Site 2 bounded by rock dam impounding Whitten Pond, August 2019



Figure 6. Bottom of Site 2 displaying Sand/Gravel substrate and aquatic vegetation, August 2019



Figure 7. Habitat looking upstream from the bottom of Site 1, August 2019.



Figure 8. Multiple age classes of Brook Trout captured in Nineteen Mile Brook, Tuftonboro NH, August 2019.



Figure 9. Golden Shiner and Eastern Creek Chubsucker collected at both Sites 2 and 1, August 2019.



Figure 10. Pumpkinseed and Eastern Chain Pickerel collected at both Sites 2 and 1, August 2019.

Appendix B RBP Field Data Sheets August 2019

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME <u>19 mile brook</u>		LOCATION <u>Tiltonboro, NH</u>
STATION # <u>4</u>	RIVERMILE	STREAM CLASS
LAT <u>43° 38.182</u> LONG <u>71° 15.244</u>		RIVER BASIN
STORET #		AGENCY <u>NAI</u>
INVESTIGATORS <u>CG, TP, AH</u>		
FORM COMPLETED BY	DATE <u>8/14/19</u> TIME <u>11:05</u> AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	<p>Now</p> <p><input type="checkbox"/> storm (heavy rain)</p> <p><input type="checkbox"/> rain (steady rain)</p> <p><input type="checkbox"/> showers (intermittent)</p> <p><input type="checkbox"/> %cloud cover</p> <p><input type="checkbox"/> clear/sunny</p> <p>Past 24 hours</p> <p><input type="checkbox"/> storm (heavy rain)</p> <p><input type="checkbox"/> rain (steady rain)</p> <p><input type="checkbox"/> showers (intermittent)</p> <p><input type="checkbox"/> %cloud cover</p> <p><input type="checkbox"/> clear/sunny</p> <p>Has there been a heavy rain in the last 7 days?</p> <p><input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Air Temperature <u>70°</u> F</p> <p>Other _____</p>
SITE LOCATION/MAP	<p>Draw a map of the site and indicate the areas sampled (or attach a photograph)</p> <p>Aquatic vegetation prevalent in and along entirety of reach</p> <p>Personal Comm from SPS 11.21.19 T. Parent</p>
STREAM CHARACTERIZATION	<p>Stream Subsystem</p> <p><input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Tidal</p> <p>Stream Type</p> <p><input checked="" type="checkbox"/> Coldwater <input type="checkbox"/> Warmwater</p> <p>Stream Origin</p> <p><input type="checkbox"/> Glacial <input checked="" type="checkbox"/> Spring-fed</p> <p><input type="checkbox"/> Non-glacial montane <input type="checkbox"/> Mixture of origins</p> <p><input type="checkbox"/> Swamp and bog <input type="checkbox"/> Other _____</p> <p>Catchment Area _____ km²</p>

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	Predominant Surrounding Landuse <input type="checkbox"/> Forest <input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input checked="" type="checkbox"/> Agricultural <input checked="" type="checkbox"/> Other <u>wetland</u> <input checked="" type="checkbox"/> Residential	Local Watershed NPS Pollution <input checked="" type="checkbox"/> No evidence <input type="checkbox"/> Some potential sources <input type="checkbox"/> Obvious sources Local Watershed Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy
RIPARIAN VEGETATION (18 meter buffer)	Indicate the dominant type and record the dominant species present <input type="checkbox"/> Trees <input checked="" type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous dominant species present <u>Grasses Alder</u>	
INSTREAM FEATURES	Estimated Reach Length <u>150</u> m Estimated Stream Width <u>3.5</u> m <u>very build</u> Sampling Reach Area <u>525</u> m ² Area in km² (m² x 1000) _____ km ² Estimated Stream Depth <u>0.5</u> m Surface Velocity (at thalweg) <u>0.58</u> m/sec <u>ft/sec</u> Canopy Cover <input checked="" type="checkbox"/> Partly open <input type="checkbox"/> Partly shaded <input type="checkbox"/> Shaded <u>Mostly open</u> High Water Mark <u>0.1</u> m Proportion of Reach Represented by Stream Morphology Types <input type="checkbox"/> Riffle _____ % <input type="checkbox"/> Run _____ % <input checked="" type="checkbox"/> Pool <u>100</u> % Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Dam Present <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <u>2 Beaver Dams</u>	
LARGE WOODY DEBRIS	LWD <u>5</u> m ² Density of LWD <u>.009</u> m ² /km ² (LWD/ reach area)	
AQUATIC VEGETATION	Indicate the dominant type and record the dominant species present <input checked="" type="checkbox"/> Rooted emergent <input checked="" type="checkbox"/> Rooted submergent <input checked="" type="checkbox"/> Rooted floating <input type="checkbox"/> Free floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae dominant species present <u>Roots</u> Portion of the reach with aquatic vegetation _____ %	
WATER QUALITY	Temperature <u>17.8</u> °C Specific Conductance <u>867</u> <u>µmhos/cm</u> Dissolved Oxygen <u>97.9%</u> <u>9.29</u> % pH <u>8.03</u> Turbidity _____ WQ Instrument Used <u>Sonde 6920</u> Water Odors <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other _____ Water Surface Oils <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Globbs <input type="checkbox"/> Flecks <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____ Turbidity (if not measured) <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Opaque <input type="checkbox"/> Stained <input type="checkbox"/> Other _____	
SEDIMENT/SUBSTRATE	Odors <input checked="" type="checkbox"/> Normal <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Anaerobic <input type="checkbox"/> None <input type="checkbox"/> Other _____ Deposits <input type="checkbox"/> Sludge <input type="checkbox"/> Sawdust <input type="checkbox"/> Paper fiber <input type="checkbox"/> Sand <input type="checkbox"/> Relict shells <input type="checkbox"/> Other _____ Looking at stones which are not deeply embedded, are the undersides black in color? <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> No	

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	5
Boulder	> 256 mm (10")		Muck-Mud	black, very fine organic (FPOM)	5
Cobble	64-256 mm (2.5"-10")		Marl	grey, shell fragments	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	50			
Silt	0.004-0.06 mm	50			
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME <u>19 mile brook</u>	LOCATION <u>Tuffordboro, VT</u>	
STATION # <u>4</u> RIVERMILE	STREAM CLASS	
LAT <u>43°38.152</u> LONG <u>-71°15.244</u>	RIVER BASIN	
STORET #	AGENCY <u>MAI</u>	
INVESTIGATORS <u>CG, TP, AH</u>		
FORM COMPLETED BY <u>T. Parent</u>	DATE <u>8/14/19</u> TIME <u>11:45</u> <u>AM</u> PM	REASON FOR SURVEY

	Habitat Parameter	Condition Category			
		Optimal	Suboptimal	Marginal	Poor
Parameters to be evaluated in sampling reach	1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE <u>17</u>	20 19 18 <u>17</u> 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
	SCORE <u>13</u>	20 19 18 17 16	15 14 <u>13</u> 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
	SCORE <u>13</u>	20 19 18 17 16	15 14 <u>13</u> 12 11	10 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE <u>12</u>	20 19 18 17 16	15 14 13 <u>12</u> 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE <u>19</u>	20 <u>19</u> 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.	
SCORE <u>20</u>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.	
SCORE <u>19</u>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
SCORE <u>10</u> (LB)	Left Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0
SCORE <u>10</u> (RB)	Right Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE <u>10</u> (LB)	Left Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0
SCORE <u>10</u> (RB)	Right Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone) Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.	
SCORE <u>10</u> (LB)	Left Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0
SCORE <u>10</u> (RB)	Right Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0

Total Score _____

very sandy soil. Riparian Habitat consist of much lower plants only because the soil is not stable to allow larger trees to stay standing

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

Sample 194509

194509
1-1-19

STREAM NAME <u>17 mile brook</u>		LOCATION <u>Tuftsboro, VT</u>	
STATION # <u>4</u> RIVERMILE		STREAM CLASS	
LAT <u>43° 38.182</u> LONG <u>-71° 15.244</u>		RIVER BASIN	
STORET #		AGENCY <u>NAT</u>	
INVESTIGATORS <u>CG, TP, AM</u>		LOT NUMBER	
FORM COMPLETED BY <u>T. Paccant</u>		DATE <u>8/14/19</u> TIME <u>1115</u> <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present <input type="checkbox"/> Cobble <u> </u> % <input checked="" type="checkbox"/> Snags <u>5</u> % <input checked="" type="checkbox"/> Vegetated Banks <u>10</u> % <input checked="" type="checkbox"/> Sand <u>35</u> % <input checked="" type="checkbox"/> Submerged Macrophytes <u>50</u> % <input type="checkbox"/> Other (<u> </u>) <u> </u> %
SAMPLE COLLECTION	Gear used <input checked="" type="checkbox"/> D-frame <input type="checkbox"/> kick-net <input type="checkbox"/> Other <u> </u> How were the samples collected? <input checked="" type="checkbox"/> wading <input type="checkbox"/> from bank <input type="checkbox"/> from boat Indicate the number of jabs/kicks taken in each habitat type. <input type="checkbox"/> Cobble <u> </u> <input checked="" type="checkbox"/> Snags <u>1</u> <input checked="" type="checkbox"/> Vegetated Banks <u>2</u> <input checked="" type="checkbox"/> Sand <u>7</u> <input checked="" type="checkbox"/> Submerged Macrophytes <u>10</u> <input type="checkbox"/> Other (<u> </u>) <u> </u>
GENERAL COMMENTS	- 2 beaver dams - Leeches observed

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3 = Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culicidae	0	1	2	3	4						

FISH SAMPLING FIELD DATA SHEET (FRONT)

page of

STREAM NAME <u>19 mile brook</u>	LOCATION <u>Tuftonboro, NH</u>	
STATION # <u>4</u> RIVERMILE <u> </u>	STREAM CLASS <u> </u>	
LAT <u>43°38.182</u> LONG <u>-71°15.244</u>	RIVER BASIN <u> </u>	
STORET # <u> </u>	AGENCY <u>NAI</u>	
GEAR <u>Handtech Backpack</u>	INVESTIGATORS <u>CG, TP, AH</u>	
FORM COMPLETED BY <u>BH</u>	DATE <u>08/14/19</u> TIME <u>9:23</u> <u>AM</u> PM	REASON FOR SURVEY <u> </u>

SAMPLE COLLECTION	How were the fish captured? <input checked="" type="checkbox"/> back pack <input type="checkbox"/> tote barge <input type="checkbox"/> other <u> </u>
	Block nets used? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
	Sampling Duration Start time <u>10:00</u> End time <u>10:55</u> Duration <u>1803.6</u> Stream width (in meters) Max <u>5.5</u> Mean <u>3.5</u> 250 v. 15 100 H2
HABITAT TYPES	Indicate the percentage of each habitat type present <input type="checkbox"/> Riffles <u> </u> % <input type="checkbox"/> Pools <u>60</u> % <input type="checkbox"/> Runs <u> </u> % <input checked="" type="checkbox"/> Snags <u>5</u> % <input checked="" type="checkbox"/> Submerged Macrophytes <u>35</u> % <input type="checkbox"/> Other (<u> </u>) <u> </u> %
GENERAL COMMENTS	<u> </u>

SPECIES	TOTAL (COUNT)	OPTIONAL: LENGTH (mm)/WEIGHT (g) (25 SPECIMEN MAX SUBSAMPLE)						ANOMALIES*							
								D	E	F	L	M	S	T	Z
Brook trout	2	202/98	116/50												
Chain Pickerel	12	139/15	121/12	117/10	185/37	118/9									
		114/8	129/12	115/9	125/10	134/11									
		114/10	115/14												
Golden Shiner	20	120/18	72/4	109/14	68/3	78/5									
		75/4	102/10	110/12	87/7	85/6									
		86/6	72/4	76/4	74/4	72/3									
		102/12	70/3	75/4	22/1	62/2									
Creek Chub Sucker	16	85/7	154/44	142/35	30/9	134/29									
		128/20	85/7	120/18	66/3	72/9									
		85/6	53/2	105/12	78/12	62/3									
		80/6													

FISH SAMPLING FIELD DATA SHEET (BACK)[illegible]

* **ANOMALY CODES:** D = deformities; E = eroded fins; F = fungus; L = lesions; M = multiple DELT anomalies; S = emaciated; Z = other

STA 2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME	19 mile Brook	LOCATION	Tuftonboro, NH
STATION #	3	RIVERMILE	
LAT	43.37.960	LONG	-71.14.653
STORET #		AGENCY	Normandeau Associates
INVESTIGATORS	Christian Gagne	Tyler Parent	Abigail Mayne
FORM COMPLETED BY	T. Parent	DATE	8/13/19
		TIME	10:00 AM
		REASON FOR SURVEY	

WEATHER CONDITIONS	<p>Now</p> <p><input type="checkbox"/> storm (heavy rain)</p> <p><input type="checkbox"/> rain (steady rain)</p> <p><input type="checkbox"/> showers (intermittent)</p> <p><input checked="" type="checkbox"/> 65% cloud cover</p> <p><input type="checkbox"/> clear/sunny</p>	<p>Past 24 hours</p> <p><input type="checkbox"/></p> <p><input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p>	<p>Has there been a heavy rain in the last 7 days?</p> <p><input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Air Temperature 73°C</p> <p>Other</p>
SITE LOCATION/MAP	<p>Draw a map of the site and indicate the areas sampled (or attach a photograph)</p>		
STREAM CHARACTERIZATION	<p>Stream Subsystem</p> <p><input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Tidal</p> <p>Stream Origin</p> <p><input type="checkbox"/> Glacial <input checked="" type="checkbox"/> Spring-fed</p> <p><input type="checkbox"/> Non-glacial montane <input type="checkbox"/> Mixture of origins</p> <p><input type="checkbox"/> Swamp and bog <input type="checkbox"/> Other</p> <p>Stream Type</p> <p><input checked="" type="checkbox"/> Coldwater <input type="checkbox"/> Warmwater</p> <p>Catchment Area _____ km²</p>		

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Other _____ <input type="checkbox"/> Residential		Local Watershed NPS Pollution <input checked="" type="checkbox"/> No evidence <input type="checkbox"/> Some potential sources <input type="checkbox"/> Obvious sources Local Watershed Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy
RIPARIAN VEGETATION (18 meter buffer)	Indicate the dominant type and record the dominant species present <input checked="" type="checkbox"/> Trees <input checked="" type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous dominant species present <u>Allder, Maple, Fern, Various grasses</u>		
INSTREAM FEATURES	Estimated Reach Length _____ m Estimated Stream Width <u>3.5</u> m Sampling Reach Area _____ m ² Area in km² (m²x1000) _____ km ² Estimated Stream Depth <u>0.3</u> m Surface Velocity (at thalweg) _____ m/sec <u>0.53 m/sec</u>		Canopy Cover <input type="checkbox"/> Partly open <input checked="" type="checkbox"/> Partly shaded <input type="checkbox"/> Shaded High Water Mark <u>0.6</u> m Proportion of Reach Represented by Stream Morphology Types <input checked="" type="checkbox"/> Riffle <u>10</u> % <input type="checkbox"/> Run _____ % <input checked="" type="checkbox"/> Pool <u>90</u> % Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Dam Present <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <u>Rock Dam</u>
LARGE WOODY DEBRIS	LWD <u>7</u> m ² Density of LWD _____ m ² /km ² (LWD/ reach area)		
AQUATIC VEGETATION	Indicate the dominant type and record the dominant species present <input checked="" type="checkbox"/> Rooted emergent <input type="checkbox"/> Rooted submergent <input checked="" type="checkbox"/> Rooted floating <input type="checkbox"/> Free floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae dominant species present _____ Portion of the reach with aquatic vegetation <u>60</u> %		
WATER QUALITY	Temperature <u>17.34</u> °C Specific Conductance <u>218</u> Dissolved Oxygen <u>102.5%</u> <u>9.83</u> mg/L pH <u>7.99</u> Turbidity <u>Low</u> WQ Instrument Used <u>Spnde 6920</u>		Water Odors <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other _____ Water Surface Oils <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Globs <input type="checkbox"/> Flecks <input type="checkbox"/> None <input type="checkbox"/> Other _____ Turbidity (if not measured) <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Opaque <input type="checkbox"/> Stained <input type="checkbox"/> Other _____
SEDIMENT/SUBSTRATE	Odors <input checked="" type="checkbox"/> Normal <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Anaerobic <input type="checkbox"/> None <input type="checkbox"/> Other _____ Oils <input checked="" type="checkbox"/> Absent <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Profuse Deposits <input type="checkbox"/> Sludge <input type="checkbox"/> Sawdust <input type="checkbox"/> Paper fiber <input type="checkbox"/> Sand <input type="checkbox"/> Relict shells <input type="checkbox"/> Other _____ Looking at stones which are not deeply embedded, are the undersides black in color? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	15
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	40			
Sand	0.06-2mm (gritty)	40	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	10			
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category																				
	Optimal					Suboptimal					Marginal					Poor					
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.					Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.					Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.					Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)					The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.					The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.					Channel straight; waterway has been channelized for a long distance.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.					Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.					Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.					Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.					
SCORE ____ (LB)	Left Bank 10 9					8 7 6					5 4 3					2 1 0					
SCORE ____ (RB)	Right Bank 10 9					8 7 6					5 4 3					2 1 0					
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.					70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.					50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.					Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.					
SCORE ____ (LB)	Left Bank 10 9					8 7 6					5 4 3					2 1 0					
SCORE ____ (RB)	Right Bank 10 9					8 7 6					5 4 3					2 1 0					
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.					Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.					Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.					Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.					
SCORE ____ (LB)	Left Bank 10 9					8 7 6					5 4 3					2 1 0					
SCORE ____ (RB)	Right Bank 10 9					8 7 6					5 4 3					2 1 0					

Total Score _____

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME <u>19 mile Brook</u>	LOCATION <u>Tuftsboro NH</u>	
STATION # <u>3</u> RIVERMILE	STREAM CLASS	
LAT <u>43° 37.960</u> LONG <u>-71° 14.653</u>	RIVER BASIN	
STORET #	AGENCY <u>NH</u>	
INVESTIGATORS <u>CGP, AH</u>		
FORM COMPLETED BY <u>A Hayne</u>	DATE <u>8/13/19</u> TIME <u>1140</u> <u>AM</u> PM	REASON FOR SURVEY

	Habitat Parameter	Condition Category			
		Optimal	Suboptimal	Marginal	Poor
Parameters to be evaluated in sampling reach	1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 <u>(17)</u> 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
	SCORE	20 19 18 17 <u>(16)</u>	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
	SCORE	20 19 18 17 16	15 <u>(14)</u> 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE	20 19 18 17 16	15 14 <u>(13)</u> 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE	20 19 18 17 16	<u>(15)</u> 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME <u>19 mile Brook</u>	LOCATION <u>TUFTONBORO NH</u>	
STATION # <u>3</u> RIVERMILE	STREAM CLASS	
LAT <u>43° 05' 37.960</u> LONG <u>-71° 04' 14.653</u>	RIVER BASIN	
STORET #	AGENCY <u>NAT</u>	
INVESTIGATORS <u>CTPAH</u>	LOT NUMBER	
FORM COMPLETED BY <u>A Hayne</u>	DATE <u>9/13/19</u> TIME <u>10:00</u> AM PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present <input checked="" type="checkbox"/> Cobble <u>10</u> % <input checked="" type="checkbox"/> Snags <u>10</u> % <input type="checkbox"/> Vegetated Banks _____ % <input checked="" type="checkbox"/> Sand <u>20</u> % <input checked="" type="checkbox"/> Submerged Macrophytes <u>60</u> % <input type="checkbox"/> Other (_____) _____ %
SAMPLE COLLECTION	Gear used <input checked="" type="checkbox"/> D-frame <input type="checkbox"/> kick-net <input type="checkbox"/> Other _____ How were the samples collected? <input checked="" type="checkbox"/> wading <input type="checkbox"/> from bank <input type="checkbox"/> from boat Indicate the number of jabs/kicks taken in each habitat type. <input checked="" type="checkbox"/> Cobble <u>2</u> <input checked="" type="checkbox"/> Snags <u>2</u> <input type="checkbox"/> Vegetated Banks _____ <input checked="" type="checkbox"/> Sand <u>4</u> <input checked="" type="checkbox"/> Submerged Macrophytes <u>12</u> <input type="checkbox"/> Other (_____) _____
GENERAL COMMENTS	

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0	<u>1</u>	2	3	4	Slimes	0	<u>1</u>	2	3	4
Filamentous Algae	0	1	<u>2</u>	3	4	Macroinvertebrates	0	1	2	<u>3</u>	4
Macrophytes	0	1	2	<u>3</u>	4	Fish	0	1	<u>2</u>	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3 = Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

FISH SAMPLING FIELD DATA SHEET (FRONT)

page of

STREAM NAME <u>19 mile brook</u>	LOCATION <u>Tuftsboro</u>	
STATION # <u>3</u> RIVERMILE <u> </u>	STREAM CLASS <u> </u>	
LAT <u>43 deg 37.960</u> LONG <u>-71 deg 14.653</u>	RIVER BASIN <u> </u>	
STORET # <u> </u>	AGENCY <u>NAI</u>	
GEAR <u>Backpack Electrostatic Hauler</u>	INVESTIGATORS <u>CG, TP, AH</u>	
FORM COMPLETED BY <u>Abigail Hayne</u>	DATE <u>8/13/19</u> TIME <u>11:40</u> <input checked="" type="radio"/> AM <input type="radio"/> PM	REASON FOR SURVEY <u> </u>

SAMPLE COLLECTION	How were the fish captured? <input checked="" type="checkbox"/> back pack <input type="checkbox"/> tote barge <input type="checkbox"/> other <u> </u>
	Block nets used? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
	Sampling Duration Start time <u>11:10</u> End time <u>11:40</u> Duration <u>1336.8</u> seconds
	Stream width (in meters) Max <u>6</u> Mean <u>3.5</u>
HABITAT TYPES	Indicate the percentage of each habitat type present <input type="checkbox"/> Riffles <u>15</u> % <input type="checkbox"/> Pools <u>45</u> % <input type="checkbox"/> Runs <u> </u> % <input type="checkbox"/> Snags <u>15</u> % <input type="checkbox"/> Submerged Macrophytes <u>25</u> % <input type="checkbox"/> Other (<u> </u>) <u> </u> %
GENERAL COMMENTS	<u> </u>

SPECIES	TOTAL (COUNT)	OPTIONAL: LENGTH (mm)/WEIGHT (g) (25 SPECIMEN MAX SUBSAMPLE)						ANOMALIES*							
								D	E	F	L	M	S	T	Z
Brook trout	9	83/6	85/6	105/37	92/7	111/15									
Orchard trout		110/49	156/42	150/34	82/5										
Golden shiner	20	84/6	85/6	84/10	90/7	95/2									
		131/4	72/3	95/8	93/8	75/4									
		85/5	131/4	75/4	71/4	82/5									
		90/6	65/2	68/3	80/4	80/5									
Pumpkinseed	5	78/9	81/10	83/12	65/5	76/9									
TBA	11	102/12	115/12	132/19	86/7	116/18									
		114/13	84/7	83/6	102/14	70/3									
		84/6													

FISH SAMPLING FIELD DATA SHEET (BACK)[illegible]

* **ANOMALY CODES:** D = deformities; E = eroded fins; F = fungus; L = lesions; M = multiple DELT anomalies; S = emaciated; Z = other

STA 3

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STATION 2
will be
STATION 3
in report
for consistency
with 2008
report/comparison
SPS
11-21-19

STREAM NAME 19 mile brook	LOCATION Tuffon brook, NH
STATION # 25 RIVERMILE	STREAM CLASS
LAT 43 deg 37.900 LONG -71 deg 14.076	RIVER BASIN
STORET #	AGENCY NHI
INVESTIGATORS T.P. C. G. A. H.	
FORM COMPLETED BY T. Parent	DATE 8/13/19 TIME 1615 AM PM REASON FOR SURVEY

WEATHER CONDITIONS	<p>Now</p> <p><input type="checkbox"/> storm (heavy rain)</p> <p><input type="checkbox"/> rain (steady rain)</p> <p><input type="checkbox"/> showers (intermittent)</p> <p><input checked="" type="checkbox"/> 100% %cloud cover</p> <p><input type="checkbox"/> clear/sunny</p> <p>Past 24 hours</p> <p><input type="checkbox"/> storm (heavy rain)</p> <p><input type="checkbox"/> rain (steady rain)</p> <p><input type="checkbox"/> showers (intermittent)</p> <p><input type="checkbox"/> %cloud cover</p> <p><input type="checkbox"/> clear/sunny</p> <p>Has there been a heavy rain in the last 7 days? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Air Temperature 76 °C</p> <p>Other</p>
SITE LOCATION/MAP	<p>Draw a map of the site and indicate the areas sampled (or attach a photograph)</p>
STREAM CHARACTERIZATION	<p>Stream Subsystem <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Tidal</p> <p>Stream Origin <input type="checkbox"/> Glacial <input checked="" type="checkbox"/> Spring-fed <input type="checkbox"/> Non-glacial montane <input type="checkbox"/> Mixture of origins <input type="checkbox"/> Swamp and bog <input type="checkbox"/> Other</p> <p>Stream Type <input checked="" type="checkbox"/> Coldwater <input type="checkbox"/> Warmwater</p> <p>Catchment Area _____ km²</p>

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Other _____ <input type="checkbox"/> Residential	Local Watershed NPS Pollution <input checked="" type="checkbox"/> No evidence <input type="checkbox"/> Some potential sources <input type="checkbox"/> Obvious sources Local Watershed Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy
RIPARIAN VEGETATION (18 meter buffer)	Indicate the dominant type and record the dominant species present <input checked="" type="checkbox"/> Trees <input checked="" type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous dominant species present <u>Herbaceous, Alder, Birch, white Hazel,</u>	
INSTREAM FEATURES	Estimated Reach Length <u>150</u> m Canopy Cover <input type="checkbox"/> Partly open <input type="checkbox"/> Partly shaded <input checked="" type="checkbox"/> Shaded Estimated Stream Width <u>4</u> m Sampling Reach Area <u>600</u> m ² High Water Mark <u>.3</u> m Area in km² (m²x1000) _____ km ² Proportion of Reach Represented by Stream Morphology Types <input checked="" type="checkbox"/> Riffle <u>50</u> % <input type="checkbox"/> Run _____ % Estimated Stream Depth <u>0.2</u> m <input checked="" type="checkbox"/> Pool <u>70</u> % Surface Velocity (at thalweg) <u>.44</u> m/sec <u>54</u> /sec Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Dam Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
LARGE WOODY DEBRIS	LWD <u>10</u> m ² Density of LWD <u>0.02</u> m ² /km ² (LWD/ reach area)	
AQUATIC VEGETATION	Indicate the dominant type and record the dominant species present <input type="checkbox"/> Rooted emergent <input type="checkbox"/> Rooted submergent <input type="checkbox"/> Rooted floating <input type="checkbox"/> Free floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae dominant species present _____ Portion of the reach with aquatic vegetation <u>40</u> %	
WATER QUALITY	Temperature <u>15.2</u> °C Water Odors <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other _____ Specific Conductance <u>248</u> µm Water Surface Oils <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Globbs <input type="checkbox"/> Flecks <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____ Dissolved Oxygen <u>100%</u> <u>10.04</u> % pH <u>8.0</u> Turbidity <u>Low</u> WQ Instrument Used <u>Sonde 6920</u> Turbidity (if not measured) <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Opaque <input type="checkbox"/> Stained <input type="checkbox"/> Other _____	
SEDIMENT/SUBSTRATE	Odors <input checked="" type="checkbox"/> Normal <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Anaerobic <input type="checkbox"/> None <input type="checkbox"/> Other _____ Deposits <input type="checkbox"/> Sludge <input type="checkbox"/> Sawdust <input type="checkbox"/> Paper fiber <input type="checkbox"/> Sand <input type="checkbox"/> Relict shells <input type="checkbox"/> Other _____ Oils <input checked="" type="checkbox"/> Absent <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Profuse Looking at stones which are not deeply embedded, are the undersides black in color? <input type="checkbox"/> Yes <input type="checkbox"/> No	

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	10 %
Boulder	> 256 mm (10")	5	Muck-Mud	black, very fine organic (FPOM)	10 %
Cobble	64-256 mm (2.5"-10")	50			
Gravel	2-64 mm (0.1"-2.5")	5			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	10			
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME <u>19 mile brook</u>	LOCATION <u>Tuftsboro, VT</u>	
STATION # <u>2</u> RIVERMILE	STREAM CLASS	
LAT <u>43 deg 37.900</u> LONG <u>71 deg 14.076</u>	RIVER BASIN	
STORET #	AGENCY <u>NRE</u>	
INVESTIGATORS <u>CG, TP, AH</u>		
FORM COMPLETED BY <u>T. Parent</u>	DATE <u>8/13/17</u> TIME <u>1615</u> AM <input checked="" type="radio"/> PM	REASON FOR SURVEY

	Habitat Parameter	Condition Category			
		Optimal	Suboptimal	Marginal	Poor
Parameters to be evaluated in sampling reach	1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE <u>19</u>	20 <u>(19)</u> 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
	SCORE <u>15</u>	20 19 18 17 16	<u>(15)</u> 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
	SCORE <u>17</u>	20 19 18 <u>(17)</u> 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE <u>13</u>	20 19 18 17 16	15 14 <u>(13)</u> 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE <u>14</u>	20 19 18 17 16	15 <u>(14)</u> 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.	
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.	
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.	
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone) Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.	
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 7 (RB)	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0

Total Score 183

194510

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME <u>19 mile Brook</u>		LOCATION <u>Tuffenboro, NH</u>	
STATION # <u>2</u> RIVERMILE		STREAM CLASS	
LAT <u>43 Deg 37.900</u> LONG <u>71 Deg 14.076</u>		RIVER BASIN	
STORET #		AGENCY <u>Normandeau Associates</u>	
INVESTIGATORS <u>CG, TP, AH</u>		LOT NUMBER	
FORM COMPLETED BY <u>T. Parent</u>		DATE <u>8/13/19</u> TIME <u>1715</u> AM <input checked="" type="radio"/> PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present <input checked="" type="checkbox"/> Cobble <u>50</u> % <input type="checkbox"/> Snags <u>5</u> % <input type="checkbox"/> Vegetated Banks _____ % <input type="checkbox"/> Sand <u>30</u> % <input type="checkbox"/> Submerged Macrophytes _____ % <input checked="" type="checkbox"/> Other (<u>Boulder</u>) <u>5</u> % <u>Silt 10%</u>
SAMPLE COLLECTION	Gear used <input checked="" type="checkbox"/> D-frame <input type="checkbox"/> kick-net <input type="checkbox"/> Other _____ How were the samples collected? <input checked="" type="checkbox"/> wading <input type="checkbox"/> from bank <input type="checkbox"/> from boat Indicate the number of jabs/kicks taken in each habitat type. <input checked="" type="checkbox"/> Cobble <u>10</u> <input type="checkbox"/> Snags <u>1</u> <input type="checkbox"/> Vegetated Banks _____ <input checked="" type="checkbox"/> Sand <u>6</u> <input type="checkbox"/> Submerged Macrophytes _____ <input checked="" type="checkbox"/> Other (<u>Boulder</u>) <u>1</u> <u>Silt 10% (2)</u>
GENERAL COMMENTS	- Lots of dark algae on rocks - Lots of mussels -> photos taken

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3 = Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culicidae	0	1	2	3	4						

page _____ of _____

SAMPLE COLLECTION	How were the fish captured? <input checked="" type="checkbox"/> backpack <input type="checkbox"/> tote barge <input type="checkbox"/> other _____		
	Block nets used? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO		
	Sampling Duration Start time <u>15:00</u> End time <u>1545</u>		Duration <u>1806.2 sec</u>
	Stream width (in meters) Max _____ Mean _____		<u>250 volts</u> <u>80 HZ</u>
HABITAT TYPES	Indicate the percentage of each habitat type present		
	<input checked="" type="checkbox"/> Riffles <u>29</u> % <input type="checkbox"/> Pools <u>60</u> % <input type="checkbox"/> Runs _____ % <input type="checkbox"/> Snags <u>10</u> % <input checked="" type="checkbox"/> Submerged Macrophytes <u>1</u> % <input type="checkbox"/> Other (_____) _____ %		
GENERAL COMMENTS	<u>Mussels found + Photographed</u>		

[illegible]

STA 4

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME <u>19 mile brook</u>	LOCATION <u>Tuftsboro</u>	
STATION # <u>1</u> RIVERMILE _____	STREAM CLASS _____	
LAT <u>43° 37.805</u> LONG <u>-71° 3.763</u>	RIVER BASIN _____	
STORET # _____	AGENCY <u>NAI</u>	
INVESTIGATORS <u>CG, TP, AH</u>		
FORM COMPLETED BY <u>T. Parent</u>	DATE <u>8/14/19</u> TIME <u>1600</u> AM <input checked="" type="radio"/> PM	REASON FOR SURVEY _____

WEATHER CONDITIONS	<p>Now</p> <p><input type="checkbox"/> storm (heavy rain)</p> <p><input type="checkbox"/> rain (steady rain)</p> <p><input type="checkbox"/> showers (intermittent)</p> <p><input checked="" type="checkbox"/> %cloud cover _____</p> <p><input type="checkbox"/> clear/sunny</p> <p>Past 24 hours</p> <p><input type="checkbox"/> storm (heavy rain)</p> <p><input type="checkbox"/> rain (steady rain)</p> <p><input type="checkbox"/> showers (intermittent)</p> <p><input type="checkbox"/> %cloud cover _____</p> <p><input type="checkbox"/> clear/sunny</p> <p>Has there been a heavy rain in the last 7 days? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Air Temperature _____ °C</p> <p>Other _____</p>
SITE LOCATION/MAP	<p>Draw a map of the site and indicate the areas sampled (or attach a photograph)</p>
STREAM CHARACTERIZATION	<p>Stream Subsystem <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Tidal</p> <p>Stream Type <input checked="" type="checkbox"/> Coldwater <input type="checkbox"/> Warmwater</p> <p>Stream Origin <input type="checkbox"/> Glacial <input checked="" type="checkbox"/> Spring-fed <input type="checkbox"/> Non-glacial montane <input type="checkbox"/> Mixture of origins <input type="checkbox"/> Swamp and bog <input type="checkbox"/> Other _____</p> <p>Catchment Area _____ km²</p>

Station 1
is site 4
in report
for consistency
w/ 2008
Report/
Campenson

SPS 11.21.19

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Other _____ <input type="checkbox"/> Residential	Local Watershed NPS Pollution <input checked="" type="checkbox"/> No evidence <input type="checkbox"/> Some potential sources <input type="checkbox"/> Obvious sources Local Watershed Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy	
RIPARIAN VEGETATION (18 meter buffer)	Indicate the dominant type and record the dominant species present <input checked="" type="checkbox"/> Trees <input checked="" type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous dominant species present <u>Hemlock, Alder, White Birch, Ferns</u>		
INSTREAM FEATURES	Estimated Reach Length <u>150</u> m Estimated Stream Width <u>3.7</u> m Sampling Reach Area <u>555</u> m ² Area in km² (m² x 1000) _____ km ² Estimated Stream Depth <u>0.3</u> m Surface Velocity (at thalweg) _____ m/sec <u>Low Gradient, 0.924/sec High 1.75</u>		Canopy Cover <input type="checkbox"/> Partly open <input type="checkbox"/> Partly shaded <input checked="" type="checkbox"/> Shaded High Water Mark _____ m Proportion of Reach Represented by Stream Morphology Types <input type="checkbox"/> Riffle _____ % <input checked="" type="checkbox"/> Run <u>20</u> % <input checked="" type="checkbox"/> Pool <u>80</u> % Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Dam Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
LARGE WOODY DEBRIS	LWD <u>12</u> m ² Density of LWD <u>.022</u> m ² /km ² (LWD/ reach area)		
AQUATIC VEGETATION	Indicate the dominant type and record the dominant species present <input type="checkbox"/> Rooted emergent <input type="checkbox"/> Rooted submergent <input type="checkbox"/> Rooted floating <input type="checkbox"/> Free floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae dominant species present _____ Portion of the reach with aquatic vegetation <u>15</u> %		
WATER QUALITY	Temperature <u>16.4</u> °C Specific Conductance <u>50.15</u> µm Dissolved Oxygen <u>97.7%</u> <u>9.56</u> mg/L pH <u>7.15</u> Turbidity _____ WQ Instrument Used <u>Sonde 6920</u>		Water Odors <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other _____ Water Surface Oils <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Globbs <input type="checkbox"/> Flecks <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____ Turbidity (if not measured) <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Opaque <input type="checkbox"/> Stained <input type="checkbox"/> Other _____
SEDIMENT/SUBSTRATE	Odors <input checked="" type="checkbox"/> Normal <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Anaerobic <input type="checkbox"/> None <input type="checkbox"/> Other _____ Oils <input checked="" type="checkbox"/> Absent <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Profuse Deposits <input type="checkbox"/> Sludge <input type="checkbox"/> Sawdust <input type="checkbox"/> Paper fiber <input type="checkbox"/> Sand <input type="checkbox"/> Relict shells <input type="checkbox"/> Other _____ Looking at stones which are not deeply embedded, are the undersides black in color? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		<u>5</u>	Detritus	sticks, wood, coarse plant materials (CPOM)	<u>25%</u>
Boulder	> 256 mm (10")	<u>40</u>			
Cobble	64-256 mm (2.5"-10")	<u>20</u>	Muck-Mud	black, very fine organic (FPOM)	<u>5%</u>
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	<u>35</u>	Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

Personal comp. fro T. Parent

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category																				
	Optimal					Suboptimal					Marginal					Poor					
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.					Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.					Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.					Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)					The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.					The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.					Channel straight; waterway has been channelized for a long distance.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.					Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.					Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.					Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.					
SCORE __ (LB)	Left Bank 10 9					8 7 6					5 4 3					2 1 0					
SCORE __ (RB)	Right Bank 10 9					8 7 6					5 4 3					2 1 0					
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.					70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.					50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.					Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.					
SCORE __ (LB)	Left Bank 10 9					8 7 6					5 4 3					2 1 0					
SCORE __ (RB)	Right Bank 10 9					8 7 6					5 4 3					2 1 0					
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.					Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.					Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.					Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.					
SCORE __ (LB)	Left Bank 10 9					8 7 6					5 4 3					2 1 0					
SCORE __ (RB)	Right Bank 10 9					8 7 6					5 4 3					2 1 0					

Total Score _____

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME <u>19 mile Brook</u>	LOCATION <u>Jeffersonboro, NH</u>	
STATION # <u>1</u> RIVERMILE	STREAM CLASS	
LAT <u>43° 37.805</u> LONG <u>-71° 13.763</u>	RIVER BASIN	
STORET #	AGENCY <u>NAI</u>	
INVESTIGATORS <u>CG, TP, AH</u>		
FORM COMPLETED BY <u>T. Parent</u>	DATE <u>08/14/19</u> TIME <u>1640</u> AM PM	REASON FOR SURVEY

	Habitat Parameter	Condition Category			
		Optimal	Suboptimal	Marginal	Poor
Parameters to be evaluated in sampling reach	1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 <u>(19)</u> 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
	SCORE	20 19 18 17 16	15 <u>(14)</u> 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
	SCORE	20 19 18 17 16	15 14 13 12 11	<u>(10)</u> 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE	20 19 18 17 16	15 <u>(14)</u> 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE	20 19 18 17 16	15 14 13 12 <u>(11)</u>	10 9 8 7 6	5 4 3 2 1 0

* 2 separate sheets according to different stream type for same station

page of

SITE 4
in Report
For consistency
w/ 2009

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2 Jars →

194503

194502

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME <u>19 mile brook</u>		LOCATION <u>Tuftsboro, NH</u>	
STATION # <u>1</u> RIVERMILE		STREAM CLASS	
LAT <u>43°37.805</u> LONG <u>-71°13.765</u>		RIVER BASIN	
STORET #		AGENCY <u>NAI</u>	
INVESTIGATORS <u>CG, TP, AH</u>		LOT NUMBER	
FORM COMPLETED BY <u>T. Parent</u>		DATE <u>8/14/19</u> TIME <u>1614</u> AM <input checked="" type="checkbox"/> PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present <input checked="" type="checkbox"/> Cobble <u>40</u> % <input checked="" type="checkbox"/> Snags <u>20</u> % <input type="checkbox"/> Vegetated Banks <u> </u> % <input checked="" type="checkbox"/> Sand <u>30</u> % <input type="checkbox"/> Submerged Macrophytes <u> </u> % <input checked="" type="checkbox"/> Other (<u>Algae on Rock</u>) <u>10</u> %
SAMPLE COLLECTION	Gear used <input checked="" type="checkbox"/> D-frame <input type="checkbox"/> kick-net <input type="checkbox"/> Other _____ How were the samples collected? <input checked="" type="checkbox"/> wading <input type="checkbox"/> from bank <input type="checkbox"/> from boat Indicate the number of jabs/kicks taken in each habitat type. <input type="checkbox"/> Cobble <u>8</u> <input type="checkbox"/> Snags <u>4</u> <input type="checkbox"/> Vegetated Banks <u> </u> <input type="checkbox"/> Sand <u>6</u> <input type="checkbox"/> Submerged Macrophytes <u> </u> <input checked="" type="checkbox"/> Other (<u>Algae on Rock</u>) <u>2</u>
GENERAL COMMENTS	<ul style="list-style-type: none"> - mussels abundant - Amphibians abundant - crayfish common

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0	1	<u>2</u>	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	<u>1</u>	2	3	4	Macroinvertebrates	0	1	2	<u>3</u>	4
Macrophytes	0	<u>1</u>	2	3	4	Fish	0	1	2	<u>3</u>	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3 = Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

BENTHIC MACROINVERTEBRATE SAMPLE LOG-IN SHEET

[illegible]

Serial Code Example: B0754001(1)

B = Benthos (F = Fish; P = Periphyton) # 0754 = project number # 001 = sample number (1) = lot number (e.g., winter 1996 = 1; summer 1996 = 2)