Attachment 1

Sampling and Analysis Plan

2022–2023 Granite State Landfill Baseline Environmental Studies

Sampling and Analysis Plan

Prepared for

Granite State Landfill
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Table of Contents

List of Tables

List of Figures

1 Introduction

Granite State Landfill, LLC (GSL), a subsidiary of New England Waste Services, Inc. (NEWS) proposes to develop a modern lined landfill facility off Route 116 in the Town of Dalton, New Hampshire. The project will include activities located in wetlands and will therefore require standard dredge and fill permits from the New Hampshire Department of Environmental Services (NHDES) and the United States Army Corps of Engineers (USACE). It is expected the project will require an individual permit from the USACE and therefore will also require project water quality certification (WQC) from NHDES, per Section 401 of the federal Clean Water Act. This Sampling and Analysis Plan (SAP) has been prepared in anticipation of 401 WQC requirements and presents the proposed baseline environmental studies for characterizing the existing fish community, habitat, and water quality in Alder Brook and its tributaries in Dalton, NH that may potentially be impacted by the project. This SAP includes descriptions of the study area, the sampling design, and approach for site selection, environmental sample collection methods, analytical techniques, and documentation procedures.

2 Project Description

GSL previously submitted standard wetland impact permit applications in 2020 for the landfill project and, based on agency feedback, has withdrawn the original permit applications in order to develop project modifications that will address concerns over potential environmental impacts. A modified project is proposed that includes a smaller project footprint, reduced area of wetlands impacted, reduced vernal pools impacts, and greater setbacks of limits of waste from other wetlands and surface waters. New wetland permit applications will be prepared and submitted in coordination with agencies and stakeholders and will incorporate changes based on comments received during the prior permit application. Concerns were expressed by agencies and stakeholders on the potential project impacts to natural resources including the resident fish community, in-stream habitat, surface water temperature, and surface water quality. There is currently limited existing information on the aquatic resources and surface water quality within the project area and downstream receiving waters. Therefore, baseline environmental studies are required to characterize current conditions, evaluate any future environmental effects due to construction and operation of the project, and provide supporting information for NHDES to make a WQC determination.

A sampling and analysis plan (SAP) to complete baseline environmental studies was submitted to NHDES on June 9, 2022 by Normandeau Associates, Inc on behalf of GSL. The baseline studies are intended to characterize current surface water quality and in-stream habitat and benthic and fish communities within the project watershed. The draft SAP was returned to GSL with NHDES comments on June 23, 2022. GSL responded to and addressed comments in a revised SAP submitted to NHDES on July 20, 2022 which was reviewed and returned with comments on September 22, 2022. A site visit was completed on November 22, 2022 with NHDES staff and the GSL project team to review the project site, monitoring stations, preliminary site data, and discuss the goals and objectives of the baseline studies. The baseline studies commenced on July 14, 2022 and continued through November 2022, and were implemented consistent with the revised (but still provisional) SAP that was submitted on July 20, 2022 in order to begin collecting preliminary data while awaiting final SAP review by NHDES. The preliminary data collected in 2022 have been informative and have helped to

strengthen the current revised SAP, which also incorporates revisions based on NHDES comments from June 23, 2022, September 22, 2022, January 30, 2023, and March 30, 2023, as well as discussions with NHDES during a November 22, 2022 site visit and a March 6, 2023 meeting, in addition to other communications with NHDES.

The baseline environmental studies include assessments of the fish community, macroinvertebrate community, in-stream habitat, and surface water quality in Alder Brook and its tributaries. Normandeau will continue the environmental studies that commenced in 2022, with modifications, through the 2023 field season, including monitoring at six sampling stations located within the expected project impact area as well as two additional reference stations located within the Hatch Brook watershed adjacent to the upper Alder Brook watershed and outside the area of direct impacts associated with the project. The following baseline environmental study elements are proposed for the 2023 field season:

- Stream reach habitat assessment
- Stream reach fish community assessment
- Macroinvertebrate sample collection and analysis
- Continuous monitoring of dissolved oxygen, pH, and water temperature
- Collection of water quality samples for laboratory analysis of nutrients, metals, and other parameters
- Continuous flow monitoring

These baseline environmental studies will be used to characterize the existing conditions at the project site and will also provide the framework for anticipated construction and post-construction monitoring. Not all elements of the baseline studies will be completed at each monitoring location, as discussed in Section 3.

During a site meeting with NHDES on November 22, 2022, it was recommended that off-site reference stations be established comparable in watershed area and stream characteristics to sampling station “5” (now referred to as station AB-5) located in Alder Brook near the southern property boundary. Additional comments received from NHDES on January 30 and March 30, 2023 recommended the removal of Station 6 as a headwater reference location and relocating it in the upper watershed of Hatch Brook as a comparative reference to headwater tributary stations sampled during 2022 and removing Station 1 as a monitoring station for the 2023 sampling season. Appropriate reference stations have been selected and established in Hatch Brook (HB-7 and HBT-10) during the 2023 sampling season. The proposed sampling at these locations will be identical to the on-site sampling locations to facilitate comparison between conditions with the project area and immediately outside the project area. The additional reference station in the lower reach of Hatch Brook (HB-7), the relocation of Station 6 (to HBT-10), and the removal of Station 1 will provide a total of 8 monitoring stations to be sampled during 2023, compared to the 7 stations monitored in 2022. Stations 3a (now referred to as ABT-3a) and the ‘old’ Station 2 (now referred to as station ABT-2a) will generally continue to be sampled for all elements except continuous logging of pH, DO, and flow. Continuous temperature logging will continue at ABT-2a in 2023 per NHDES request.

3 Monitoring and Data Collection Methods and Locations

The proposed GSL landfill in Dalton, NH falls within the Hatch/Alder Brook watershed that is part of the larger Ammonoosuc River watershed. Concerns over impacts to the coldwater fishery habitat in the Hatch/Alder Brook watershed were expressed during agency meetings as were concerns about project impacts to water quality and natural resources in the watershed. The project team will collect data necessary to describe the existing conditions of the Alder Brook watershed within the project area and establish a baseline to evaluate the effects of future development in the watershed. Multiple studies are proposed to establish existing conditions, including the following:

1. Fisheries study to determine the existing composition of the fishery in the affected watershed;
2. Aquatic habitat assessment to describe the existing habitat conditions in the surface water resources of the watershed;
3. Macroinvertebrate study to determine the composition and relative abundance of the existing benthic organisms and evaluate biotic integrity or equivalent metrics in the stream environment;
4. Temperature/dissolved oxygen/pH study to continuously measure these regulated water quality criteria throughout a growing season in the watershed; and
5. Water quality sample collection and laboratory analysis to evaluate color, turbidity, nutrients, and toxic substances in comparison with applicable surface water quality standards.

The proposed environmental studies will be completed at up to six locations within Alder Brook or tributaries of Alder Brook, representing sites within and downstream of the proposed landfill footprint, other development areas, and near the downstream property boundary. Two reference locations (Hatch Brook and a tributary of Hatch Brook) will be sampled for comparative data. The proposed monitoring sites in the Alder Brook watershed represent multiple habitat/landscape types and represent areas of individual and cumulative impacts from various components of the proposed project. The two reference stations provide data from the Hatch Brook watershed that are outside of the potential project-related impacts and represents streams with a similar drainage area to some of the headwater and mainstem stations in Alder Brook.

3.1 Station Selection

Station selection is targeted to represent different habitats/landscapes with varying degrees of potential impacts from drainages within the project development (Table 3-1, Figure 3-1):

1. **ABT-1** (previously “Station 1”): Intermittent stream segment above (upstream of) Douglas Dr near the southwestern edge of the proposed landfill with a moderate gradient and closed canopy. This stream reach has been characterized as perennial, however, during the summer of 2022 there was no visible flow in the channel and the stream segment may be reclassified as intermittent. This Station was sampled in 2022 but will not be sampled during 2023.
2. **ABT-2a** (previously “Station 2”): Perennial stream segment below (downstream of) Douglas Dr adjacent to proposed improvements to the access road and weigh station facilities with a low gradient and bordering wetlands. Beaver activity flooded the original

sampling location during September 2022 altering the character of the sampling location. With the exception of continuous pH and dissolved oxygen, all other sampling (i.e., fisheries, macroinvertebrates, gaging, habitat, discrete water quality, continuous temperature logging, and lab samples) will be completed at this station in 2023.

3. **ABT-2b**: This station will replace the flooded ABT-2a for continuous water quality monitoring. ABT-2b is below the series of beaver impoundments downstream of ABT-2a and is more representative of a flowing perennial stream. Along with continuous water quality monitoring, all other sampling (i.e., fisheries, macroinvertebrates, gaging, habitat, discrete water quality and samples) will be completed at this station during 2023.
4. **ABT-3a** (previously "Station 3a"): Intermittent stream segment near the northwestern edge of the proposed landfill footprint in an upland setting with moderate gradient and disconnected subsurface flow through boulders. Sampling at this station will occur whenever possible in 2023, but is flow dependent and the stream segment is likely to be seasonally dry.
5. **ABT-3b** (Previously "Station 3b"): Perennial stream segment downstream of ABT-3a and downgradient of the proposed landfill footprint with a low gradient and bordering wetlands. Above Douglas Drive the stream was dry during July and August 2022 and classified as intermittent; however the reach at ABT-3b has been classified as perennial and was sampled during 2022 even during a dry low-flow period. Sampling will be conducted at this station again in 2023.
6. **AB-4** (previously "Station 4"): This station resides on Alder Brook and represents a perennial stream segment below Douglas Drive receiving streamflow from the proposed landfill area and other non-landfill industrial activity on the property (gravel operations), as well as the ABT-3a/b and Station 6 sub-watersheds. Stream segment has low gradient and is located above and below wetlands;
7. **AB-5** (previously "Station 5"): Alder Brook stream segment near the southwestern property boundary. Stream segment receives outflow from the majority of the proposed project area and other non-landfill industrial uses on the property and is located below a large wetland complex in a defined channel with mostly closed canopy.
8. **ABT-6** (previously "Station 6"): This perennial stream segment near the northwestern property boundary was monitored in 2022 as a reference reach. Stream segment is outside the drainage area of the proposed project but is within the drainage area of other industrial site uses including gravel operations and timber harvesting by the current landowner. Stream segment is near the transition from a high gradient upland stream to a low gradient lowland stream and is located above a large wetland complex. This station was sampled during 2022 but abandoned as a sampling location during 2023.
6. **HB-7**: Perennial stream segment of Hatch Brook to be used as a reference reach during 2023. Stream segment is upstream of the convergence with Alder Brook and upstream of the Route 116 culvert where the joined streams flow toward the Ammonoosuc River. The stream segment is outside of the drainage area of the proposed project but is within an area that has been impacted by recent timber harvesting operations. HB-7 represents a stream segment of a similar drainage area and stream characteristics as AB-5.
7. **HBT-8**: Proposed monitoring location on a tributary generally located north of the main stem of Hatch Brook. This tributary was identified by NHDES as a potentially good reference reach; however, the tributary was ultimately determined to be unsuitable for

monitoring after field review as there is minimal defined stream channel and the primary drainage line is characterized by subsurface open-channel flow through rock voids.

8. **HB-9**: Proposed monitoring location on the main stem of Hatch Brook. This station was located upstream of HB-7 at the project property line and above two tributaries. NHDES expressed concerns that this location was not comparable to ABT-2a/2b and ABT-3b due to the larger watershed area; therefore, this monitoring location was abandoned.
9. **HBT-10**: This presumed-perennial tributary of Hatch Brook is located generally south of the main stem of Hatch Brook in an upper watershed position comparable to stations ABT-2a/b and ABT-3b. HBT-10 was selected for monitoring based on stream location outside of the project area and watershed drainage area that falls within the range calculated for the Alder Brook headwater stations ABT-3b and ABT-2b.

Monitoring station locations are provided in Figure 3-1 and may be altered in the future to meet the following criteria:

1. An adequate fish assessment sample can be obtained (minimum 150 meters);
2. A representative macroinvertebrate sample can be collected; and
3. A long-term water quality monitoring station that is representative of conditions and will remain submerged throughout a field season can be established.

The exception to these criteria is the intermittent stream segments at Station ABT-3a and the perennial stream segment at Station ABT-2a. Sampling at these locations will include a habitat assessment, fisheries sample, and macroinvertebrate sample, if possible. Due to the intermittent flows at ABT-3a and the inundation by beaver activity at ABT-2a, long term sampling loggers for temperature, dissolved oxygen, and pH will not be deployed, except at ABT-2a where a continuous temperature logger will be deployed. Instead, discrete water quality measurements will be collected during site visits to download and maintain loggers at other locations.

Appendix H provides photographs at selected stations providing perspective on the environmental conditions in the vicinity of each stream, stream size, and instream substrates. Appendix I provides figures showing the project in greater detail with regards to the proposed ponds, outfall watershed boundaries, impervious surfaces, and existing wetlands.

Table 3-1. Coordinates for Monitoring Stations at the Proposed GSL Project in Dalton and Littleton, NH

Station	Coordinates (Lat, Lon)		
	Long-Term Monitoring	Downstream Electrofishing Macroinvertebrate Sampling	Upstream Electrofishing/ Macroinvertebrate Sampling
ABT-1[1]	44.34617, -71.69125	44.346004, -71.691289	44.346834, -71.690203
ABT-2a[2]	44.344353, -71.693974	44.3443923, -71.6939781	44.3448733, -71.6926873
ABT-2b	44.343684, -71.699852	44.34382, -71.70034	44.34335, -71.69890
ABT-3a[3]	44.352583, -71.697305	44.352487, -71.697484	44.352616, -71.697327

Station	Coordinates (Lat, Lon)		
	Long-Term Monitoring	Downstream Electrofishing Macroinvertebrate Sampling	Upstream Electrofishing/ Macroinvertebrate Sampling
ABT-3b	44.34950, -71.70397	44.3492837, -71.7036250	44.350251, -71.703171
AB-4	44.347086, -71.702369	44.345586, -71.703809	44.346620, -71.703200
AB-5	44.340000, -71.702583	44.339543, -71.702537	44.340763, -71.702811
ABT-6	44.350576, -71.707569	44.349805, -71.705864	44.350590, -71.707041
HB-7	44.336638, -71.711311	44.336004, -71.711051	44.337128, -71.711297
HBT-10	44.339784, -71.717177	44.33932, - 71.71607	44.33995, -71.71753

[1] ABT-1 (previously "Station 1") was discontinued as a monitoring station in 2023.

[2] ABT-2a (previously "Station 2a") was discontinued as a continuous logging monitoring station in 2023 (except continuous temperature, which will be collected in 2023) but will continue to be sampled discretely and have water samples collected during site visits.

[3] During 2022, ABT-3a (previously "Station 3a") did not have sufficient water during visits in July and August for habitat/fish/macroinvertebrate sampling. October sampling was conducted for macroinvertebrates only and covered a reach of wetted pools existing. No aquatic habitat assessment was made and sampling consisted of wetted pools by Oct 10 and did not represent the aquatic habitat observed during the spring of 2022. Coordinates reflect the location where water samples were collected (long term monitoring coordinates) and the upper and lower extent of macroinvertebrate sampling.

Table 3-2. Monitoring Station Drainage Areas, Elevations, and Average Basin Slopes at the Proposed GSL Project in Dalton and Littleton, NH

Station	Drainage Area (acres)	Station Elevation (feet)	Average Basin Slope
ABT-2a	132	1,076	18%
ABT-2b	193	1,020	18%
ABT-3a	47	1,132	24%
ABT-3b	287	1,070	28%
AB-4	730	1,037	24%
AB-5	1,138	997	21%
HB-7	1,125	994	19%
HBT-10	263	1,060	17%

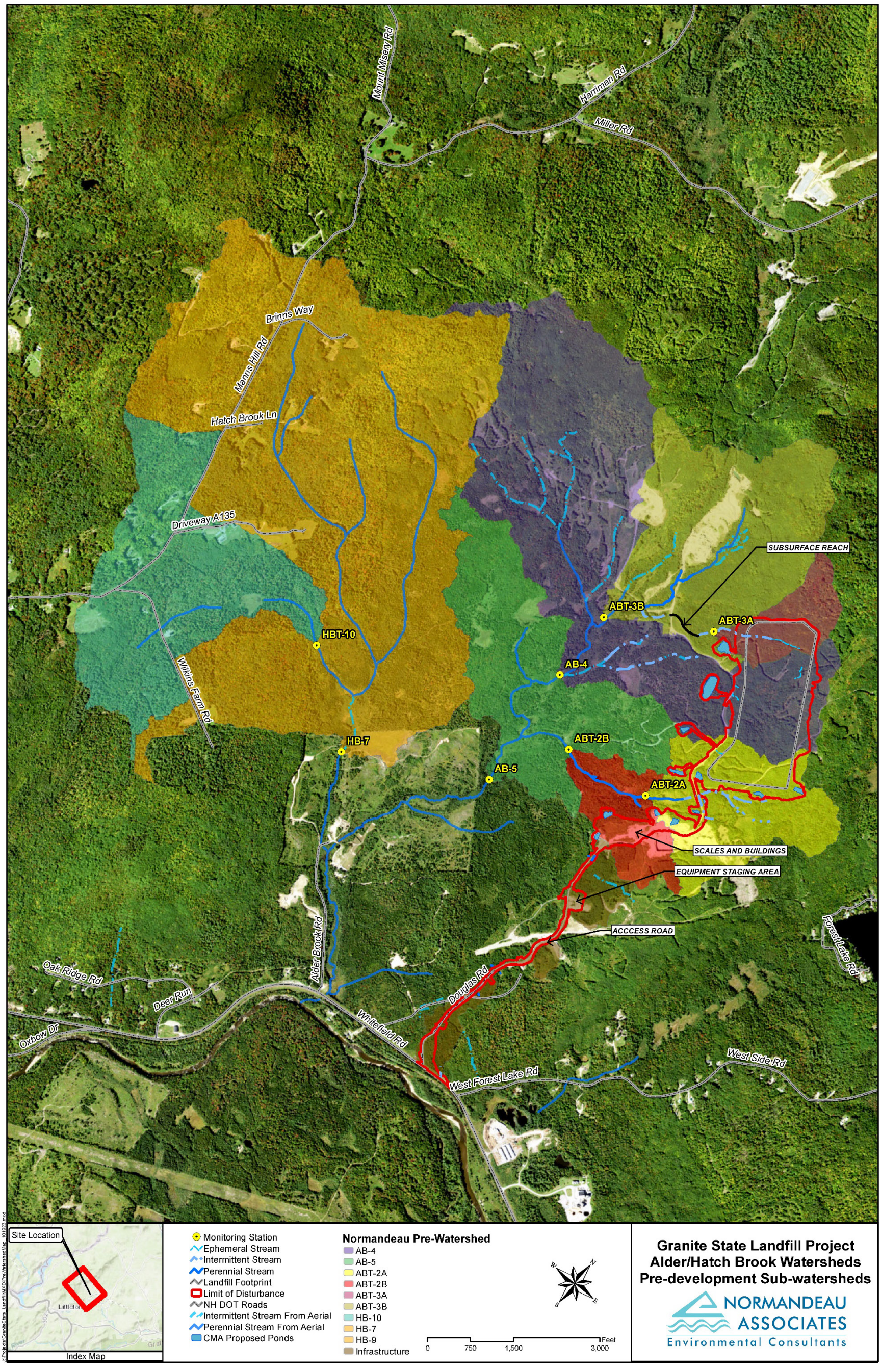

Figure 3-1. Sampling locations and pre-development subwatersheds.

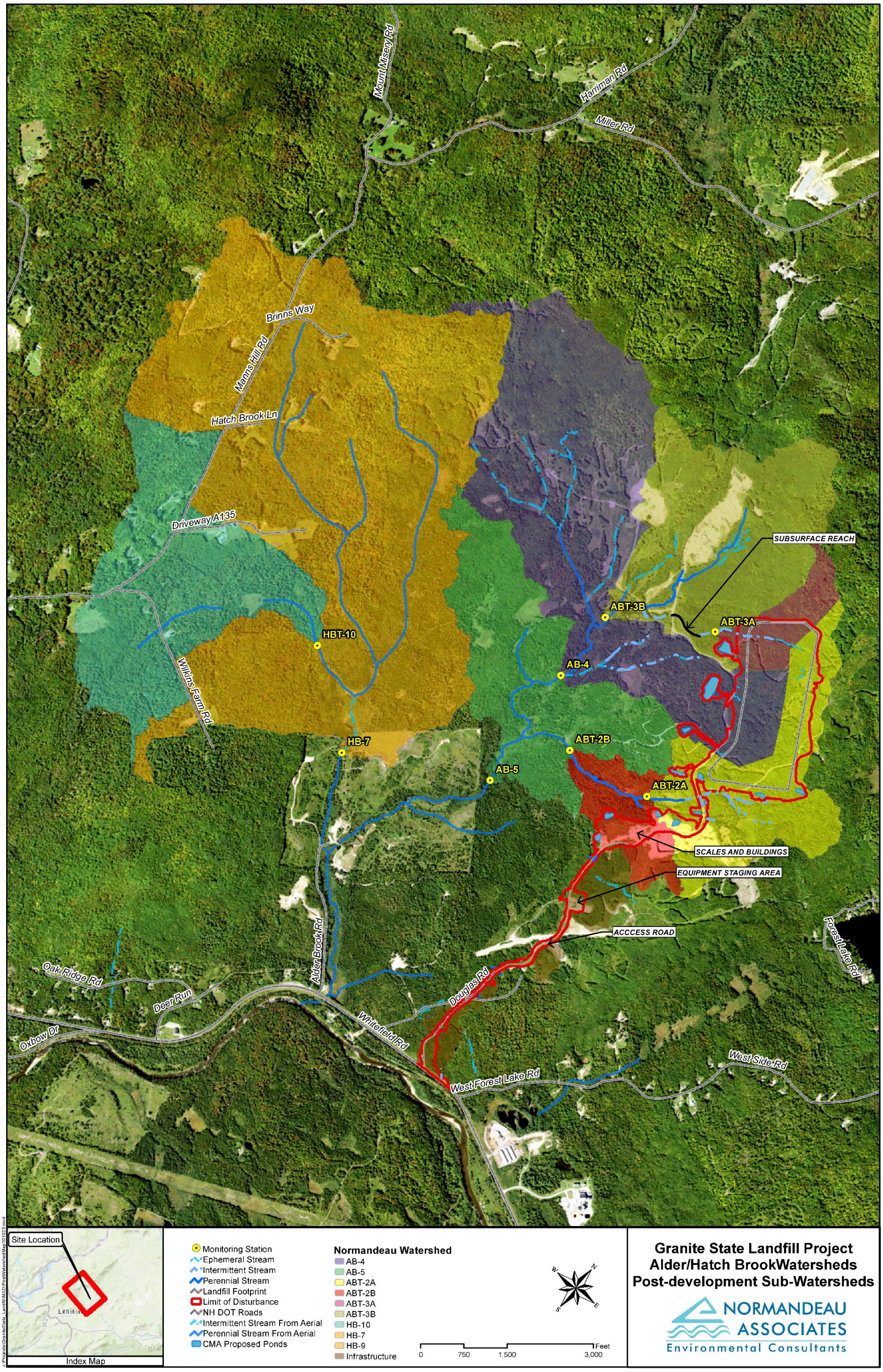

Figure 3-2. Sampling locations and post-development subwatersheds.

3.2 Task 1 Aquatic Habitats and Fisheries Assessments

An aquatic habitat and fisheries assessment will be completed to address Env-Wq 1703.19 Biological and Aquatic Community Integrity to help inform on whether surface waters in the project study area support and maintain a balanced, integrated, and adaptive community of organisms comparable to natural habitats and whether any differences from naturally occurring conditions are detrimental to the aquatic environment. The aquatic habitat assessment will be completed following the methods of Barbour et al. (1999). The fisheries assessment will be completed by electrofishing following the methods detailed in the '*Protocols for Collection, Identification, and Enumeration of Freshwater fishes (Revision Date: February 2022)*' (NHDES 2022). The habitat and fisheries studies will be used to establish baseline conditions at the site for comparison to future data to evaluate impacts to water quality due to project construction and operation.

3.2.1 Habitat Assessment

2022 Habitat Assessment

Per the provisional SAP, the methodology implemented during 2022 to conduct the habitat assessment at each site followed those described in the USEPA Rapid Bioassessment Protocols (USEPA RBP) for Use in Streams and Wadeable Rivers (Barbour et al. 1999). The source document for the habitat assessment is provided as part of Appendix A. During the site selection process, a representative reach was selected for sampling. Datasheets for habitat assessments at each site will follow the USEPA Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999) and include data recorded on:

1. Habitat Assessment Field Data Sheet (high or low gradient dependent on final site selection)
2. Physical Characterization/Water Quality Field Data Sheet

Two biologists assessed the entire stream reach at each sampling station and completed the physical Water Quality Data Sheet. Based on the data collected and reach observations, two biologists cooperatively discussed and completed the USEPA RPB Habitat Field Assessment Data Sheet at each station.

2023 Habitat Assessment

Based on comments to the provisional SAP and discussion during the March 6 meeting with NHDES, additional components for the habitat assessment will be included during 2023. Similar to 2022, the USEPA RBP Habitat Assessment and Physical Water Quality Data forms will be completed, providing a broad scale overview of the physical stream components, chemistry, and stream reach and riparian zone habitat. These methods will be supplemented using portions the 2018/19 USEPA National Rivers and Streams Assessment 2018/2019 Field Operations Manual for wadeable (streams and rivers) to document channel attributes, substrate composition and embeddedness, an estimate of woody debris by reach, and bankfull width, depth, and incision. NRSA data sheets for collecting habitat data collected using the NRSA methods will include:

1. The 2018/19 PHAB: Thalweg profile and woody debris data sheet, and
2. The NRSA 2018/19 PHAB: Channel/Riparian Cross-Section data form.

Both data sheets have been included as part of Appendix B with highlighted sections of the Channel/Riparian Cross-Section form denoting portions that will be included as part of the 2023 sampling.

Each 150-meter reach will be marked and divided into 11 transects (ten 15-meter sections per 150-meter reach). The NRSA 2018/19 PHAB: Thalweg profile and woody debris data sheet will be completed in its entirety for each of the 10 sections (15-meters each) providing thalweg depths, presence of bars, soft sediment, side channels or backwaters, and channel unit/habitat coding (i.e., pool, glide, riffle, etc.) at approximately every meter. Additionally, within each of these 15- meter sections wetted widths will be recorded at two points, woody debris will be quantified, and a cross section (mid-way between transects) will be evaluated for substrate at five points (left bank or 0%, 25%, 50%, 75%, right bank or 100%).

Portions of the NRSA 2018/19 PHAB: Channel/Riparian Cross-Section data form (yellow highlighted sections representing portions to be completed) will be used at each of the 11 transects. These data forms will provide 11 cross sections per reach informing on wetted width, depth, substrate, and embeddedness. Additional measurements will include bankfull width, height, and incision at these locations. The addition of these measurements can be used to supplement the baseline condition assessment and inform on future conditions using similar methods.

To avoid the collection of records on two data sheets that represent a similar parameter with different assessment methods, data collected using NRSA methods during 2023 will also be used to complete two sections of the USEPA Physical Water Quality Data Sheet in a more quantifiable manner. These sections are:

- Large Woody Debris: Instead of using the USEPA RBP method that only includes woody debris present in the stream channel (i.e., in water), the NRSA (2018/2019) assessment methodology will be used that evaluates all woody debris present in the stream channel at a bank full width/depth level. This assessment will take some variability (stream flow/depth) out of any subsequent assessments.
- Inorganic Substrate Components: Instead of establishing a breakdown of inorganic habitat components by an estimate of the percent presence in each 150-meter reach, the inorganic substrate data collected during the NRSA transects will be used to determine the substrate percentage within each 15-meter sections between transects. Compiled data from all 15-meter sections will be used to calculate these values for the entire reach.

These data sheets are provided in Appendix B.

3.2.2 Fish Community Assessment

2022 and 2023 Fish Community Assessment

Normandeau will conduct a fish community assessment at each of the seven selected sampling locations to assess the existing composition of the fish community based on the methods detailed in '*Protocols for Collection, Identification, and Enumeration of Freshwater fishes (Revision Date: February 2022*: NHDES 2022). Sampling will occur as recommended in the *Protocols for Collection, Identification, and Enumeration of Freshwater fishes (Revision Date: November 2022)* from the end of June through September. Sampling during this period will inform on

community presence and composition as it exists during a stable condition (i.e., little resident fish movement, no migratory activity) and during the seasonal elevated water temperature period while avoiding disruption to the spawning period. The 2022 NHDES SOP is attached as part of Appendix A. Fisheries collection datasheets will be the 1999 USEPA RBP forms but additional information from the NDHES SOP will be included (unit settings, mortalities, etc.). These data sheets are attached as part of Appendix B.

Backpack electrofishing will be conducted over a 150-meter reach of representative habitat as recommended by NHDES for streams less than 7.5 meters in width (NHDES 2022). In some of the reaches, attaining a distance of 150 meters may be difficult due to the fragmented nature of the headwaters (transitioning between beaver pond, wetlands, and stream). In the event that this occurs, electrofishing will be conducted to the furthest extent available. The following records will be recorded in relation to the fisheries survey:

- Start and end coordinates for each fish survey.
- Electrofishing time (seconds fished).
- Specific conductance during fish survey.
- All fish will be identified to species and enumerated. Length and weight of captured specimens will be collected (subsamples of 20 fish per species as needed).
- Additional information on the backpack sampling unit (make/model) along with available information from the unit.

After processing, all fish will be returned to the stream. Photo documentation of each species identified as well as photos representing multiple age classes of species captured (if they exist) will be collected. Data will be presented in tabular form describing baseline community conditions by reach including CPUE (fish or species per 100-meter, fish or species per hour), length distribution data, watershed distribution of species, etc.

Task 2 Assumptions:

- Field site selection will be based on establishing a reach that has habitat representative of the stream but will not include areas that are not accessible to fisheries sampling (e.g., beaver impoundments).
- Normandeau will provide data in a tabular form for each site with all available fish community data collected to provide a baseline for further assessment.
- Sampling to assess the existing fish community is in reference to the proposed landfill site. Sampling will occur in at least one upstream location (representing the areas not impacted by the proposed landfill) but may not represent the furthest upstream extent in each stream.
- Normandeau will obtain a valid State of New Hampshire scientific collectors permit for this work.
- Backpack electrofishing will not be conducted near any water quality data loggers or water quality loggers will be removed during sampling to avoid damaging equipment.
- Backpack electrofish sampling will not occur at Station ABT-1 and Station ABT-6 during 2023 and sampling at Station ABT-3a will occur opportunistically (i.e. if possible and

may occur earlier than sampling at other stations and may not incorporate a complete 150-meter reach).

3.3 Task 2: Benthic Macroinvertebrate Sampling

An assessment of benthic macroinvertebrates will be completed to address Env-Wq 1703.19 Biological and Aquatic Community Integrity to help inform on whether surface waters in the project study area support and maintain a balanced, integrated, and adaptive community of organisms comparable to natural habitats and whether any differences from naturally occurring conditions are detrimental to the aquatic environment. The benthic macroinvertebrate study will be used to establish baseline conditions at the site and for comparison to future data to determine any impacts to water quality due to project construction and operation. Benthic macroinvertebrate samples will be collected from each of the seven sample locations selected.

3.3.1 2022 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrate sampling during 2022 followed field procedures from the USEPA Multihabitat Approach sampling procedure (Barbour et al.1999; attached in Appendix A). During 2022, stream assessments included observations on depth and habitat that prohibited the use of rock basket sampling (as per NHDES 2013). Stream channels at all stations in 2022 were too narrow and/or did not have the required depth to fully submerge rock basket samplers. Additionally, habitat at several upper headwater stations were represented by areas of coarse substrate (cobble/gravel) and riffles as well as pools and sand, mud, and emergent aquatic vegetation. Based on this, the USEPA RBP Multihabitat approach (Barbour et al. 1999), which uses a D-frame net to sweep, kick, or jab sample habitat proportionately to it presence within the reach, was used to collect macroinvertebrate samples. A total of 20 kicks, sweeps, or jabs (each sampling approximately 0.15-meters^2 of habitat) were completed at each reach with an approximate sample collection of 3.1-meters^2.

Field staff preserved collected macroinvertebrates in 70% isopropyl alcohol with external and internal labels. Samples were shipped to the Normandeau benthic macroinvertebrate laboratory in Stowe, PA where samples were sorted and identified to the lowest possible taxonomic level to provide data required for the New Hampshire Benthic Index of Biotic Integrity (B-IBI) or any equivalent evaluation metrics if B-IBI is not appropriate for the collected data. Multihabitat net samples were processed in one-quarter increments to provide a minimum quota of 100-speciemens. Benthic macroinvertebrate collection datasheets are attached in Appendix B.

3.3.2 2023 Benthic Macroinvertebrate Sampling

In 2023, sampling will again follow the USEPA multihabitat approach (Barbour et al. 1999) but also include the NHDES protocol for macroinvertebrate collection at two locations (NHDES 2013). The USEPA multihabitat approach will be used based on the diverse types of habitat documented in each reach during 2022 and the narrow wetted widths and shallow depths that did not allow for the placement of replicate rock basket samplers.

At Station AB-5 (downstream station in Alder Brook) and the associated reference station on lower Hatch Brook (Station HB-7), three replicate rock bag samplers will be used as a reasonable substitute for rock baskets. While the sampling reaches consist of coarse substrates and a wetted width that will support three replicate rock basket samplers required by the NHDES protocol,

depths at Station 5 during 2022 were either 1) not sufficient to prevent exposure during late summer, or 2) did not provide a minimum of 5 inches water over the samplers as required in the macroinvertebrate SOP (NHDES 2013). Rock bags, filled with the same size and mass of substrate as a rock basket sampler, should have a lower profile and remain submerged during low water conditions. Rock bag samplers will be collected at stations in a manner similar to that described for rock basket samplers by the 2013 NHDES protocols. Each replicate sample will be individually preserved in a container(s) and labeled uniquely with an internal and external label.

Field staff will preserve collected macroinvertebrates (both rock bag and multihabitat samples) in 70% isopropyl alcohol with external and internal labels. Samples will be shipped to the Normandeau benthic macroinvertebrate laboratory in Stowe PA where samples will be sorted and identified to the lowest taxonomic level to provide data required for the New Hampshire Benthic Index of Biotic Integrity (B-IBI) or any equivalent evaluation metrics if B-IBI is not appropriate for the collected data. Multihabitat net sample and rock basket replicate matrices will be processed in one-quarter increments to provide a minimum quota of 100-speciemens. Benthic macroinvertebrate collection datasheets are attached in Appendix B.

The aquatic habitat, macroinvertebrate, and fisheries studies will be completed by senior Normandeau biologists who are highly experienced with conducting fish and aquatic habitat assessments. Normandeau biologists have completed numerous fish and aquatic habitat studies throughout the northeast and NH and are members of relevant professional organizations, such as the American Fisheries Society, have published and presented wildlife studies in peer review formats, and are recognized by agencies and peers for their high-quality work and ability to complete studies under challenging logistical conditions. Normandeau biologists are highly experienced in macroinvertebrate sample collection and have successfully collected benthic samples in small headwater streams using a variety of artificial substrate samplers as well as kick-net sample collection to supplement or replace artificial substrate sampling, when necessary. Normandeau's benthic taxonomy lab is led by a senior taxonomist with over 40 years of professional experience and multiple taxonomic certifications from the Society for Freshwater Science.

Task 2 Assumptions:

- Macroinvertebrate samples collected using the USEPA multihabitat approach outlined in Barbour et al. (1999). Rock bags (3 replicates per location) will be used for sampling at Station AB-5 and the comparative lower Hatch Brook reference station and will follow the sampling guidance from NHDES (NHDES 2013).
- 100 specimen sub-samples, processed in ¼ increments with taxonomy to the genus level is assumed. Midges will be identified to the family level.
- Successful collection of macroinvertebrate samples at some stations is dependent on water conditions.

3.4 Task 3: Continuous Water Quality Monitoring for Dissolved Oxygen, Temperature, and pH

A water quality study will be completed to address Env-Wq 1703.07 (dissolved oxygen), Env-Wq 1703.13 (temperature), and Env-Wq 1703.18 (pH). The proposed study will collect continuous water quality data using deployed data logging instruments at the majority of the

proposed monitoring sites during the growing season and will establish existing baseline conditions at the site and whether there is evidence of impairment to water quality (i.e., exceedances of water quality standards). Baseline data will be used for comparison to future data to determine any impacts to water quality due to project construction and operation.

The proposed continuous water quality monitoring study will be conducted at six of the eight 2023 monitoring locations identified in this SAP (monitoring stations varied slightly in 2022, as noted in 3.1). Final site selection will be determined in the field and will necessarily accommodate the requirements of each of the proposed studies. For the continuous monitoring water quality study, site selection will include considerations for accessibility, safety and security of instruments, and sufficient water depth for continuous monitoring throughout the study period. Final monitoring station locations will be documented with GPS position and site photographs, along with any useful supporting information such as water depth and channel width, as appropriate. The data logging instruments proposed for this study are Onset Hobo U26-001 DO & temperature loggers, Onset Hobo MX2501 pH & temperature loggers, and Onset Hobo U20-001 water level loggers (used for barometric pressure reference), see Appendix C for specifications.

Instruments will be deployed with an anchor and buoy system (where there is sufficient depth) or will be deployed on the channel bottom in shallow locations and secured with a chain or cable to the adjacent bank. In soft-bottom substrates the instrument may be deployed from a concrete block or other means to ensure the instrument sensors are not submerged into the bottom sediments. Deployed instrumentation will be set to collect water quality data at 15-minute intervals and will remain deployed for the entirety of the study period. The deployed instruments will be retrieved every other week to download data and to maintain, clean, and calibrate the instruments. An additional water quality instrument (e.g., YSI ProDSS, see Appendix C) will be used for independent calibration checks of the continuously deployed instrumentation and will be used to take recurring spot measurements at Stations ABT-2a and ABT-3a. (spot measurements will be taken rather continuous monitoring due to the likelihood of the stream going dry). Calibration of the deployed instruments will occur every other week using commercially produced calibration standards for pH and 100% water saturated air for dissolved oxygen. The barometer used for determining oxygen saturation values at calibration and for calculating oxygen saturation values in the data record (i.e. from oxygen concentration values) will be either the YSI ProDSS barometer or a water level pressure logger dry-mounted at the site as an atmospheric pressure reference for the DO monitoring. Calibration of the additional QC meter will be conducted prior to each measurement.

The proposed study will be completed from late-May through mid-November. This period covers the majority of the growing season and the most likely period of maximum water temperature, low stream flow, and low dissolved oxygen conditions. Instruments will be deployed for the entire study period, if possible. If an instrument is found dry or if it appears likely the water level will drop below the instrument level, then the instrument will be removed until flows increase.

QA/QC Protocols

Prior to deployment, redeployment, or use for spot measurements, water quality instruments will be cleaned, inspected for fouling, damage, or other performance affecting conditions, and

calibrated according to manufacturer recommendations and established best practices. Instrument calibration checks will be performed for all instruments by comparing instrument readings to calibration standards (for pH) and 100% water saturated oxygen (for DO). Calibration checks will be completed prior to the first measurement (for the mobile instrument) or prior to deployment (for continuous monitoring instruments). Calibration checks will also be completed when a deployed instrument is retrieved or any time there is reason to suspect the calibration is off. In addition to calibration checks, side-by-side QC comparisons will be made between the mobile instrument and the deployed instruments to further evaluate instrument performance. Side-by-side QC readings will be taken prior to deployment and at retrieval for all continuous monitoring instruments and can be measured in-stream at the monitoring station or in a bucket of stream water collected for QC readings. A log of calibration data will be maintained to establish a project record of instrument performance history. Calibration acceptance criteria is presented in Table 3-3 and side-by-side QC acceptance criteria is presented in Table 3-4. All calibration information will be included in a final data report and any post-deployment calibration checks that fail the QA/QC targets will be flagged and noted in the report.

Table 3-3. Field Meter Calibration Method, Frequency, and Acceptance Criteria

Frequency of Calibration	Calibration Acceptance Criteria
DISSOLVED OXYGEN	
Instantaneous Readings	
Prior to each measurement	• Record the calibration value in % saturation and after one minute record the % saturation reading and compare to the calibration value. • The dissolved oxygen % saturation reading should be ± 5.0% of dissolved oxygen % saturation calibration value.
Datasonde Deployments	
Datasonde must be calibrated before deployment and at least every two weeks (or more frequently if meter fouling is likely to occur) for deployments lasting more than two weeks.	• After the datasonde is calibrated, record the datasonde instantaneous mg/L reading immediately after calibration and the Oxygen Solubility in Water Value based on concurrent water temperature and barometric conditions. • The difference between the datasonde instantaneous reading immediately after calibration and the Oxygen Solubility Water Value must be no greater than ± 0.2 mg/L. If the difference is greater, recalibrate.
Datasonde Retrieval	
	• After removal from water, set up the datasonde so that it is under 100% saturated air conditions. After dissolved oxygen readings have stabilized, record the datasonde instantaneous mg/L reading and the Oxygen Solubility in Water Value based on concurrent water temperature and barometric conditions. • The difference between the datasonde instantaneous reading immediately after calibration and the Oxygen Solubility Water Value from Table 4

Frequency of Calibration	Calibration Acceptance Criteria
	of Appendix A must be no greater than ±0.5 mg/L to be considered valid data. • If the datasonde is going to be redeployed, and it hasn't been more than 2 weeks since the last calibration, recalibrate if the difference is greater than ±0.2 mg/L. If it has been 2 weeks since the last calibration, recalibrate regardless of the difference.
TEMPERATURE	
Not Applicable	Not Applicable
pH	
Instantaneous Readings	
Three-point calibration prior to each measurement (4.00, 7.00, and 10.00 pH calibration standards)	• Record calibration slope prior to each measurement. Slope should be between 95% - 105%. If slope is out of range, the meter should be recalibrated. • During each day of sampling the handheld meter should measure a standard not used in the calibrations (i.e. 6.00 pH standard). Meter should read ± 0.3 pH units from the standard. If the difference is greater, it may indicate a contaminated standard or faulty meter. Try again with a fresh standard. If it is still out of range, the meter may be faulty.
Datasonde Deployments	
Datasonde must be calibrated before deployment and at least weekly (or more frequently if meter fouling is likely to occur) for deployments lasting more than one week. PH sensors are to be rinsed with storage solutions after calibration to improve response time at redeployment.	• After three-point calibration (4.00, 7.00, and 10 pH calibration standards) record the datasonde reading of the two standards used. Reading should be ± 0.05 pH units from both calibration standards. If the difference is greater, recalibrate.
Datasonde Retrieval	
	• After removal from water, and without cleaning the probe, datasonde should measure the three standards used in the calibration. Datasonde readings should be ± 0.3 pH units from each calibration standard for the data to be considered valid. • If the datasonde is going to be redeployed, and it hasn't been more than 2 weeks since the last calibration, recalibrate if the difference is greater than ± 0.3 pH units. If it has been 2 weeks since the last calibration, recalibrate regardless of the difference.

Table 3-4. Data QC Acceptance Criteria

Acceptance criteria is the maximum difference between handheld and datasonde measurements*

Parameter	Frequency of Measurement Checks*	Acceptance Criteria
Dissolved Oxygen	Handheld measurements should be taken at the time of datalogger deployment once a week throughout the deployment and at the time the datalogger is removed. Handheld measurements should be taken as close as possible to the location of the datalogger.	Relative Percent Difference (RPD)** between handheld measurement and datalogger should be ≤ 10%. If RPD is > 10% the absolute value of the difference between the handheld measurement and the datalogger measurement should be ≤ 0.4 mg/l or ≤ 4% saturation.
Temperature	Same as above	RPD between handheld measurement and datalogger should be ≤ 10%. If RPD is > 10% the absolute value of the difference between the handheld measurement and the datalogger measurement should be ≤ 0.5 °C.
pH	Same as above	The absolute value of the difference between the handheld measurement and the datalogger measurement should be ≤ 0.3 pH units
Specific Conductance	Same as above	± 5 µS/cm or ± 3% of the measured value, whichever is greater

*Adjacent measurements with the handheld meter are taken at same location and depth as the datasonde.

**RPD is equal to the following:

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\%$$

where x_1 is the original sample concentration, and
x_2 is the replicate sample concentration

If a deployed meter fails a side-by-side QC check and calibration acceptance criteria and the error is due to instrument drift (i.e., no equipment issues), then data correction may be warranted. Any data correction will be applied as presented in the US Geological Survey (USGS) publication "Guidelines and Standard Procedures for Continuous Water Quality Monitors: Station Operation, Record Computation, and Data Reporting" (Wagner et al. 2006). The USGS method applies a weighted linear correction to an instrument deployment period based on the combined fouling and instrument drift error, where there is zero correction applied at the start of the deployment period and the full correction (equivalent to the combined measured error) is applied at the end of the deployment period. The final data report will include, in Excel format, both the raw datalogger data and the adjusted data in a single spreadsheet as well as figures based on uncorrected and corrected data to allow for comparison between the two data sets. The results of tests to determine fouling and/or drift error and a description of how the data were corrected will also be included in the report. If data were corrected, findings and conclusions based on uncorrected data will also be provided in the final water quality report.

3.5 Task 4: Water Sample Collection and Laboratory Analysis for Color, Turbidity, Nutrients, and Toxic Substances

A water quality study will be completed to address Env-Wq 1703.10 (color), Env-Wq 1703.11 (turbidity), Env-Wq 1703.14 (nutrients), and Env-Wq 1703.21 (toxic substances). The proposed study will consist of periodic collection and laboratory analysis of surface water samples at each of the eight proposed monitoring sites in 2023 (station locations varied slightly in 2022, see 3.1), concurrent with the other proposed studies. The proposed water sampling study will establish existing baseline conditions at the site and whether there is evidence of impairment to water quality (i.e. exceedances of water quality standards). Baseline data will be used for comparison to future data to determine any impacts to water quality due to project construction and operation.

The surface water sampling study will consist of collection of surface water grab samples at each of the eight proposed monitoring locations using standard sample collection techniques (See Appendix A - New Hampshire Volunteer Lake Assessment Program Field Manual). Each of the proposed monitoring locations is shallow and there should be no concern with thermal stratification as occurs in deeper water bodies. Therefore, the collection of water samples will be from the near-surface and it will be unnecessary to sample a water column composite or collect samples from discrete water column layers. Nutrients (except chlorophyll-a) and turbidity samples, as well as field conductivity readings, will be collected during recurring site visits for a total of 10 samples. Chlorophyll-a samples will be collected twice from each station. Toxic substance samples will be collected five times during the study period. Color and PFAS samples will be collected once during the study. Toxics samples will be collected at different flow levels and will include at least one sample each collected at low flow (summer 2023), base flow (autumn 2023), high flow (spring 2023), and peak flow (autumn 2023). All other samples will be collected during the period of May 15 through September 15, 2023. All of the stream segments are expected to maintain flow through the summer, with the exception of the intermittent stream (ABT-3a) where it is likely to go dry at some point during the study period. Samples will be collected from the intermittent stream if there is sufficient flow for collection; if flows are too low then sampling will be suspended until sufficient flows resume.

The following samples will be collected in support of evaluating water quality standards:

- Env-Wq 1703.10 (color)
  - Color sample (1 sample from each station)
- Env-Wq 1703.11 (turbidity)
  - Field reading using turbidity meter (10 samples from each station)
- Env-Wq 1703.14 (nutrients)
  - NO3 + NO2 – Nitrogen (10 samples from each station)
  - TKN (10 samples from each station)
  - Ammonia (10 samples from each station)
  - Total Phosphorus (10 samples from each station)
  - Chlorophyll-a (2 samples from each station)
  - Conductivity field readings (10 samples from each station)

- Env-Wq 1703.21 (toxic substances)
  - Chloride (5 samples from each station)
  - Iron, manganese, and aluminum (dissolved and total, 5 samples from each station)
  - Drinking water metals (dissolved and total arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) (5 samples from each station)
  - Hardness (5 samples from each station)
  - Dissolved Organic Carbon (5 samples from each station)
  - PH field readings (5 samples from each station concurrent with collection of toxic substances using the field meter (YSI ProDSS) described in Section 4.3)
- Env-Dw 705.06 (MCLs for Per- and Polyfluoroalkyl Substances (PFAS) Contaminants)
  - PFAS (1 sample from each station)

Laboratory methods for sample analysis are presented in Table 3-5. The list of compounds to be sampled for the baseline studies was developed in coordination with NHDES and is based on both water quality sampling programs in other NH Release Detection sites and specific recommendations provided by NHDES. The proposed landfill will collect municipal solid waste and the future GMP water quality monitoring program should be comparable to other active or closed MSW landfill sites in the state. Therefore, the baseline water quality study will collect samples typically required for other GMP sites associated with MSW facilities (although as surface water samples rather than groundwater samples).

The surface water quality studies will be completed by Normandeau environmental scientists with multiple decades of collective water quality experience. The studies will be led by a Normandeau Professional Hydrologist (registered with the American Institute of Hydrology) with nearly 20 years of project experience executing hydrologic studies that include process scale hydrology, watershed hydrology, and surface water quality. The Normandeau team has successfully completed many water quality demonstrations to assess the effects of industrial discharges, stormwater discharges, hydroelectric operations, and land development projects on water quality and flows. Normandeau has provided supporting studies for NPDES, FERC, and other projects requiring CWA Section 401 Water Quality Certification.

Table 3-5. Laboratory Methods and Protocols

Parameter	Laboratory Method	Container (Preservation) Hold Time	Precision (RPD Based on Field Replicates)	Sensitivity (Method Detection Limit or MDL)	Sensitivity (Reporting Detection Limit or RDL)
Total Kjeldahl Nitrogen	SM 4500 NorgC/NH3-D	4 oz. plastic container (sulfuric acid & ice) 28 day holding period	RPD<20%	0.032 mg/L	0.2 mg/L
Nitrite + Nitrate Nitrogen	EPA Method 353.2 or EPA Method 300.0	4 oz. plastic container (sulfuric acid & ice) 28 day holding period	RPD<20%	0.0441 mg/L	0.05 mg/L
Ammonia	TM NH3-001	28 day holding period	RPD<20%	0.5 mg/L	0.5 mg/L
Total Phosphorus	EPA Method 365.1	4 oz. plastic container (sulfuric acid & ice) 28 day holding period	RPD<20%	0.0006 mg/L	0.002 mg/L
Total Hardness	EPA 200.8	180 day holding period	RPD<20%	0.5 mg/L	0.5 mg/L
DOC (Aqueous)	SM 5310C	7 day holding period to filtration	RPD<20%	0.5 mg/L	0.5 mg/L
PFAS	EPA 537.1 (4 compounds: Perfluorooctanoic acid; Perfluoroctanesulfonic acid; Perfluorohexanesulfonic acid; and Perfluorononanoic acid)	14 day holding period	RPD<20%	2 ng/L	2 ng/L
Color	SM 2120B	24 hour holding period	RPD<20%	5.0 PtCo	5.0 PtCo
Chloride	EPA 300.0 or SM 4500Cl E	28 day holding period	RPD<20%	1.0 mg/L	1.0 mg/L
Metals	EPA 200.8	28 day holding period	RPD<20%	0.0001 mg/L (mercury); 0.0005 mg/L (arsenic); 0.001 mg/L (barium, cadmium, chromium, lead, selenium, silver); 0.005 mg/L (manganese); 0.05 mg/L (iron, aluminum)	0.0001 mg/L (mercury); 0.0005 mg/L (arsenic); 0.001 mg/L (barium, cadmium, chromium, lead, selenium, silver); 0.005 mg/L (manganese); 0.05 mg/L (iron, aluminum)

3.5.1 QA/QC

Field replicate samples will be collected as a quality assurance protocol. The proposed QA sampling frequency and acceptance criteria is presented in Table 3-6.

Table 3-6. Field Replicate Frequency and Acceptance Criteria

Parameters	Frequency of Field Replicates	Precision (RPD Based on Field Replicates)
TP, TKN, NO2/NO3-N, Color, Turbidity, Chloride, Metals	Once every 10 samples	RPD < 20%

3.6 Task 5: Flow Monitoring

Streamflow will be monitored with pressure/level loggers deployed at four stations: ABT-2b, AB-5, HB-7, and HBT-10. The level loggers will record stream stage at 15-minute intervals to provide a flow record throughout the monitoring period. Level loggers will be deployed at a fixed position to ensure consistent readings throughout the study period. The logger mounting system will consist of a piece of PVC pipe with a vented bottom cap attached vertically with hose clamps to a piece of steel rebar driven to a refusal depth in the stream substrate. The level logger will rest securely in the PVC housing at a fixed depth near the stream bed that will not vary during the deployment period even with multiple instrument retrievals/redeployments (i.e. the instrument is always returned to the same vertical position in the PVC housing). The depth from the water surface to the top of the steel rebar will be measured at the time of instrument retrieval and redeployment (i.e., the steel rebar also serves as a staff gage as it is at a fixed position). The instrument mooring and top of rebar will be surveyed relative to a nearby permanent benchmark to ensure the flow monitoring stations can be relocated if necessary.

Flow gaging will be completed at each of the four flow monitoring stations on at least ten occasions at different flow levels and will use standard gaging techniques with a flow meter (See Appendix A, Standard Operating Procedure for Stream Flow Determination developed by NHDES). A pair of "duplicate" flow measurements will be completed at different times that approximate previous measurements. Flow gaging will also be completed once at each of the eight monitoring stations as part of the 2023 habitat assessments. Precipitation data will be evaluated from the nearest NWS weather station (Whitefield ASOS). The antecedent site conditions (recent precipitation, snowpack, stream stage) and weather forecast will be used to target specific flow conditions for sampling and gaging events.

3.7 Data Handling and Shipping

3.7.1 Data Handling

Each completed data sheet is reviewed for completeness and legibility by the originator. A second individual (crew member) must review each data sheet for legibility, completeness, and accuracy before proceeding to the next sample. Data sheets reviewed after each sampling day and necessary corrections made by a single line through the error, the correction written adjacent, and the initials and date of the person making the correction. Corrected, final data sheets will be scanned and saved and uploaded after field collection.

3.7.2 Shipping

All samples will be logged on a Chain of Custody sheet provided by Normandeau after field collection. Samples will be preserved in 70% alcohol and maintained in coolers while in the field. Shipping will occur following the Sample Shipping, Handling, and Custody SOP provided below:

3.7.3 Sample Shipping, Handling, and Custody

This SOP describes how to properly handle and ship samples for analysis while maintaining established COC requirements.

1. Ensure all sample labels are fully filled out, that the samples are tightly capped, and that clear tape is wrapped around the entire circumference of the sample bottle so that it completely covers the label.
    a. Note that COC forms usually only have enough entries for 10–20 samples
    b. Samples listed on a single COC form will not be split between coolers
    c. More than one COC form can be used for each cooler.

2. Record the following contact information on each COC form:
    a. Project name
    b. Field Lead
    c. Field Lead contact information (email address and phone number)
    d. Special instructions/comments.

3. Record the following sample information on respective COC forms:
    a. Sample number
    b. Date and time of the sample collection (information should be found on the respective, completed datasheets)
    c. Number of sample containers sharing the same, respective sample ID

4. Record the following COC information at the bottom of the COC form:
    a. Printed name and signature of individual relinquishing custody
    b. Date and time when samples were relinquished from custody (this will be the last entry made before making copies of the completed COC form and sealing it in the cooler or securing with stored samples).

5. Pack the cooler as follows as required for shipping samples preserve in 70% alcohol.

6. Confirm that each cooler only contains samples that are listed on the COC form(s) in that cooler.

7. Seal the original COC form(s) in a plastic re-sealable bag and tape the bag to the underside of the cooler lid (or the inside of the cooler).

8. Seal the cooler by taping around the seam between the lid and body of the cooler and around the entire cooler.

9. Deliver cooler(s) to a FedEx location or have FedEx pick up the cooler(s). Do not leave the cooler(s) at an unattended FedEx drop-off location. Avoid shipping samples over weekends or holidays.

4 Schedule and Reporting

The proposed studies will commence in mid-May 2023 and continue through mid-November 2023 as summarized in Table 4-1. The specific sampling planned for each station during 2023 (i.e., continuous/discrete, fisheries, gaging, etc.) is presented in Table 4-2. This SAP is being submitted for NHDES review with the understanding that if reviews are delayed then the studies may commence prior to NHDES review and comment and subsequent submittal of a final SAP. If any changes are agreed to in project approach, sampling locations, parameters, methods, etc., then it may be necessary to adjust the study(ies) after they have already commenced. However, GSL will coordinate efforts with NHDES as closely as possible to ensure the details in the proposed scope and impacts of the project are clearly identified and that this SAP is mutually agreed upon before commencing the studies. Any changes or variances from the final approved SAP will be noted in the study reports.

Table 4-1. Proposed Baseline Environmental Studies Schedule

Study	Duration	Proposed Timeframe
Fisheries Study	1 week	8/08/22–8/12/22, 8/19/22, 08/1/23–08/31/23
Aquatic Habitat Characterization	1 week	8/08/22–8/12/22, 7/15/23–8/31/23
Benthic Macroinvertebrates Sample Collection	1 week	8/08/22–8/12/22, 10/7/22, 10/21/22, 08/01/23–09/31/23
Temperature, Dissolved Oxygen, and pH Monitoring	19; 29 weeks	7/14/22–11/18/22, 5/1/23–11/15/23
Sample collection and analysis for nutrients, Chlorophyll a, Specific Conductance, and Turbidity	10; 18 weeks	7/14/22–9/15/22, 5/15/23–9/15/23
Sample collection and analysis for metals, hardness, DOC, color, chloride, and PFAS	6; 29 weeks	7/25/22–8/26/22, 5/1/23–11/15/23

Table 4-2. Proposed Baseline Sampling Proposed by Station During 2023

Station ID	Task 1: Aquatic Habitats and Fisheries Assessment	Task 2: Benthic Macroinvertebrate Sampling	Task 3: Continuous Water Quality Monitoring	Task 4: Water Sample Collection for Laboratory Analysis	Task 5: Flow Monitoring
ABT-2a	x	x	Temperature logging only; Discrete samples	x	x
ABT-2b	x	x	x	x	x
ABT-3a	x (as possible)	x (as possible)	Discrete samples	x	x (as part of habitat assessment)
ABT-3b	x	x	x	x	x (as part of habitat assessment)
AB-4	x	x	x	x	x (as part of habitat assessment)
AB-5	x	x	x	x	x
HB-7	x	x	x	x	x
HBT-10	x	x	x	x	x

A Baseline Study Report will be prepared and submitted to NHDES to present results from each of the baseline environmental studies, to include graphics and tables which present the data collected and provide a narrative of our findings using the QC methods outlined in Section 3.0. Any anomalous or indicative results will be highlighted. All quality-controlled water quality data obtained as part of these studies will be presented, as will a comparison of measured data to state water quality standards, a comparison of water quality between different stations, QC data, and a site map showing final station locations. A summary of all variances from the SAP will be provided in the report. All study data including corrected data, uncorrected data, QA/QC data, calculations, etc. will be provided to NHDES in working Microsoft Excel spreadsheets. Water quality data will also be submitted to the NHDES Environmental Monitoring Database following submittal of the final report and completion of any report edits and/or recommended changes to the data record. The list of graphs, graphics, and tables to be included with the report includes:

- Time series plots of temperature, dissolved oxygen concentration & percent saturation, and pH will be presented for each parameter and station. Water quality standards will be shown and stream flow will be included for stations ABT-2b, AB-5, HB-7, and HBT-10;
- For any time series data that include QC-adjusted data the raw and corrected datasets will be presented on a single time series plot for comparison;
- Regional flow conditions will be presented as a time series plot for the study period (USGS gage station 01137500 AMMONOOSUC RIVER AT BETHLEHEM

JUNCTION, NH), and will also include stream flow for stations ABT-2b, AB-5, HB-7, and HBT-10, as well as precipitation data from the Whitefield, NH NWS station;

- A summary table of maximum, minimum, median, and mean values for temp, DO, and pH for each station will be presented;
- A summary table of exceedances of water quality standards for pH and DO will be presented and will include the number of exceedances and duration of exceedances, as applicable;
- A summary table of laboratory analytical results will be presented and will include all values by station and date, a summary of maximum, minimum, median, and mean values by station, and the number of exceedances of surface water quality standards, as applicable;
- A table summarizing species and number of specimens caught, length, weight, and reach length start and end points;
- Data sheets for fish, macroinvertebrates, and habitat; and
- A Table summarizing calculated indexes (IBI, RBP metrics)

5 References

NHDES. 2022. 2020/2022 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology. New Hampshire Department of Environmental Services. Retrieved from: https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdfAppendix

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at http://pubs.water.usgs.gov/tm1d3

Appendix A: Standard Operating Procedures

SOP L1: DISSOLVED OXYGEN AND TEMPERATURE PROFILES

1. Locate the deep spot using triangulation, a depth finder, or GPS fathometer. Reference the sampling station map or bathymetric map for a general idea of where the deep spot is located.
2. Anchor at the deep spot and record the bottom depth on the field data sheets.
3. Turn on the dissolved oxygen/temperature meter (DO/temp). Calibrate the DO/temp meter according to Standard Operating Procedures (SOPs) included with the meter.
4. Determine the starting depth of the DO/temp profile. This is approximately 0.5 meters above the bottom depth. For example, if the bottom depth is 8.0 meters, start the profile at 7.5 meters. Then move to the nearest whole number and collect data every meter to the surface. For example, if the starting depth is 7.5 meters, the next reading would be collected at 7.0 meters, 6.0, 5.0, and so on to the 1.0 meter. The last reading will be at the surface, approximately 0.1 meters.
5. Lower the probe to the starting depth and once the readings have stabilized, record the values on the field data sheet. Repeat to the surface.
6. Determine lake stratification, or thermal layers, based on the temperature profile. The top and bottom layers will have relatively uniform temperature, less than 1°C difference between meters. The middle layer, or thermocline, will exhibit greater than 1°C difference between meters. The boundaries are determined when the temperature changes more than 1°C as you move from the bottom layer to the thermocline, and then when the temperature changes less than 1°C as you move from the thermocline to the upper layer. Note: not all lakes stratify into three distinct thermal layers. Some may only have two and shallow lakes typically less than four meters will only have one layer.

Table 4 Dissolved Oxygen (mg/L) Solubility in Water

Temp.	Pressure (mmHg)																	
(°C)	795.0	790.0	785.0	780.0	775.0	770.0	765.0	760.0	755.0	750.0	745.0	740.0	735.0	730.0	725.0	720.0	715.0	710.0	705.0
0.0	15.3	15.2	15.1	15.0	14.9	14.8	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5
0.5	15.1	15.0	14.9	14.8	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3
1.0	14.8	14.7	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.2	13.2
1.5	14.6	14.5	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.2	13.2	13.1	13.0
2	14.4	14.3	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8
2.5	14.2	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6
3.0	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.5	12.5
3.5	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.6	12.5	12.4	12.3
4.0	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.6	12.5	12.4	12.3	12.2	12.1
4.5	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.7	12.6	12.5	12.4	12.3	12.2	12.1	12.1	12.0
5.0	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.7	12.6	12.5	12.4	12.3	12.2	12.2	12.1	12.0	11.9	11.8
5.5	13.2	13.1	13.0	12.9	12.8	12.7	12.7	12.6	12.5	12.4	12.3	12.2	12.2	12.1	12.0	11.9	11.8	11.7	11.7
6.0	13.0	12.9	12.8	12.8	12.7	12.6	12.5	12.4	12.3	12.3	12.2	12.1	12.0	11.9	11.8	11.8	11.7	11.6	11.5
6.5	12.8	12.8	12.7	12.6	12.5	12.4	12.3	12.3	12.2	12.1	12.0	11.9	11.9	11.8	11.7	11.6	11.5	11.5	11.4
7.0	12.7	12.6	12.5	12.4	12.4	12.3	12.2	12.1	12.0	12.0	11.9	11.8	11.7	11.6	11.6	11.5	11.4	11.3	11.2
7.5	12.5	12.4	12.4	12.3	12.2	12.1	12.0	12.0	11.9	11.8	11.7	11.6	11.6	11.5	11.4	11.3	11.3	11.2	11.1
8.0	12.4	12.3	12.2	12.1	12.1	12.0	11.9	11.8	11.7	11.7	11.6	11.5	11.4	11.3	11.3	11.2	11.1	11.0	11.0
8.5	12.2	12.1	12.1	12.0	11.9	11.8	11.8	11.7	11.6	11.5	11.4	11.4	11.3	11.2	11.1	11.1	11.0	10.9	10.8
9.0	12.1	12.0	11.9	11.8	11.8	11.7	11.6	11.5	11.5	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.8	10.8	10.7
9.5	11.9	11.9	11.8	11.7	11.6	11.6	11.5	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.9	10.8	10.7	10.6	10.6
10.0	11.8	11.7	11.6	11.6	11.5	11.4	11.3	11.3	11.2	11.1	11.0	11.0	10.9	10.8	10.7	10.7	10.6	10.5	10.4
10.5	11.7	11.6	11.5	11.4	11.4	11.3	11.2	11.1	11.1	11.0	10.9	10.8	10.8	10.7	10.6	10.5	10.5	10.4	10.3
11.0	11.5	11.4	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.9	10.8	10.7	10.6	10.6	10.5	10.4	10.3	10.3	10.2
11.5	11.4	11.3	11.2	11.2	11.1	11.0	11.0	10.9	10.8	10.7	10.7	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1
12.0	11.3	11.2	11.1	11.0	11.0	10.9	10.8	10.8	10.7	10.6	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.0	10.0
12.5	11.1	11.1	11.0	10.9	10.8	10.8	10.7	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.1	10.1	10.0	9.9	9.9
13.0	11.0	10.9	10.9	10.8	10.7	10.7	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.7
13.5	10.9	10.8	10.7	10.7	10.6	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.1	10.0	9.9	9.8	9.8	9.7	9.6
14.0	10.8	10.7	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5
14.5	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4
15.0	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3
15.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.2
16.0	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.1
16.5	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.4	9.3	9.2	9.2	9.1	9.0
17.0	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9
17.5	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.8
18.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.7
18.5	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.7
19.0	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6
19.5	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.5	8.5
20.0	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4
20.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3

Table 4 Dissolved Oxygen (mg/L) Solubility in Water (continued)

Pressure (mmHg)																		
795	790	785	780	775	770	765	760	755	750.0	745	740	735	730	725	720	715	710	705
9.3	9.2	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.2
9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.1
9.1	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.7	8.6	8.5	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1
9.0	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0
9.0	8.9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9
8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8
8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8
8.7	8.7	8.6	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7
8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8	7.8	7.7	7.7	7.6
8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6
8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.5
8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4
8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.3
8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.5	7.5	7.4	7.4	7.3	7.3
8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2
8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.1
8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.3	7.3	7.2	7.2	7.1	7.1
8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0
7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0	7.0
7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9
7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.1	7.1	7	7	6.9	6.9	6.8
7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8
7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7
7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7
7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6
7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6
7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.7	6.6	6.6	6.5
7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.5	6.5
7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.5	6.4	6.4

SOP L3: Deep Spot Sampling Methods For TP, TKN and Nitrite+Nitrate

- Consult the temperature profile to identify the lake's thermal layers. If the lake is thermally stratified you will want to collect a sample in the mid-epilimnion and 1-2 meters from the bottom, in the hypolimnion. If the lake is not thermally stratified, collect a sample at mid-depth. Record the sample depths on the field data sheet. Please change these depths as necessary based upon your current temperature profile.

- Properly set up the Kemmerer bottle (Figure 1). Open the bottle by pulling apart both ends until you hear a click and the bottle does not close. Place the sender in the indented space on the top of the bottle and lower the bottle to the desired depth. The depth marker should be on the surface of the water.

- Drop the messenger down the chain to close the bottle and collect the desired sample. Pull up the bottle and check to make sure there is no sediment in the sample. If you observe any sediment, discard the water and start the process in a slightly different location such as the other side of the boat, or you may need to adjust the sample depth by 0.5 meter or more (as long as you remain in the thermal layer) until you get a sample free of sediment.

- From the mid-epilimnion sample (if thermally stratified), or the mid-depth sample (if not thermally stratified), fill 1 small white bottle (without acid) for nitrite+nitrate analysis, and fill 1 small brown bottle (which contains acid) for total phosphorus (TP) and total kjeldhal nitrogen (TKN) analyses. ***DO NOT rinse or overflow the small brown bottle as it contains a sulfuric acid preservative! If you overfill the bottle, immediately rinse with water.***

From the mid-epilimnion sample (if thermally stratified), or the mid-depth sample (if not thermally stratified), fill one small white bottle (without acid) for nitrite+nitrate analysis, and fill one small brown bottle (which contains acid) for total phosphorus and total kjeldhal nitrogen (TKN) analyses. From the mid-hypolimnion sample (if thermally stratified), fill another small brown bottle (which contains acid) for total phosphorus analysis. ***DO NOT rinse or overflow the small brown bottle as it contains a sulfuric acid preservative! If you overfill the bottle, immediately rinse with water.***

- Place the bottles in a cooler with ice. Return to DES. The hold time for nitrogen samples is 24 hours, so the samples must be returned to DES by the end of the day or early the next morning. Coordinate with DES staff to ensure transfer of samples in a timely manner.

Figure 1.

SOP L4: CHLOROPHYLL-A SAMPLING

Method 1: Composite

Equipment

- Bucket
- Kemmerer bottle (Figure 1)
- Calibrated chain with clip

1. Rinse the bucket with lake water and discard. A dirty bucket could contain old plant material that may contaminate the sample, so make sure to rinse it clean.
2. Lower the open Kemmerer bottle to the middle of the metalimnion (thermocline) as determined from the DO/temp profile. If the lake is not stratified, lower the open Kemmerer bottle to two-thirds of the total depth.
3. Close the bottle, pull it up, and deposit into the bucket.
4. Repeat every meter to the surface. For example, if you were conducting a 4 meter composite, collect an equal amount of water from 4, 3, 2, and 1 meters.
5. Rinse the large brown bottle with a small amount of water from the bucket and discard.
6. Fill the bottle with the well-mixed composited water from the bucket.

Method 2: Integrated tube

Equipment

- Bucket
- Integrated tube (Figure 2)
- Calibrated chain with clip

1. Rinse the bucket with lake water and discard. A dirty bucket could contain old plant material that may contaminate the sample, so make sure to rinse it clean.
2. Connect the calibrated chain to the eyehook on the weighted end of the integrated tube. Lower the weighted end and chain to the middle of the metalimnion (thermocline) as determined from the DO/temp profile. If the lake is not stratified, lower to two-thirds of the total depth.
3. Crimp the top end of the tube tightly.
4. Haul the weighted end of the tube up by the chain only. Do not pull on the tube itself.
5. Place the weighted end into the bucket and uncramp the top end of the tube.
6. Lift the uncrimped end above your head so the open end is always higher than the water level in the tube. This allows the water to drain out of the tube into the bucket.
7. Rinse the large brown bottle with a small amount of water from the bucket and discard.
8. Fill the bottle with the well-mixed water from the bucket.

Figure 1. Kemmerer bottle

Figure 2. Integrated Tube Sampler

Standard Operating Procedure for Stream Flow Determinations and Use of Temporary Staff Gages
Revision Number: **3**
Effective Date: **September 5, 2012**

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Standard Operating Procedure for Stream Flow Determination and Temporary Staff Gages

Equipment: Marsh-McBirney Model 2000 Flo-Mate, Flow field sheet
Velocity Measurement: Electromagnetic
Zero Stability: +/- 0.05 ft/sec
Accuracy: +/- 2% of reading + zero stability
Range: -0.5 to +19.99 ft/sec (-0.15 m/sec to 6 m/sec)

Calibration:

1. Flow meter calibration shall occur before the first measurement of the day, after the last measurement of the day and after any battery change.

2. Turn meter on and look for 'low battery' display. If display does not come on, proceed as follows. If light comes on, change batteries, then proceed with the following procedures. If you get a message on the screen that says "**NOISE - - -**" there is excessive electrical noise (such as from high voltage power lines) that could interfere with the readings. In such case it may be necessary to take flow readings at another location.

3. Set meter reading to **'time constant filtering" (rC)** by pressing the up and down arrow keys at the same time until the screen shows "rC". Set the time to **5 seconds** by pressing either the up or down arrow key. *Note: Once you see something on the screen it is thereby set. There is no 'enter' key needed.*

4. Fill a 5 gallon bucket with water from stream. Insert the velocity probe into bucket **keeping it at least 3 inches away from the sides and bottom of the bucket**. To make sure the water and probe are motionless, **wait 10 minutes** after you have positioned the sensor before taking any zero readings. **Clear the meter reading by pressing the On/C key** and check for zero reading (no flow should be going on in bucket, thus zero reading). Based on a rC filter value of 5 seconds, **zero stability is +/- 0.05 ft/sec**. If the reading is outside of this range, see the manual for "Zero Adjust" procedures.

Quality Control/Quality Assurance:

For quality assurance purposes, duplicate analyses are required on at least ten percent (10%) of all incremental velocity/depth measurement groups collected as part of each flow measurement event. For every set of 10 increments where velocity and depth are recorded, duplicate the velocity and depth measurements for one full group *($D_{beginning}$, D_{middle}, D_{end}, and V_{middle})* and record them on the worksheet. Quality control shall be based on a comparison of flows calculated for each group (Velocity x Area of increment where the area is equal to the average of the depths at the beginning and end of the increment times the width of the increment) and should be less than 10%. If greater than 10%, repeat the measurements and recalculate the flow.

Standard Operating Procedure for Stream Flow Determinations and Use of Temporary Staff Gages
Revision Number: **3**
Effective Date: **September 5, 2012**

Incases where the best possible site has low velocities, this may not be possible. The flow for an increment may be calculated using the following equation:

$$\text{Flow for an increment (cfs)} = \text{Velocity (ft/sec)} \times \text{Increment Width (ft)} \times \frac{[D_b + D_m + D_e]\ \text{(ft)}}{3}$$

Where:

D_b= depth at the beginning of the increment
D_m= depth at the middle of the increment
D_e= depth at the end of the increment.

Measuring Stream Channel Flow:

1. Select an area of the stream in which to measure flow (area near staff gauge is usually selected). Guidelines for site selection include the following:

- The channel should have as much straight run as possible. Where the length is limited, the straight length upstream from the selected location should be twice the downstream straight length.
- The channel should be as free as possible from flow disturbances.
- The flow should be free from swirls, eddies, vortices, backward flow or dead zones.
- Avoid areas immediately downstream from sharp bends or obstructions.
- Avoid converging or diverging flow or vertical drops
- Avoid areas immediately downstream of a sluice gate or where the channel empties into a body of stationary water.
- The stream bottom should be relatively flat and free of obstructions (large rocks, plants). Clear them if necessary.
- Since the meter accuracy is +/- 0.05 ft/sec there should be a minimum of points with velocity less then 0.10 ft/sec. All thawleg measurements should be >>0.10 ft/sec.

2. Measure the width of the stream from bank to bank using a measuring tape. Record the total width of the stream on the worksheet.

3. The goal is to get 20 velocity and therefore 40 depth measurements. Divide the total stream width by 40 and the round down to the nearest foot increment you can easily add in the field. For example, if the stream width is 60 feet, the largest size increment between depth measurements would be 1.5 feet (60/40). If the stream width is 46 feet, the largest size interval between depth measurements would be 2.0 feet (46/40 = 1.15 feet which rounds down to 1.1 feet). For streams of less than 4 feet, use an interval of 0.2 feet between velocity measurements and therefore 0.1 feet between depth measurements. Using the measuring tape, break the stream width into segments at that are no larger than the maximum size interval calculated above.

Standard Operating Procedure for Stream Flow Determinations and Use of Temporary Staff Gages
Revision Number: **3**
Effective Date: **September 5, 2012**

4. Set the meter to record in **feet per second (ft/s)** by pressing down on the ON/C and OFF keys simultaneously until FT/S appears on the display.

5. Set meter reading to **'Fixed Point Average"** by pressing the up and down arrow keys at the same time until the screen shows "**FPA**". In the FPA mode, the meter will display the average of velocities over a fixed period of time. **Set the averaging time to 30 seconds** by pressing either the up or down arrow key.

6. Take a **depth reading at the beginning, middle and end of each increment** across the stream, starting at river right and ending at river left. Record these depths on the flow sheet. Measure the velocity at the midpoints of each increment at the same time its depth is being measured. To do this, attach the velocity probe to either a top-setting or bottom setting rod. **For increments with a depth less than 2 feet at the point where a velocity reading will be taken**, point the velocity probe upstream and position the center of the probe at a depth which is 60% of the way down from the surface of the stream, and 40% of the way above the sediments. When taking velocity measurements, **stand an arm's length away facing perpendicular to the flow, to the side, and downstream of the flow meter.** This is very important to avoid interfering with the velocity measurements. **Clear the display by pressing the ON/C button. Allow one full averaging period to pass. Record the velocity on the flow sheet after the second, 30 seconds averaging periods has elapsed.**

7. In the event that the best possible cross-section contains flow that is not perpendicular to the cross-section apply a degree of deviation correction. For this correction place the meter at the appropriate tape measurement and dept and point the meter directly into the current. Hold the field datasheet so that the line on the left edge of the page is lies on and is parallel to the tape and it is centered at the measurement point on the tape. Project the line created by the probe up into the flow so that it intersects the degree ticks on the upstream edge (right edge while reading) of the page. Record the degree of deviation in the comments on the field data sheet.

8. Move to the middle of the next increment and Step 8. **For increments where the middle depth exceeds 2 feet, take velocity measurements at depths equal to 20 % and 80% from the surface** and record these on the worksheet. Continue until velocity readings are collected for entire stream width.

9. Take a reading off the staff gauge in the stream if available, recording this number in the appropriate column on the field data sheet and the time.

Standard Operating Procedure for Stream Flow Determinations and Use of Temporary Staff Gages
Revision Number: **3**
Effective Date: **September 5, 2012**

20, 60, 80% Depths from Surface Cheat-Sheet

Water Depth	SET PROBE AT THIS MARK ON STADIA ROD FOR:			OR	*Set Vernier Scale to this level for:*		
	60% Depth from surface (ft)	80% Depth from surface (ft)	20% Depth from surface (ft)		*60% Depth from surface (ft)*	*80% Depth from surface (ft)*	*20% Depth from surface (ft)*
0.1	0.04	0.02	0.08		*0.1*	*0.05*	*0.20*
0.2	0.08	0.04	0.16		*0.2*	*0.10*	*0.40*
0.3	0.12	0.06	0.24		*0.3*	*0.15*	*0.60*
0.4	0.16	0.08	0.32		*0.4*	*0.19*	*0.79*
0.5	0.20	0.10	0.40		*0.5*	*0.24*	*0.99*
0.6	0.24	0.12	0.48		*0.6*	*0.29*	*1.19*
0.7	0.28	0.14	0.56		*0.7*	*0.34*	*1.39*
0.8	0.32	0.16	0.64		*0.8*	*0.39*	*1.59*
0.9	0.36	0.18	0.72		*0.9*	*0.44*	*1.79*
1.0	0.40	0.20	0.80		*1.0*	*0.48*	*1.99*
1.1	0.44	0.22	0.88		*1.1*	*0.53*	*2.18*
1.2	0.48	0.24	0.96		*1.2*	*0.58*	*2.38*
1.3	0.52	0.26	1.04		*1.3*	*0.63*	*2.58*
1.4	0.56	0.28	1.12		*1.4*	*0.68*	*2.78*
1.5	0.60	0.30	1.20		*1.5*	*0.73*	*2.98*
1.6	0.64	0.32	1.28		*1.6*	*0.78*	*3.18*
1.7	0.68	0.34	1.36		*1.7*	*0.82*	*3.38*
1.8	0.72	0.36	1.44		*1.8*	*0.87*	*3.57*
1.9	0.76	0.38	1.52		*1.9*	*0.92*	*3.77*
2.0	0.80	0.40	1.60		*2.0*	*0.97*	*3.97*
2.1	0.84	0.42	1.68		*2.1*	*1.02*	*4.17*
2.2	0.88	0.44	1.76		*2.2*	*1.07*	*4.37*
2.3	0.92	0.46	1.84		*2.3*	*1.12*	*4.57*
2.4	0.96	0.48	1.92		*2.4*	*1.16*	*4.77*
2.5	1.00	0.50	2.00		*2.5*	*1.21*	*4.96*
2.6	1.04	0.52	2.08		*2.6*	*1.26*	*5.16*
2.7	1.08	0.54	2.16		*2.7*	*1.31*	*5.36*
2.8	1.12	0.56	2.24		*2.8*	*1.36*	*5.56*
2.9	1.16	0.58	2.32		*2.9*	*1.41*	*5.76*
3.0	1.20	0.60	2.40		*3.0*	*1.45*	*5.96*
3.1	1.24	0.62	2.48		*3.1*	*1.50*	*6.16*
3.2	1.28	0.64	2.56		*3.2*	*1.55*	*6.35*
3.3	1.32	0.66	2.64		*3.3*	*1.60*	*6.55*
3.4	1.36	0.68	2.72		*3.4*	*1.65*	*6.75*
3.5	1.40	0.70	2.80		*3.5*	*1.70*	*6.95*
3.6	1.44	0.72	2.88		*3.6*	*1.75*	*7.15*
3.7	1.48	0.74	2.96		*3.7*	*1.79*	*7.35*
3.8	1.52	0.76	3.04		*3.8*	*1.84*	*7.55*
3.9	1.56	0.78	3.12		*3.9*	*1.89*	*7.74*
4.0	1.60	0.80	3.20		*4.0*	*1.94*	*7.94*

Standard Operating Procedure for Stream Flow Determinations and Use of Temporary Staff Gages
Revision Number: **3**
Effective Date: **September 5, 2012**

Increments for Stream Widths Cheat-Sheet

Stream Width (ft) [Round your stream width down]	Increment Between Velocity Measurements (ft)	Increment Between Depth Measurements (ft)
1	0.2	0.1
2	0.2	0.1
3	0.2	0.1
4	0.2	0.1
5	0.25	0.125
6	0.3	0.15
7	0.35	0.175
8	0.4	0.2
9	0.45	0.225
10	0.5	0.25
11	0.55	0.275
12	0.6	0.3
13	0.65	0.325
14	0.7	0.35
15	0.75	0.375
16	0.8	0.4
17	0.85	0.425
18	0.9	0.45
19	0.95	0.475
20	1	0.5
21	1.05	0.525
22	1.1	0.55
23	1.15	0.575
24	1.2	0.6
25	1.25	0.625
26	1.3	0.65
27	1.35	0.675
28	1.4	0.7
29	1.45	0.725
30	1.5	0.75
31	1.55	0.775
32	1.6	0.8
33	1.65	0.825
34	1.7	0.85
35	1.75	0.875
36	1.8	0.9
37	1.85	0.925
38	1.9	0.95
39	1.95	0.975
40	2	1
41	2.05	1.025
42	2.1	1.05
43	2.15	1.075
44	2.2	1.1
45	2.25	1.125

Stream Width (ft) [Round your stream width down]	Increment Between Velocity Measurements (ft)	Increment Between Depth Measurements (ft)
46	2.3	1.15
47	2.35	1.175
48	2.4	1.2
49	2.45	1.225
50	2.5	1.25
51	2.55	1.275
52	2.6	1.3
53	2.65	1.325
54	2.7	1.35
55	2.75	1.375
56	2.8	1.4
57	2.85	1.425
58	2.9	1.45
59	2.95	1.475
60	3	1.5
61	3.05	1.525
62	3.1	1.55
63	3.15	1.575
64	3.2	1.6
65	3.25	1.625
66	3.3	1.65
67	3.35	1.675
68	3.4	1.7
69	3.45	1.725
70	3.5	1.75
71	3.55	1.775
72	3.6	1.8
73	3.65	1.825
74	3.7	1.85
75	3.75	1.875
76	3.8	1.9
77	3.85	1.925
78	3.9	1.95
79	3.95	1.975
80	4	2
81	4.05	2.025
82	4.1	2.05
83	4.15	2.075
84	4.2	2.1
85	4.25	2.125
86	4.3	2.15
87	4.35	2.175
88	4.4	2.2
89	4.45	2.225
90	4.5	2.25

Flow by Velocity Meter Field Worksheet

Revision Number: 5
Effective Date: **August 31, 2012**

Project:________________________________ **Date:**________________________________ **Waterbody Name:**_______________________ **Station ID:** ___________________________ **By (Staff Names):** ______________________ **Meter Serial #** :__________________________ **Total River Width (ft-in)**:__________________ **Benchmark from Waterline:** ______________ (recorded at start time)	**Station Description:**

	Time (Military):	Staff Gauge (feet):
Begin:		
End:		

Distance Readings		Depth (ft)	Velocity (V) Readings (ft/sec)			Comments
			FOR DEPTHS ≤ 2 FT	FOR DEPTHS > 2 FT		
Tape (ft)	Bank (ft)		V @ 60% depth from surface	V @ 20% depth from surface	V@ 80% depth from surface	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	

			>>>>>>>>>>	>>>>>>>>>>	>>>>>>>>>>	Duplicate a group of readings for each 10 velocity readings (i.e. a depth, depth/velocity, depth group) Recorder selects from mid- page.
			>>>>>>>>>>	>>>>>>>>>>	>>>>>>>>>>	

Page ___ of ____

Flow by Velocity Meter Field Worksheet

Revision Number: **5**
Effective Date: **August 31, 2012**

Distance Readings		Depth (ft)	Velocity (V) Readings (ft/sec)			Comments	
Tape (ft)	Bank (ft)		FOR DEPTHS ≤ 2 FT	FOR DEPTHS > 2 FT			
			V @ 60% depth from surface	V @ 20% depth from surface	V@ 80% depth from surface		
>>>>>	>>>>>	>>>>>	>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	>>>>>	
							-5°
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
							5°
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
							15°
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		20°
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		25°
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>	Duplicate a group of readings for each 10 velocity readings (i.e. a depth, depth/velocity, depth group) Recorder selects from mid- page	
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		

(extra cells below for minor overruns)

							-5°
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		
			>>>>>>>>>	>>>>>>>>>	>>>>>>>>>		5°

Page ___ of ____

SOPs attached separately for document size consideration are listed below:

- New Hampshire Department of Environmental Services (NHDES) Protocols for Collection, Identification, Enumeration and Preservation of Freshwater Fishes (NHDES 2022)
- New Hampshire Department of Environmental Services (NHDES) Protocols for Macroinvertebrate Collection, Identification, Enumeration (NHDES 2013).
- Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish (Barbour et al. 1999)
- National Rivers and Streams Assessment 2018/19. Field Operations Manual. (US EPA 2019)

Appendix B: Example Field Data Sheets

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

HABITAT TYPES	**Indicate the percentage of each habitat type present** ❑ Cobble_____% ❑ Snags_____% ❑ Vegetated Banks_____% ❑ Sand_____% ❑ Submerged Macrophytes_____% ❑ Other ( )_____%
SAMPLE COLLECTION	**Gear used** ❑ D-frame ❑ kick-net ❑ Other _____ **How were the samples collected?** ❑ wading ❑ from bank ❑ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ❑ Cobble_____ ❑ Snags_____ ❑ Vegetated Banks_____ ❑ Sand_____ ❑ Submerged Macrophytes_____ ❑ 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	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						
						Culcidae	0	1	2	3	4						

Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition - Form 1

A-25

FISH SAMPLING FIELD DATA SHEET (FRONT)

page _____ of _____

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
GEAR	INVESTIGATORS	
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

SAMPLE COLLECTION	**How were the fish captured?** ❑ back pack ❑ tote barge ❑ other _____ **Block nets used?** ❑ YES ❑ NO **Sampling Duration** Start time _____ End time _____ Duration _____ **Stream width (in meters)** Max_____ Mean_____
HABITAT TYPES	**Indicate the percentage of each habitat type present** ❑ Riffles_____% ❑ Pools_____% ❑ Runs_____% ❑ Snags_____% ❑ Submerged Macrophytes_____% ❑ Other (_____)_____%
GENERAL COMMENTS	

SPECIES	TOTAL (COUNT)	OPTIONAL: LENGTH (mm)/WEIGHT (g) (25 SPECIMEN MAX SUBSAMPLE)					ANOMALIES*							
							D	E	F	L	M	S	T	Z

Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition - Form 1

A-35

FISH SAMPLING FIELD DATA SHEET (BACK)

SPECIES	TOTAL (COUNT)	OPTIONAL: LENGTH (mm)/WEIGHT (g) (25 SPECIMEN MAX SUBSAMPLE)					ANOMALIES*							
							D	E	F	L	M	S	T	Z

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

A-36 *Appendix A-4: Fish Field and Laboratory Data Sheets - Form 1*

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

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ 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 not 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 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 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 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	20 19 18 17 16	15 14 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 11	10 9 8 7 6	5 4 3 2 1 0

Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition - Form 3

A-9

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

Parameters to be evaluated broader than sampling reach

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) 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 ___ (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—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ 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 70% 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 not new fall and not transient).	40-70% 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).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	SCORE	20 19 18 17 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 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% 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 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE	20 19 18 17 16	15 14 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 11	10 9 8 7 6	5 4 3 2 1 0

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

Parameters to be evaluated broader than sampling reach

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. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
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) Note: determine left or right side by facing downstream.	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 _____

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	**Now**		**Past 24 hours**	**Has there been a heavy rain in the last 7 days?** ❑ Yes ❑ No
	❑	storm (heavy rain)	❑	
	❑	rain (steady rain)	❑	**Air Temperature**____ ^{0} C
	❑	showers (intermittent)	❑	
	____%❑	%cloud cover	❑____%	**Other**_____
	❑	clear/sunny	❑	
SITE LOCATION/MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)**			
STREAM CHARACTERIZATION	**Stream Subsystem** ❑ Perennial ❑ Intermittent ❑ Tidal			**Stream Type** ❑ Coldwater ❑ Warmwater
	Stream Origin ❑ Glacial ❑ Non-glacial montane ❑ Swamp and bog	❑ Spring-fed ❑ Mixture of origins ❑ Other_____		**Catchment Area**_____km^2

Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition - Form 1 A-5

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Other _____ ❑ Residential **Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources **Local Watershed Erosion** ❑ None ❑ Moderate ❑ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ❑ Trees ❑ Shrubs ❑ Grasses ❑ Herbaceous **dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** _____m **Estimated Stream Width** _____m **Sampling Reach Area** _____m^2 **Area in km^2 (m^2x1000)** _____km^2 **Estimated Stream Depth** _____m **Surface Velocity (at thalweg)** _____m/sec **Canopy Cover** ❑ Partly open ❑ Partly shaded ❑ Shaded **High Water Mark** _____m **Proportion of Reach Represented by Stream Morphology Types** ❑ Riffle_____% ❑ Run_____% ❑ Pool_____% **Channelized** ❑ Yes ❑ No **Dam Present** ❑ Yes ❑ No
LARGE WOODY DEBRIS	**LWD** _____m^2 **Density of LWD** _____m^2/km^2 **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ❑ Rooted emergent ❑ Rooted submergent ❑ Rooted floating ❑ Free floating ❑ Floating Algae ❑ Attached Algae **dominant species present** _____ **Portion of the reach with aquatic vegetation** _____%
WATER QUALITY	**Temperature**_____^{0} C **Specific Conductance**_____ **Dissolved Oxygen** _____ **pH** _____ **Turbidity** _____ **WQ Instrument Used** _____ **Water Odors** ❑ Normal/None ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Fishy ❑ Other_____ **Water Surface Oils** ❑ Slick ❑ Sheen ❑ Globs ❑ Flecks ❑ None ❑ Other_____ **Turbidity (if not measured)** ❑ Clear ❑ Slightly turbid ❑ Turbid ❑ Opaque ❑ Stained ❑ Other_____
SEDIMENT/ SUBSTRATE	**Odors** ❑ Normal ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Anaerobic ❑ None ❑ Other_____ **Oils** ❑ Absent ❑ Slight ❑ Moderate ❑ Profuse **Deposits** ❑ Sludge ❑ Sawdust ❑ Paper fiber ❑ Sand ❑ Relict shells ❑ Other_____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ❑ Yes ❑ 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)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

NRSA 2018/19 PHAB: THALWEG PROFILE & WOODY DEBRIS - WADEABLE ONLY

Reviewed by (initial): _____

Site ID: _____ Date: ___ / ___ / _____ TRANSECT: O A-B O B-C O C-D O D-E O E-F O F-G O G-H O H-I O I-J O J-K

THALWEG PROFILE

For Transect A-B ONLY: Increment (m) X.X: _____ Total Reach Length (m): _____

STATION	THALWEG DEPTH (cm) (XXX)	WETTED WIDTH (m) (XXX.X)	BAR WIDTH 1 Present	BAR WIDTH 1 XX.X	SOFT /SMALL SEDIMENT	CHANNEL UNIT CODE	SIDE CHANNEL	BACK WATER	THALWEG PROFILE COMMENTS
0									
1									
2									
3									
4									
*5									
6									
*7									
8									
9									
10									
11									
12									
13									
14									

CHANNEL UNIT CODES: PO = Pool GL = Glide RI = Riffle RA = Rapid CA = Cascade FA = Falls DR = Dry

SUBSTRATE

Station (5 or 7) _____ LFT _____ LCTR _____ CTR _____ RCTR _____ RGT _____ FLAG _____

RS = BEDROCK (SMOOTH) - (LARGER THAN A CAR)
RR = BEDROCK (ROUGH) - (LARGER THAN A CAR)
RC = CONCRETE/ASPHALT
XB = LG. BOULDER (1000 TO 4000 mm) - METERSTICK TO CAR)
SB = SM. BOULDER (250 TO 1000 mm) - BASKETBALL TO METERSTICK)
CB = COBBLE (64 TO 250 mm) - (TENNIS BALL TO BASKETBALL)
GC = COARSE GRAVEL (16 TO 64 mm) - (MARBLE TO TENNIS BALL)
GF = FINE GRAVEL (2 TO 16 mm) - (LADYBUG TO MARBLE)
SA = SAND (0.06 TO 2 mm) - (GRITTY - UP TO LADYBUG SIZE)
FN = SILT/ CLAY / MUCK - (NOT GRITTY)
HP = HARDPAN - (FIRM, CONSOLIDATED FINE SUBSTRATE)
WD = WOOD - (ANY SIZE)
OT = OTHER (FLAG AND EXPLAIN IN COMMENTS)

FLAG	COMMENTS (for SUBSTRATE and LWD)

LARGE WOODY DEBRIS

(10 cm small end diameter; 1.5 m length) FILL IN IF UNMARKED BOXES ARE ZERO ◯ FLAG: _____

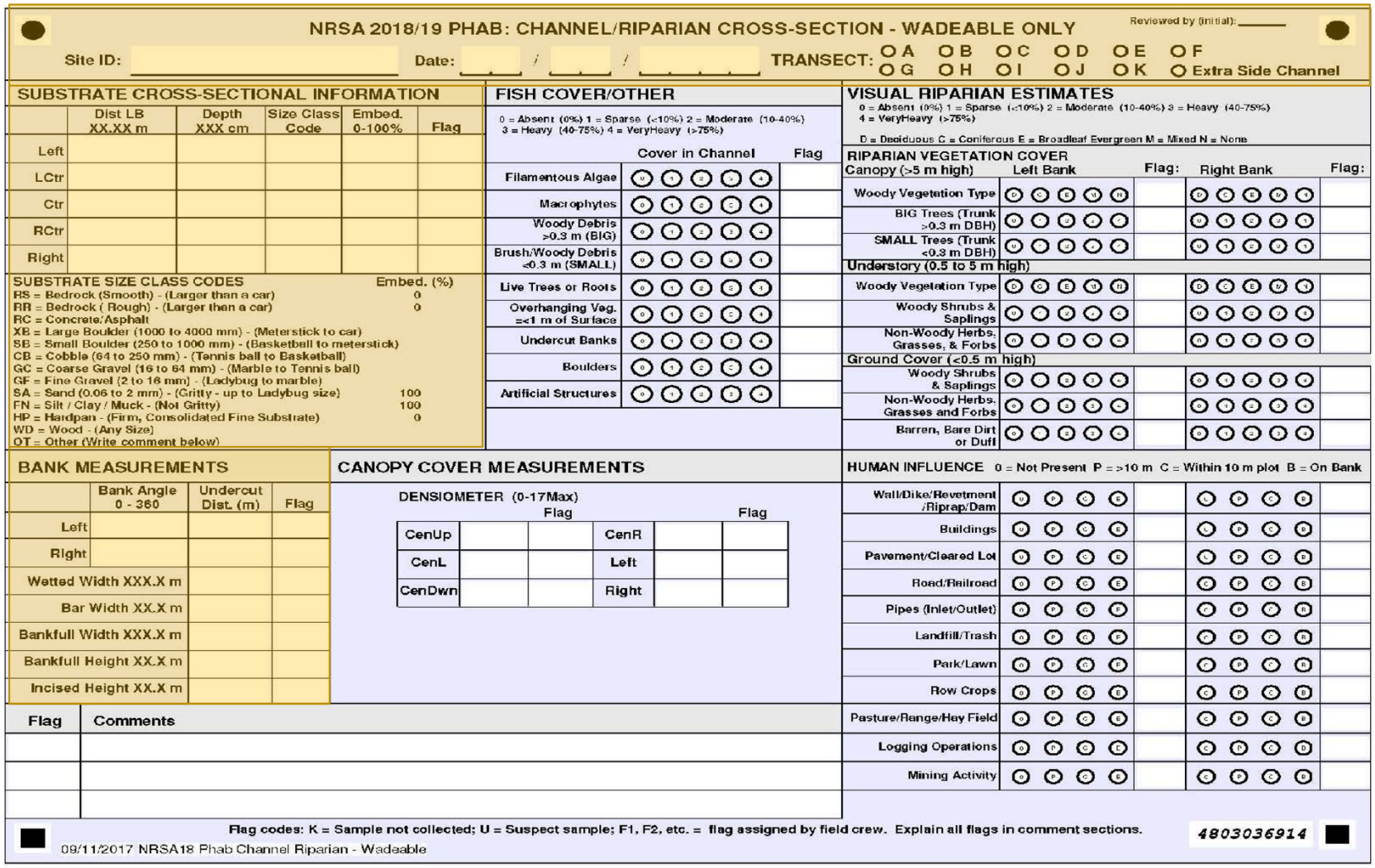
DIAMETER LARGE END	PIECES ALL/PART IN BANKFULL CHANNEL Length 1.5-5m		5-15m		>15m		PIECES BRIDGE ABOVE BANKFULL CHANNEL Length 1.5-5m		5-15m		>15m	
0.1-<0.3 m												
0.3-0.6 m												
0.6-0.8 m												
>0.8 m												

1 = Measure Bar Width at Station 0 and Mid-Station (5 or 7).

Flag Codes: K = no measurement made; U = suspect measurement; F1, F2, etc. = flags assigned by each field crew. Explain all flags in comments.

10/04/2017 NRSA18 Phab Thalweg Profile - Wadeable

6364573600



NRSA 2018/19 PHAB: CHANNEL/RIPARIAN CROSS-SECTION - WADEABLE ONLY

Reviewed by (initial): _____

Site ID: _____ Date: ___ / ___ / _____ TRANSECT: ○A ○B ○C ○D ○E ○F ○G ○H ○I ○J ○K ○ Extra Side Channel

SUBSTRATE CROSS-SECTIONAL INFORMATION

	Dist LB XX.XX m	Depth XXX cm	Size Class Code	Embed. 0-100%	Flag
Left					
LCtr					
Ctr					
RCtr					
Right					

SUBSTRATE SIZE CLASS CODES Embed. (%)

RS = Bedrock (Smooth) - (Larger than a car) 0
RR = Bedrock (Rough) - (Larger than a car) 0
RC = Concrete/Asphalt
XB = Large Boulder (1000 to 4000 mm) - (Meterstick to car)
SB = Small Boulder (250 to 1000 mm) - (Basketball to meterstick)
CB = Cobble (64 to 250 mm) - (Tennis ball to Basketball)
GC = Coarse Gravel (16 to 64 mm) - (Marble to Tennis ball)
GF = Fine Gravel (2 to 16 mm) - (Ladybug to marble)
SA = Sand (0.06 to 2 mm) - (Gritty - up to Ladybug size) 100
FN = Silt / Clay / Muck - (Not Gritty) 100
HP = Hardpan - (Firm, Consolidated Fine Substrate) 0
WD = Wood - (Any Size)
OT = Other (Write comment below)

FISH COVER/OTHER

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = VeryHeavy (>75%)

	Cover in Channel	Flag
Filamentous Algae	○0 ○1 ○2 ○3 ○4	
Macrophytes	○0 ○1 ○2 ○3 ○4	
Woody Debris >0.3 m (BIG)	○0 ○1 ○2 ○3 ○4	
Brush/Woody Debris <0.3 m (SMALL)	○0 ○1 ○2 ○3 ○4	
Live Trees or Roots	○0 ○1 ○2 ○3 ○4	
Overhanging Veg. =<1 m of Surface	○0 ○1 ○2 ○3 ○4	
Undercut Banks	○0 ○1 ○2 ○3 ○4	
Boulders	○0 ○1 ○2 ○3 ○4	
Artificial Structures	○0 ○1 ○2 ○3 ○4	

VISUAL RIPARIAN ESTIMATES

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = VeryHeavy (>75%)

D = Deciduous C = Coniferous E = Broadleaf Evergreen M = Mixed N = None

RIPARIAN VEGETATION COVER

Canopy (>5 m high)	Left Bank	Flag:	Right Bank	Flag:
Woody Vegetation Type	○0 ○C ○E ○M ○N		○0 ○C ○E ○M ○N	
BIG Trees (Trunk >0.3 m DBH)	○0 ○1 ○2 ○3 ○4		○0 ○1 ○2 ○3 ○4	
SMALL Trees (Trunk <0.3 m DBH)	○0 ○1 ○2 ○3 ○4		○0 ○1 ○2 ○3 ○4	
Understory (0.5 to 5 m high)				
Woody Vegetation Type	○0 ○C ○E ○M ○N		○0 ○C ○E ○M ○N	
Woody Shrubs & Saplings	○0 ○1 ○2 ○3 ○4		○0 ○1 ○2 ○3 ○4	
Non-Woody Herbs, Grasses, & Forbs	○0 ○1 ○2 ○3 ○4		○0 ○1 ○2 ○3 ○4	
Ground Cover (<0.5 m high)				
Woody Shrubs & Saplings	○0 ○1 ○2 ○3 ○4		○0 ○1 ○2 ○3 ○4	
Non-Woody Herbs, Grasses and Forbs	○0 ○1 ○2 ○3 ○4		○0 ○1 ○2 ○3 ○4	
Barren, Bare Dirt or Duff	○0 ○1 ○2 ○3 ○4		○0 ○1 ○2 ○3 ○4	

BANK MEASUREMENTS

	Bank Angle 0 - 360	Undercut Dist. (m)	Flag
Left			
Right			
Wetted Width XXX.X m			
Bar Width XX.X m			
Bankfull Width XXX.X m			
Bankfull Height XX.X m			
Incised Height XX.X m			

CANOPY COVER MEASUREMENTS

DENSIOMETER (0-17Max)

		Flag			Flag
CenUp			CenR		
CenL			Left		
CenDwn			Right		

HUMAN INFLUENCE 0 = Not Present P = >10 m C = Within 10 m plot B = On Bank

		Flag		Flag
Wall/Dike/Revetment /Riprap/Dam	○0 ○P ○C ○B		○0 ○P ○C ○B	
Buildings	○0 ○P ○C ○B		○0 ○P ○C ○B	
Pavement/Cleared Lot	○0 ○P ○C ○B		○0 ○P ○C ○B	
Road/Railroad	○0 ○P ○C ○B		○0 ○P ○C ○B	
Pipes (Inlet/Outlet)	○0 ○P ○C ○B		○0 ○P ○C ○B	
Landfill/Trash	○0 ○P ○C ○B		○0 ○P ○C ○B	
Park/Lawn	○0 ○P ○C ○B		○0 ○P ○C ○B	
Row Crops	○0 ○P ○C ○B		○0 ○P ○C ○B	
Pasture/Range/Hay Field	○0 ○P ○C ○B		○0 ○P ○C ○B	
Logging Operations	○0 ○P ○C ○B		○0 ○P ○C ○B	
Mining Activity	○0 ○P ○C ○B		○0 ○P ○C ○B	

Flag	Comments

Flag codes: K = Sample not collected; U = Suspect sample; F1, F2, etc. = flag assigned by field crew. Explain all flags in comment sections.

4803036914

09/11/2017 NRSA18 Phab Channel Riparian - Wadeable

2018 River Water Quality Field Data Sheet

TRIP #_____

STATION ID: _____ **DATE:** _____/_____/ 2018 **SAMPLE TIME:** _____ **CREW:** _____

Time DO Meter turned ON: _____ **Time of DO calibration:** _____ **Genomic Sampling: Total mL per filter:** _____ **(< 480 mL)**

FIELD MEASUREMENTS	
Parameter	Result
Temperature °C	
Dissolved Oxygen (mg/L)	
Dissolved Oxygen (%)	
Specific Conductance (µS/cm)	
pH	
Turbidity (NTU)	

Limno Log In ID: **2018-**_____

Field/Lab Data Validated: _____ By: _____

Data Entered in EMD: _____ By: _____

EMD Data Check: _____ By: _____

EDAS Data Check: By:

LAB PARAMETERS			
Mark "X" if collected			
Cl		Acid Sol Al	
E.coli		Total Al	
TP		Cu	
TKN		Pb	
$NO_2 + NO_3$		Zn	
Chlor-a		Hardness	
TOC		Ca	
Alkalinity		Mg	
SO_4		K	

Meter Precision Check First Station of Sampling Day	
Station ID: _____	Result
Turbidity DI Blank (+/- 0.25 NTU)	
pH 6.0 std (+/- 0.3 units)	
Spec. Cond. 100 µS/cm (+/- 20 µS/cm)	

Meter precision check results should be filled in for all field data sheets for each team's day of sampling.

Meter Precision Check Last Station of Sampling Day	
Station ID: _____	Result
Turbidity DI Blank (+/- 0.25 NTU)	
pH 6.0 std (+/- 0.3 units)	
Spec. Cond. 100 µS/cm (+/- 20 µS/cm)	

ON SITE HANDHELD METER CALIBRATION RECORDS – COMPLETE AT EVERY STATION

Dissolved Oxygen (calibration)		Specific Conductance (verification)			pH (calibration)	Turbidity (verification/calibration)		
DO Calibration Value (%)	DO % Saturation Chamber Reading	2,000 µS/cm std. (+/- 20%)	Needs Calibration Y N	**If Yes:** After Calibration 2,000 µS/cm reading	Calibration Slope (95%-105%)	Initial 1.0 NTU Reading (+/- 0.25 NTU)	Needs Calibration Y N	**If Yes:** After Calibration 1.0 NTU Reading

Appendix C: Water Quality Meter Specifications

ONSET

HOBO® U26-001 Data Logger

Dissolved Oxygen

Measure oxygen concentrations in lakes, streams, rivers, estuaries, and coastal waters with the HOBO U26 Dissolved Oxygen Data Logger. This affordable and precise data logger is recommended for aquatic biology and hydrology research projects. The HOBO U26 uses RDO® Basic (Rugged Dissolved Oxygen) optical DO sensor technology and is easy to maintain.

Includes:

U26-001 data logger DO sensor cap Protective Guard
Calibration Boot with sponge

The HOBO U26 Dissolved Oxygen logger was part of a multi-year evaluation of DO loggers and sensors by the Alliance for Coastal Technologies (ACT), the results of which are published here. This un-biased report describes how the HOBO U26 performs in lab and field conditions. Note that our response letter, with added recommendations, is attached at the end of the report (pgs 58-59).

Key Advantages:

- Affordable, high performance dissolved oxygen (DO) monitoring with 0.2 mg/L accuracy
- Optical DO sensor technology for long-lasting calibration with less maintenance
- HOBOware Pro's Dissolved Oxygen Assistant software corrects for measurement drift from fouling; provides salinity-adjusted DO concentrations and percent saturation
- Optical USB interface for high-speed, reliable data offload
- User-replaceable DO sensor cap eliminates need to send logger back to the factory to replace membrane

NOTE: For DO measurements in saltwater, an adjustment for salinity is required. For waters with small changes in salinity (<2 ppt), a salinity meter reading typically provides enough accuracy. For environments with greater salinity changes, we generally recommend the HOBO U24-002-C conductivity logger . If you need DO in Percent Saturation, barometric pressure data is required, which can be logged with a HOBO Water Level Data Logger (U20-001-04).

HOBO U26-001 Data Logger Specifications

Dissolved Oxygen	
Sensor Type:	Optical
Measurement Range:	0 to 30 mg/L
Calibrated Range:	0 to 20 mg/L; 0 to 35°C (32 to 95°F)
Accuracy:	± 0.2 mg/L up to 8 mg/L; ± 0.5 mg/L from 8 to 20 mg/L
Resolution:	0.02 mg/L
Response Time:	To 90% in less than 2 minutes
DO Sensor Cap Life:	6 months, cap expires 7 months after initialization
Temperature	
Temperature Measurement/Operating Range:	-5 to 40°C (23 to 104°F); non-Freezing
Temperature Accuracy:	0.2°C (0.36°F)
Temperature Resolution:	0.02°C (0.04°F)
Response Time:	To 90% in less than 30 minutes
Logger	
Memory:	21,700 sets of DO and temperature measurements (64 KB total memory)
Logging Rate:	1 minute to 18 hours
Time Accuracy:	±1 minute per month at 0 to 50°C (32 to 122°F)
Battery:	3.6 V lithium battery; factory replaceable
Battery Life:	3 years (at 5 minute logging)
Download Type:	Optical
Depth Rating:	100 m (328 ft)
Buoyancy:	Salt water: 13 g (0.46 oz) negative | Fresh water: 20 g (0.71 oz) negative
Wetted Materials:	Black Delrin®, PVC, EPDM o-rings, silicone bronze screws; rated for saltwater use
Size:	39.6 mm diameter x 266.7 mm length (1.56 x 10.5 inches)
Weight:	272.4 g (9.61 oz)
Environmental Rating:	IP68
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).

Contact Us

Sales (8am to 5pm ET, Monday through Friday)
- Email sales@onsetcomp.com
- Call 1-508-759-9500
- In U.S. toll free 1-800-564-4377
- Fax 1-508-759-9100

Technical Support (8am to 6pm ET, Monday through Friday)
- Contact Product Support www.onsetcomp.com/support/contact
- Call 1-508-759-9500
- In U.S. toll free 1-877-564-4377

Onset Computer Corporation
470 MacArthur Boulevard
Bourne, MA 02532

ONSET

HOBO® MX2501 Data Logger

pH and Temperature Data Logger

The HOBO MX2501 pH and Temperature Data Logger is designed for long-term monitoring of pH in estuaries, lakes, streams, rivers, and oceans. Leveraging Bluetooth Low Energy® (BLE) technology, the MX2501 pH Logger communicates wirelessly with the free HOBOconnect app and your mobile device, making logger setup, calibration, and data offload quick and easy. A guided pH calibration process on the HOBOconnect app makes an otherwise complicated process easier to follow. This affordable and compact logger dramatically cuts the time and effort needed to collect field data, while also offering higher resolution data. (NOTE: pH electrodes should always be stored in storage solution when not deployed.)

You can download the HOBOconnect app here:

Key Advantages:

- Guided pH calibration following on-screen prompts in HOBOconnect app
- Rugged PVC housing for deployment in both freshwater and saltwater environments
- Quick and easy data offload via Bluetooth Low Energy (BLE) to iOS and Android devices
- Water detection system for longer battery life and less maintenance
- Potentiometric pH electrode with plastic body, gel electrolyte, and double cloth junction
- User-replaceable battery, pH electrode, and anti-biofouling copper guard
- Accuracy of ±0.10 pH units within ±10°C of temperature at calibration

HOBO MX2501 Data Logger Specifications

pH Sensor		
	pH	**mV**
Range	2.00 to 12.00 pH	-512 to 512 mV
Accuracy	±0.10 pH units within ±10°C of temperature at calibration	±0.20 mV
Resolution	0.01 pH	0.02 mV
Response Time	1 minute typical to 90% at constant temperature in stirred water	
Sample Ionic Strength	≥ 100 µS/cm	
Temperature Sensor		
Range	-2° to 50°C (28.4° to 122°F)	
Accuracy	±0.2°C (±0.36°F)	
Resolution	0.024°C at 25°C (0.04°F at 77°F)	
Response Time	7 minutes typical to 90% in stirred water	
Logger		
Operating Range	-2° to 50°C (28.4° to 122°F) — non-freezing	
Buoyancy	Fresh water: 13.6 g (0.48 oz) negative Salt water: 19.6 g (0.69 oz) negative	
Waterproof	To 40 m (131.2 ft)	
Water Detection	Water conductivity level of 100 µS/cm or greater is necessary for reliable detection of water. Deionized water or water below 100 µS/cm may not be detected. The water conductivity circuit may not reliably detect water that has frozen around the electrodes, i.e. below 0°C (32°F).	
Radio Power	1 mW (0 dBm)	
Transmission Range	Approximately 30.5 m (100 ft) line-of-sight in air	
Wireless Data Standard	Bluetooth Low Energy (Bluetooth Smart)	
Logging Rate	1 second to 18 hours	
Logging Modes	Fixed interval (normal, statistics) or burst	
Memory Modes	Wrap when full or stop when full	
Start Modes	Immediate, push button, date & time, or next interval	
Stop Modes	When memory is full, push button, date & time, or after a set logging period	
Time Accuracy	±1 minute per month 0° to 50°C (32° to 122°F)	
Battery Type	One AA 1.5 Volt, user-replaceable	
Battery Life	1 year typical at 25°C (77°F) with logging interval of 1 minute and Bluetooth Always On selected in software. 2 years typical at 25°C (77°F) with logging interval of 1 minute and Bluetooth Off Water Detect enabled in software. 3 years typical at 25°C (77°F) with logging interval of 1 minute and Bluetooth Always Off selected in software. Faster logging intervals and statistics sampling intervals, burst logging, remaining connected with the app, excessive downloads, and paging may impact battery life.	
pH Electrode Typical Minimum Life	6 months in sample with ionic strength ≥ 100 µS/cm	
Memory	152 KB (43,300 measurements, maximum)	
Full Memory Download Time	Approximately 60 seconds; may take longer the farther the mobile device is from the logger	
Dimensions	22.86 x 4.27 cm (9.0 x 1.68 inches); mounting hole 0.64 cm (0.25 inches)	
Weight	268.2 g (9.46 oz)	
Wetted Materials	Logger: PVC housing and sensor end cap, polycarbonate closure caps and mounting end cap with a TPE switch pH electrode: plastic-bodied with Pellon® junctions and gel electrolyte, glass pH sensor bulb	

Environmental Rating	IP68
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).
FC	

Contact Us

Sales (8am to 5pm ET, Monday through Friday)
- Email sales@onsetcomp.com
- Call 1-508-759-9500
- In U.S. toll free 1-800-564-4377
- Fax 1-508-759-9100

Technical Support (8am to 6pm ET, Monday through Friday)
- Contact Product Support www.onsetcomp.com/support/contact
- Call 1-508-759-9500
- In U.S. toll free 1-877-564-4377

Onset Computer Corporation
470 MacArthur Boulevard
Bourne, MA 02532

ONSET

HOBO® U20-001-02-Ti Data Logger

100-Foot Depth Water Level

The HOBO Water Level Titanium is recommended for saltwater deployment for recording water levels and temperatures in wetlands and tidal areas. This data logger features high accuracy at a great price and HOBO ease-of-use, with no cumbersome vent tubes or desiccants to maintain.

Helpful Links:

Sensor location drawing
Barometric Pressure Compensation Assistant Demo
Multi-rate Sampling Demo

Key Advantages:

- Lightning protection - no long signal wires, and electronics are shielded in a titanium housing for use in saltwater (see the Water Level logger sensor location drawing)
- HOBOware Pro software provides easy conversion to accurate water level reading, fully compensated for barometric pressure (see demo) temperature, and water density.
- Multiple-rate sampling (see demo) allows faster sampling at critical times such as when pumping starts or stops.
- Available in 4 depth ranges
- Ideal for use in wells, streams, lakes, wetlands and tidal areas
- No-vent-tube design for easy reliable deployment
- Available in stainless and titanium versions
- Durable ceramic pressure sensor
- 3-point NIST-traceable calibration certificate included

www.onsetcomp.com • 1-800-LOGGERS (564-4377)

HOBO U20-001-02-TI Data Logger Specifications

Pressure and Water Level Measurements U20-001-02 and U20-001-02-TI	
Operation Range	0 to 400 kPa (0 to 58 psia); approximately 0 to 30.6 m (0 to 100 ft) of water depth at sea level, or 0 to 33.6 m (0 to 111 ft) of water at 3,000 m (10,000 ft) of altitude
Factory Calibrated Range	69 to 400 kPa (10 to 58 psia), 0° to 40°C (32° to 104°F)
Burst Pressure	500 kPa (72.5 psia) or 40.8 m (134 ft) depth
Water Level Accuracy*	Typical error: ±0.05% FS, 1.5 cm (0.05 ft) water Maximum error: ±0.1% FS, 3 cm (0.1 ft) water
Raw Pressure Accuracy**	±0.3% FS, 1.20 kPa (0.17 psi) maximum error
Resolution	<0.04 kPa (0.006 psi), 0.41 cm (0.013 ft) water
Pressure Response Time (90%)***	<1 second; measurement accuracy also depends on temperature response time
Temperature Measurements (All Models)	
Operation Range	-20° to 50°C (-4° to 122°F)
Accuracy	±0.44°C from 0° to 50°C (±0.79°F from 32° to 122°F), see Plot A in manual
Resolution	0.10°C at 25°C (0.18°F at 77°F), see Plot A in manual
Response Time (90%)	5 minutes in water (typical)
Stability (Drift)	0.1°C (0.18°F) per year
Logger	
Real-time Clock	± 1 minute per month 0° to 50°C (32° to 122°F)
Battery	2/3 AA, 3.6 Volt lithium, factory-replaceable
Battery Life (Typical Use)	5 years with 1 minute or greater logging interval
Memory (Non-volatile)	64K bytes memory (approx. 21,700 pressure and temperature samples)
Weight	Stainless steel models: approximately 210 g (7.4 oz) Titanium models: approximately 140 g (4.8 oz)
Dimensions	2.46 cm (0.97 inches) diameter, 15 cm (5.9 inches) length; mounting hole 6.3 mm (0.25 inches) diameter
Wetted Materials	Titanium, Viton® o-rings, acetyl cap, ceramic sensor
Logging Interval	Fixed-rate or multiple logging intervals, with up to 8 user-defined logging intervals and durations; logging intervals from 1 second to 18 hours. Refer to the HOBOware software manual.
Launch Modes	Immediate start and delayed start
Offload Modes	Offload while logging; stop and offload
Battery Indication	Battery voltage can be viewed in status screen and optionally logged in datafile. Low battery indication in datafile.
Environmental Rating	IP68
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).

* Water Level Accuracy: With accurate reference water level measurement, known water density, accurate Barometric Compensation Assistant data, and a stable temperature environment.

** Raw Pressure Accuracy: Absolute pressure sensor accuracy includes all sensor drift, temperature, and hysteresis-induced errors.

*** Changes in Temperature: Allow 10 minutes in water to achieve full temperature compensation of the pressure sensor. Maximum error due to rapid thermal changes is approximately 0.5%.

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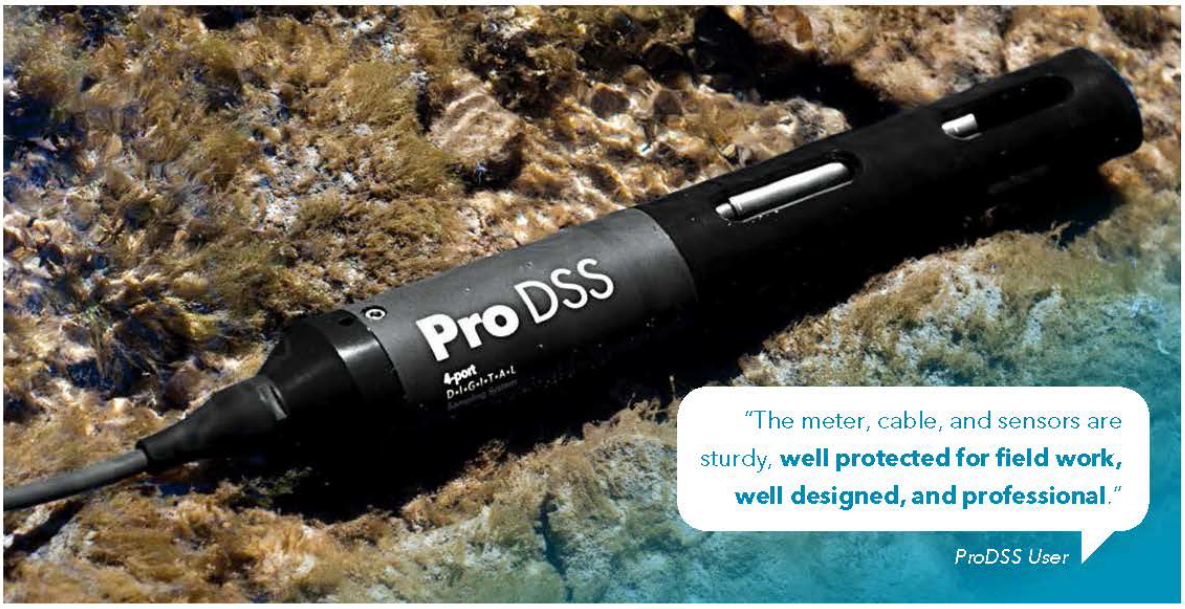
- In U.S. toll free 1-877-564-4377

Onset Computer Corporation
470 MacArthur Boulevard
Bourne, MA 02532

ProDSS General Specifications

Auto Stable	User-defined auto-stable function holds stable readings on display when criteria is met
Buffer Recognition	Auto buffer recognition and temperature compensation for US and NIST buffers
Cable Connector	MS (military spec) waterproof with bayonet lock
Calibration Points	1, 2, or 3 point for pH, Turbidity, Ammonium, Nitrate, and Chloride; 1 or 2 point for DO; 1 point for ORP, Barometer, Conductivity, Specific Conductance, Salinity, and Depth
Certifications	CE; RoHS; IP-67; WEEE; FCC; UN Part III, Section 38.3, Test methods for lithium-ion batteries (Class 9)
Connectivity	Built-in micro USB; Cable for PC connection and cable for connection to USB memory stick are included
Data Management	KorDSS desktop software included; 100 user-defined Data ID tags and 100 Sites with GPS coordinates
Data Memory	>100000 data sets (data, date, time, user-defined info); 100 files
Dimensions	Handheld is 8.3 x 21.6 x 5.6 cm
Display	Color, LCD graphic display; 3.9 x 6.5 cm
GLP Compliance	Yes; 400 detailed GLP records can be stored and are available to view, download and print
GPS	Optional internal GPS; coordinates are stored with measurement data and site lists
Languages	English, Spanish, German, French, Italian, Norwegian, Portuguese, Japanese, Chinese (Simplified & Traditional), Korean, Thai
Logging Modes	Single Point or Continuous
Operating Temperature	0 to 50° C
Password Protection	Calibration menu can be password protected to prevent unauthorized sensor calibration
Battery	Rechargeable lithium-ion battery pack provides ~20 hours with the handheld, 4 port cable and 4 smart sensors; battery recharge time is ~9 hours with the AC power adapter
Storage Temperature	0 to 45° C with battery installed; 0 to 60° C without battery installed
Recalibration Prompt	Provides reminder to recalibrate a ProDSS sensor after user-defined number of days
User ID	Optional user ID for data security
USB Port	Built-in micro USB On-The-Go port for PC connection, recharging/powering the ProDSS and connecting directly to a USB stick
Warranty	3-year; 2-year bulkhead, cable assembly, sensors; and ODO Extended Warranty cap; 1-year pH and pH/ORP sensor modules, ODO sensor caps, and Li-ion battery pack; 6-months ammonium, nitrate, and chloride sensor modules
Waterproof	IP-67; floats
Weight with Batteries (handheld)	567 grams (1.25 lbs)



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ProDSS Sensor Specifications

Sensor/Parameter	Range	Resolution	Accuracy
Temperature	-5 to 70 °C (temperature compensation range for DO mg/L measurement: -5 to 50 °C)	0.1 °C or 0.1 °F (user selectable)	±0.2 °C
pH	0 to 14 pH units	0.01 pH units	±0.2 pH units
ORP	-1999 to 1999 mV	0.1 mV	±20 mV
Dissolved Oxygen	0 to 500%, 0 to 50 mg/L	0.01 mg/L and 0.1%, or 0.1 mg/L and 1% (user selectable)	0 to 200%: ±1% of reading or 1% saturation, whichever is greater 200 to 500%: ±8% of reading 0 to 20 mg/L: ±0.1 mg/L or 1% of reading, whichever is greater 20 to 50 mg/L: ±8% of reading
Barometer	375 to 825 mmHg	0.1 mmHg	±1.5 mmHg from 0 to 50 °C
Conductivity	0 to 200 mS/cm	0.001, 0.01 or 0.1 µS/cm (range dependent)	0 - 100 mS/cm: ±0.5% of reading or .001 mS/cm, whichever is greater 100 - 200 mS/cm: ±1.0% of reading
Specific Conductance*	0 to 200 mS/cm	0.001, 0.01, 0.1 mS/cm	0 - 100 mS/cm: ±0.5% of reading or .001 mS/cm, whichever is greater 100 - 200 mS/cm: ±1.0% of reading. User selectable reference temperature (15 to 25 °C; default 25 °C) and compensation coefficient (0 to 4%/°C; default 1.91%)
Salinity*	0 to 70 ppt	0.01 ppt	±1.0% of reading or ±0.1 ppt, whichever is greater
Total Dissolved Solids (TDS)*	0 to 100 g/L	0.001, 0.01, 0.1 g/L	Calculated from specific conductance and a user-selectable TDS multiplier (0.30 to 1.00; default 0.65)
Resistivity*	0 to 2 Mohms	0.001, 0.01, 0.1 ohms	±0.1% Full Scale
Seawater Density*	0.0 to 50.0 sigma, sigma T	0.1 sigma or sigma T	-
Turbidity	0 to 4000 FNU	0.1 FNU	0 to 999 FNU: 0.3 FNU or ±2% of reading, whichever is greater 1000 to 4000 FNU: ±5% of reading
TAL-Chlorophyll	0 to 100 RFU or 0 to 400 µg/L chl	0.01 RFU or 0.01 µg/L	Linearity: $r^2 \geq 0.999$ for Rhodamine WT across full range
TAL-Phycocyanin	0 to 100 RFU or 0 to 400 µg/L PC		
TAL-Phycoerythrin	0 to 100 RFU or 0 to 400 µg/L PE		
Ammonium**	0 to 200 mg/L NH_4-N	0.01 mg/L	±10% of reading or 2 mg/L, whichever is greater
Ammonia*	0 to 200 mg/L NH_3-N	0.01 mg/L	-
Chloride**	0 to 18000 mg/L Cl	0.01 mg/L	±15% of reading or 5 mg/L, whichever is greater
Nitrate**	0 to 200 mg/L NO_3-N	0.01 mg/L	±10% of reading or 2 mg/L, whichever is greater
Depth	0 to 328 feet (0 to 100 m)	0.001 m or 0.01 ft	±0.004 m for 1, 4, and 10 m cables ±0.04 m for cables 20 m and longer

*Derived/calculated parameter
**ISEs for freshwater only; 20-meter maximum depth

9

Appendix D: Laboratory Chain of Custody

NELSON ANALYTICAL, LLC
490 E. Industrial Park Dr. Manchester, NH 03103
(603) 622-0200 phone (603) 666-0055 fax

SAMPLE SUBMISSION FORM

Page 1 of 1

CUSTOMER INFORMATION Sample Submitted by:		SAMPLE TYPE	REQUESTED TESTING							
Company Name		DW - Drinking Water GW – Ground Water SW – Surface Water S – Soil WW – wastewater O – Other								LABORATORY SAMPLE I.D. NUMBER (LAB USE)
Address										
Contact Person										
Phone / Fax Number										
PROJECT/SITE										

Sample Date	Sample Time	Sample Description / Identification	Sampled by Initials								

Relinquished By *(signature)*	Date	Time	Received By *(signature)*

Rec'd at Laboratory by:	Temp	Date	Time

Remarks: In Cooler? Y N On Ice? Y N Cl2: Pos Neg NA Lab Containers Types: TC Min 40ml Radon 40 mls HCL LC SOC Set IOC Set HAA5 Set

The laboratory reserves the right to subcontract testing at their discretion

Appendix E: Normandeau Health and Safety Plan (provide as needed)

Appendix F: New Hampshire Fish and Game Scientific Collection Permits

New Hampshire
Fish and Game Department

11 Hazen Drive, Concord, NH 03301-6500
Headquarters: (603) 271-3421
Website: www.WildNH.com

TDD Access: Relay NH 1-800-735-2964
Fax: (603) 271-1438
Email: info@wildlife.nh.gov

Scott R. Mason
Executive Director

SCIENTIFIC LICENSE #F2022-79

July 18, 2022

TO WHOM IT MAY CONCERN:

Under the authority contained in RSA 214:29, permission is hereby granted to **Sean Stimmell, Fisheries Biologist, Normandeau Associates, Inc**., **25 Nashua Rd, Bedford, NH 03110**, Tel. 603-637-1128, to collect fish and macroinvertebrates as part of a landfill impact study.

Time of collection: July 1 – September 30, 2022

Collection sites: Hatch/Alder Brook, Dalton, NH

Target species and numbers to be taken or possessed: Fish and macroinvertebrates

Method of collection: Backpack electrofishing (fish), kick nets and rock baskets (macros)

Final disposition of specimens collected: All fish released alive after processing, all macros retained in ethanol for lab ID.

Subpermittees: Tyler Parent

This permit, or a copy, shall be carried with the permittees while engaged in any activity allowed under this permit and shall be displayed to any New Hampshire Fish and Game Department Conservation Officer or employee upon request.

This permit shall expire December 31, 2022 unless sooner revoked or rescinded.
A report of specimens collected/processed shall be submitted to the Executive Director by January 31, 2023.

Scott R. Mason
Executive Director

SM/srd

cc: Law Enforcement Division
Inland Fisheries Division

New Hampshire
Fish and Game Department

11 Hazen Drive, Concord, NH 03301-6500
Headquarters: (603) 271-3421
Website: www.WildNH.com

TDD Access: Relay NH 1-800-735-2964
Fax: (603) 271-1438
Email: info@wildlife.nh.gov

Scott R. Mason
Executive Director

SCIENTIFIC LICENSE #F2023-78

May 18, 2023

TO WHOM IT MAY CONCERN:

Under the authority contained in RSA 214:29, permission is hereby granted to **Sean Stimmell, Fisheries Biologist, Normandeau Associates, Inc., 25 Nashua Rd, Bedford, NH 03110**, Tel. 603-637-1128, to collect fish and macroinvertebrates as part of a landfill impact study.

Time of collection: Late May – October 21, 2023

Collection sites: Hatch/Alder Brook and their tributaries, and several vernal pools and wetlands in Dalton, NH

Target species and numbers to be taken or possessed: Fish and macroinvertebrates

Method of collection: Backpack electrofishing (fish), kick nets and rock baskets (macros). The Permittee shall make a concerted effort to avoid dislodging amphibian egg masses from structures to which they may be attached (i.e., submerged sticks or vegetation).

Final disposition of specimens collected: All fish released alive after identification, measuring and weighing (some will be photographed), all macroinvertebrates retained in ethanol for lab ID.

Subpermittees: Rob Grenier, Christian Gagne, Tyler Parent

This permit, or a copy, shall be carried with the permittees while engaged in any activity allowed under this permit and shall be displayed to any New Hampshire Fish and Game Department Conservation Officer or employee upon request.

This permit shall expire December 31, 2023 unless sooner revoked or rescinded.
A report of specimens collected/processed shall be submitted to the Executive Director by January 31, 2024.

Scott R. Mason
Executive Director

SM/srd

cc: Law Enforcement Division
Inland Fisheries Division

Appendix G: Selected Station Photographs

Station ABT-1

Station ABT-1 was sampled during 2022 but discontinued as a sampling station during 2023 at the recommendation of NHDES.

Pool selected for long term water quality monitoring (dissolved oxygen, temperature, pH) and discrete water samples.

Upper and Lower bounds for the electrofishing and macroinvertebrate sampling at Station ABT-1. Station ABT-1 starts downstream at approximately where it crosses under Douglas Drive through a culvert and continues upstream to approximately where an old beaver dam creates a barrier and upstream wetland. The left image looks upstream from near the downstream end of the reach while the right image looks downstream from the upper bound of the reach. The reach is approximately 134 meters.

Substrates present at Station ABT-1 varied. Cobble, gravel and sand were present in the riffle sections (left photo) and finer sediments dominated in slower pool segments (right photo). Large portions of this reach had coarse and fine particulate organic matter (CPOM, FPOM) present.

Station ABT-2a

Station ABT-2a was flooded during the fall of 2022 by beaver activity. For 2023, an alternative station was selected lower in the watershed.

The Station ABT-2a long term water quality monitoring location. This stream reach is downstream of Station ABT-1 (below the Douglas Drive culvert) but is within the same stream body. This pool represents one of the few locations deep enough to be used for long term water quality monitoring.

Station ABT-2a looking upstream from the lower bound of the reach (left) and downstream from the upper bound of the reach (right). This lower portion of this reach ends in a wetland area where the stream channel becomes less distinct. The reach runs upstream approximately 50 meters where an old beaver dam creates a barrier and upstream pond. Finer sediment are more prevalent downstream in the open grassy areas while gravel and cobble (along with sand/silt) are more common in the upper, forested, parts of the reach.

Examples of substrate present at Station ABT-2a. The left image shows silt/sand/gravel covered in an organic growth near the long term monitoring station. The right image shows the upstream reach with cobble and boulder embedded in sand/gravel/ and silt.

Station ABT-2b

This station replaces the impounded Station ABT-2b with the intention of maintaining a flowing reach throughout the sampling season.

Station ABT-2b: Approximately 500-meters downstream of the original location and outside of the influence of impoundment by beaver activity. The stream flows downstream into a pond and is approximately 250-meters upstream of the confluence with Alder Brook. The reach upstream contains forested, brush, and open reaches with substrates ranging form sand to gravel, cobble, and boulder.

Beaver activity is prevalent in the stream associated with Station ABT-2b making it impossible to establish a 150-meter reach without incorporating, at minimum, multiple marsh, ponded areas (left image) and marsh channel segments (right image).

Station ABT-3a (intermittent stream)

Sampling will occur as possible here during 2023.

Station ABT-3a during a July 7, 2022, visit. No long term monitoring station was established here as wetted substrates and standing pools represented the only surface water present at this location.

Station ABT-3a during August 11-13, 2022. No flow was present in the reach although wetted substrates and remnant pool were present.

Station ABT-3a during an October 7, 2022, visit showed some flow within the channel and more surface water, primarily in pools, than during previous visits.

Station ABT-3b

Station ABT-3b was sampled during 2022 and will be monitored again during 2023.

Station ABT-3B initial long term water quality monitoring location. The station was positioned in a transitional part of the reach where the running stream flowed into a large shallow pool area. This location represented one of the few areas that maintained deep enough water for continuous logger deployment.

Example substrates at Station ABT-3B. Left image shows the lower gradient downstream area with rooted submerged macrophytes and fine (silt/sand) substrates. The right image shows the more moderate gradient upper reach with shallow flow and more gravel/cobble/small boulder habitat. Alder/shrub provided overhead cover for portions of this reach while grasses (left image) made up the riparian vegetation for other portions. This stream reach was approximately 150 meters bounded on the upper end by a beaver dam/pond, crossing an old gravel road approximately 2/3 of the way downstream. The lower bound of the stream was similar to the left image above. This perennial stream becomes intermittent above Douglas Drive (Station 3a).

Substrates commonly encountered in the lower gradient section of Station ABT-3B consisting of silt/sand and embedded gravel. Rooted vegetation was often present within the stream channel.

Substrates in more moderate gradient areas of Station ABT-3B. Sand, gravel, cobble and some small boulders were present with varying degrees of embeddedness. Organic growth or debris were commonly observed within the stream channel in this reach.

Station AB-4

Station AB-4 is in an upper portion of Alder Brook. This station was sampled during 2022 and will continue to be monitored during 2023.

Station AB-4 is within Alder Brook receiving flow from watersheds that include Stations ABT-6, ABT-3(A/B; Figure 3-1). The original location for Station AB-4 was planned to capture a drainage area between the stream associated with Stations ABT-3A/B and that associated with Stations ABT-1 and ABT-2A. All of the waters proved intermittent, resulting in placement of the station in Alder Brook.

Alder Brook at Station AB-4. Images above represent the lower (left image), mid (center image), and upper portions of the stream reach (right image). The images also show the diversity of habitat present within 150 meters of stream. Sections in the lower and mid reach transition between banks lined with herbaceous vegetation and often rooted vegetation within the stream to alder/shrub covered reaches. The upper reach was higher gradient with more riffle and pool sections, coarser in-stream habitat (cobble/boulder), and a forested overstory.

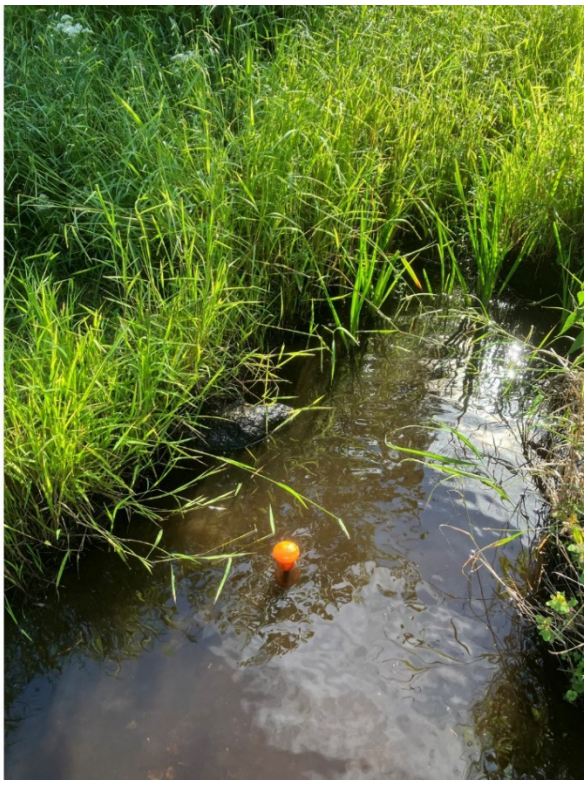
Substrates at Station AB-4 showing the transition from finer sand/silt or embedded coarse substrates in the lower parts (left image) to coarser sand and gravel and mid portions of the reach (right image).

Station AB-5

This station represents Alder Brook leaving the property and encompasses the drainage of all other stations. This station was sampled during 2022 and will continue to be monitored during 2023.

Station AB-5 was in Alder Brook where the stream leaves the property. This stream represents drainage from all Stations watersheds of the project. The lower 2/3 of this reach are a higher gradient shallow riffle/pool stream. The left image looks upstream from the lower bound of the reach. The right image looks upstream from where the stream transitions out of the forest covered portion of the reach and into a more herbaceous and alder lined lower gradient stream. The long term monitoring station was within this forested, higher gradient section.

The upper approximately 50 meters of Station AB-5 was in a lower gradient portion of the reach slower flow, grass lined banks or alders and shrubs, instream rooted vegetation, and dominated by finer substrates (left image). Riffles, not as prevalent as in the lower 2/3 of the reach, were present and had coarser substrates (right image).



In stream habitat differences at Station AB-5. The lower portion of the 150-meter reach was shaded by a spruce/fir forest and predominately riffles and pools with substrates of sand, gravel, cobble, and boulder (left image). Transitioning out of the forest, the stream becomes lower gradient with herbaceous and alder/shrub vegetation lining the banks (right image). The substrates became finer, dominated by silts and sand and often rooted emergent vegetation although gravel/cobble/boulder were present in areas of riffles.

Station AB-5 long term water quality monitoring location. This pool showed adequate depth, ensuring loggers would remain submerged.

Station ABT-6

This station was originally designated as an upstream reference location for headwater streams closer to project impacts. It was sampled during 2022 but the proximity to other industrial activity (gravel mining and forestry) was too close for use as an unimpacted site. The station was discontinued for the 2023 monitoring season.

Station ABT-6 long term water quality monitoring pool location.

Station ABT-6 represents a perennial stream segment near the northwestern property boundary to be used as a reference reach. This stream segment is outside the drainage area of the proposed project but is within the drainage area of other industrial site uses including gravel operations and timber harvesting by the current landowner. Stream segment is near the transition from a high gradient upland stream to a low gradient lowland stream and is located above a large wetland complex. The photos above show the forest canopy covered, higher gradient upper section. Coarse substrates in the form of gravel, cobble, and boulder were the dominant substrates.

Station ABT-6, similar to other stations on location, often transitions quickly between forested and higher gradient areas to lower gradient areas with herbaceous and alder/shrub lined banks. Substrates in this lower section ranged from coarse sand and gravel with some embedded cobble (left image) to silt and organic debris with emergent vegetation as in the area of this old beaver impoundment (right image).

Station HB-7

This station is on Hatch Brook and has a similar drainage area as AB-5. This station was not monitored during 2022 but will serve as a reference station for AB-5 during 2023.

At this location, Hatch Brook drains a watershed approximately similar to that at Station AB-5 and shows some similar attributes (forest cover, higher gradient, riffle/pool with boulder, cobble gravel substrates). The lower portion shown above has a forested riparian buffer.

The reference reach approximately 50-meters upstream of the road crossing transitions to a lower gradient stream running through a wetland/marsh area similar to the upper portion of Station 5 (left image). Substrates (right image) in the form of sand with some smaller gravel become more dominant as the stream flattens out and the flow slows (does not become still, flow is evident). Bank coverage in this portion of the reach consists of alder and herbaceous vegetation.

Station HBT-10

This tributary of Hatch Brook will serve as a reference station to headwater stations on Alder Brook. The drainage area of this stream falls between that calculated for ABT-3b and ABT-2b.

Station HB-9

An upstream section of Hatch Brook initially selected as an reference station to Alder Brook headwater stations. Ultimately, in an effort to maintain a reference location with a similar to Stations ABT-3b and ABT-2b resulted in the determination to monitor HB-10 instead.

Upstream reaches of Hatch Brook. The stream runs primarily through forested habitat with substrate ranging from coarse sand and gravel in lower gradient sections to cobble and boulder in higher gradient sections. Limitations on watershed access prevent matching the watershed size here to Alder Brook headwater Stations ABT-2b and ABT-3b.

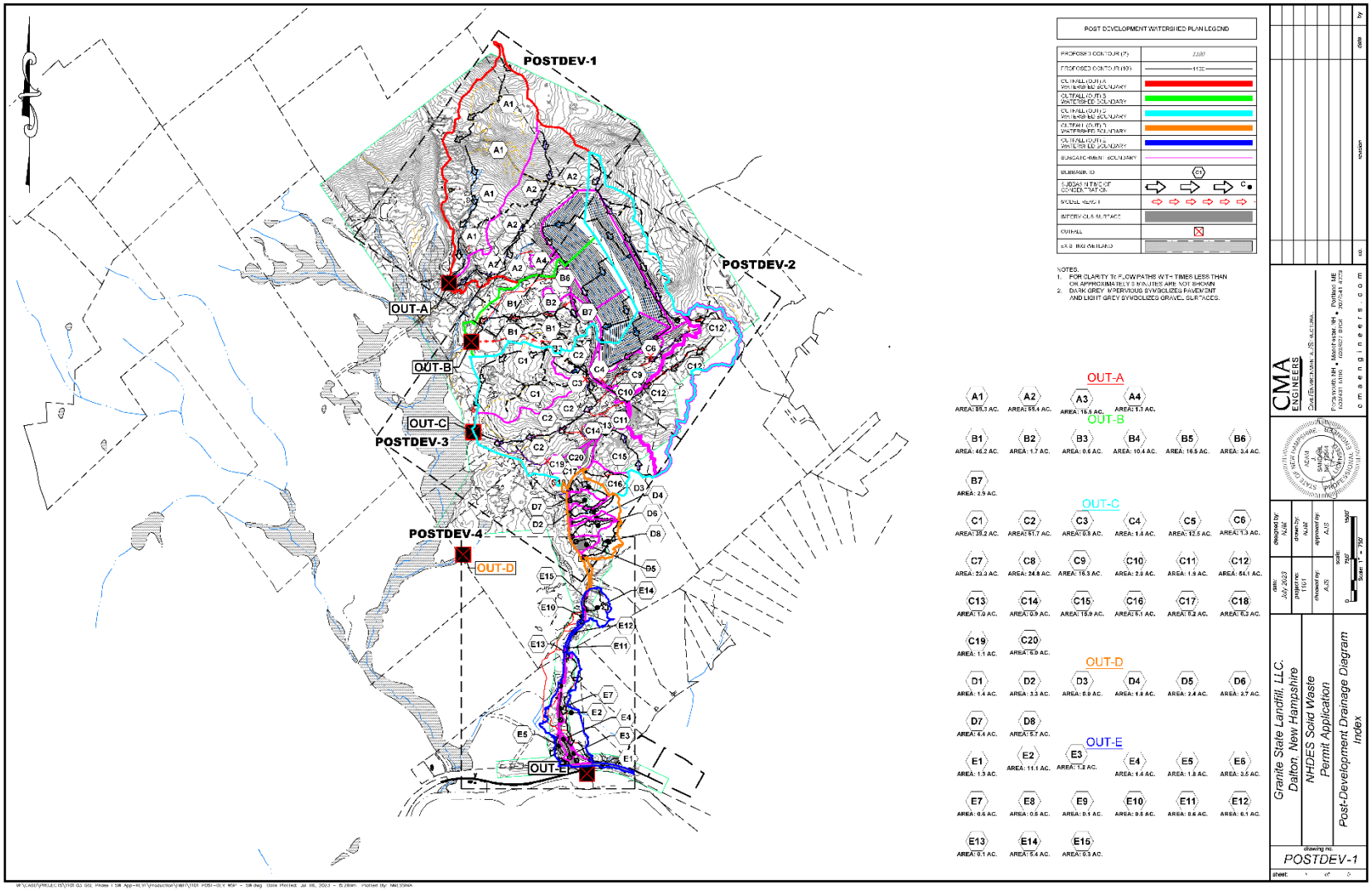
Substrate at upper Hatch Brook reference location (left figure) gravel and some coarse sand. Locations in lower gradient portions did have finer sand and some silt. Higher gradient sections had cobble and boulder substrate as shown in the right figure.

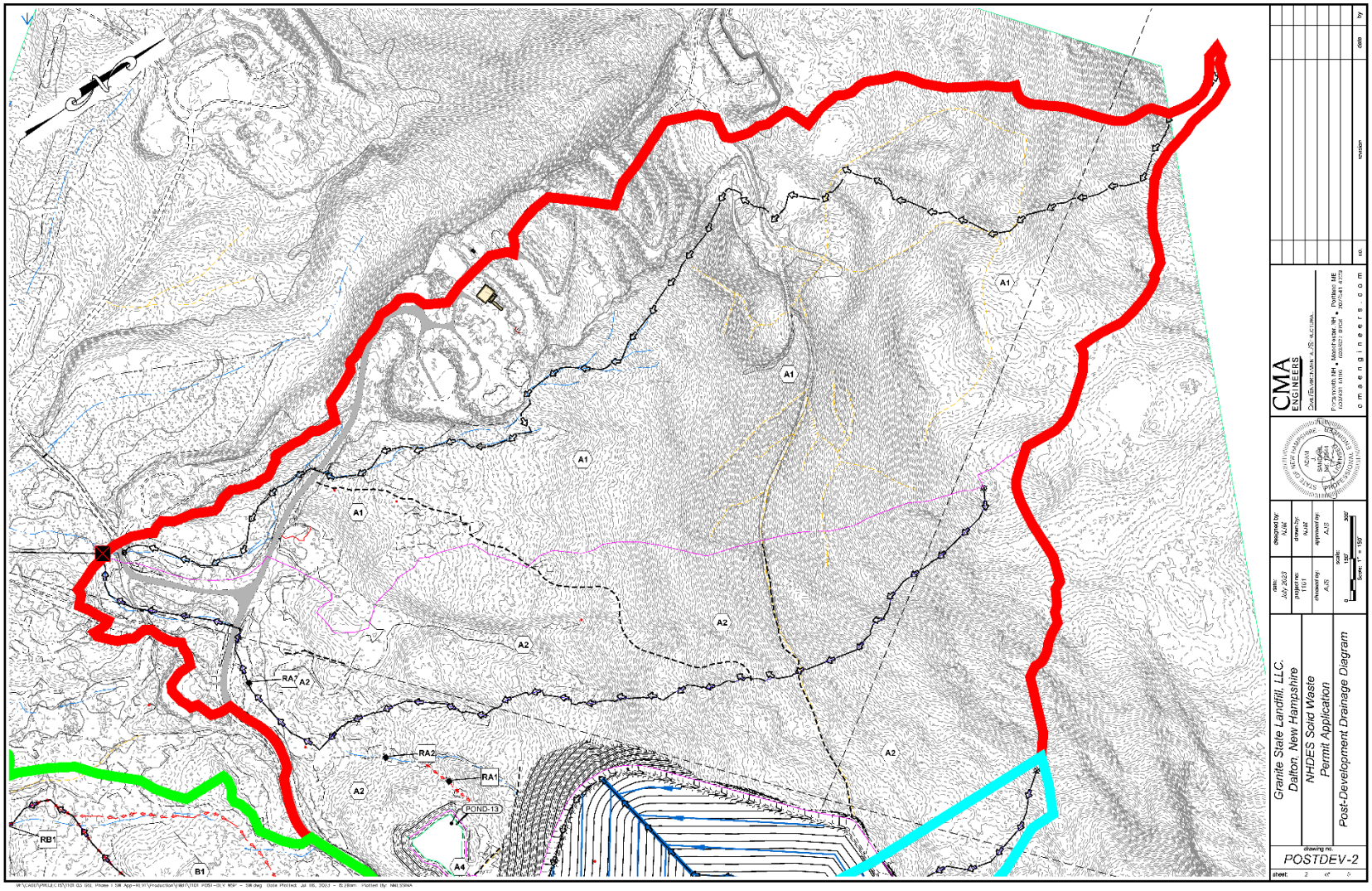
Station HBT-8

Tributary of Hatch Brook initially selected for use as a reference location for headwater stations on Alder Brook (ABT-2b and ABT-3b). The lack of a defined surface channel made this location unusable.

Tributary of Hatch Brook downstream of location selected using watershed drainage as a potential upstream reference reach (orange circled area on comments received 01/30/2023). Water was identified and heard running primarily sub surface, occasionally daylighting between boulders (right figure) are in some wetland areas. No substantial continuous, accessible tract of stream (> 15-20-meters) was identified from the confluence with Hatch Brook.

Appendix H: Project Detail Figures


POSTDEV-1
POSTDEV-2
POSTDEV-3
POSTDEV-4
OUT-A
OUT-B
OUT-C
OUT-D
OUT-E
POST DEVELOPMENT WATERSHED PLAN LEGEND
NOTES:
1. FOR CLARITY TC FLOWPATHS WITH TIMES LESS THAN OR APPROXIMATELY 5 MINUTES ARE NOT SHOWN
2. DARK GREY IMPERVIOUS SYMBOLIZES PAVEMENT AND LIGHT GREY SYMBOLIZES GRAVEL SURFACES.
OUT-A
OUT-B
OUT-C
OUT-D
OUT-E
CMA ENGINEERS
Granite State Landfill, LLC.
Dalton, New Hampshire
NHDES Solid Waste
Permit Application
Post-Development Drainage Diagram
Index
POSTDEV-1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A2
RA1
RA2
POND-13
RB1
B1
A4
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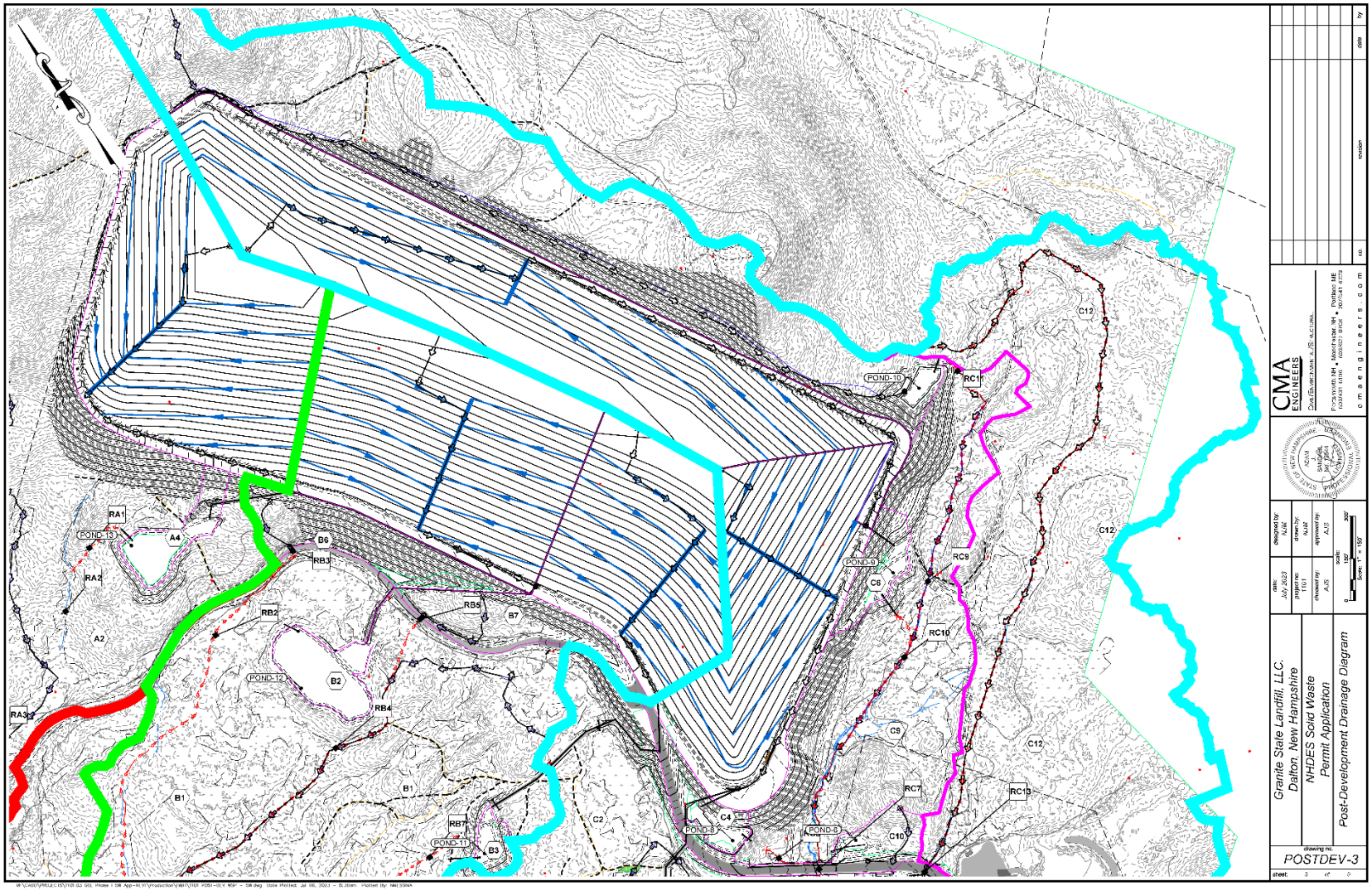
Dalton, New Hampshire
NHDES Solid Waste
Permit Application
Post-Development Drainage Diagram
POSTDEV-2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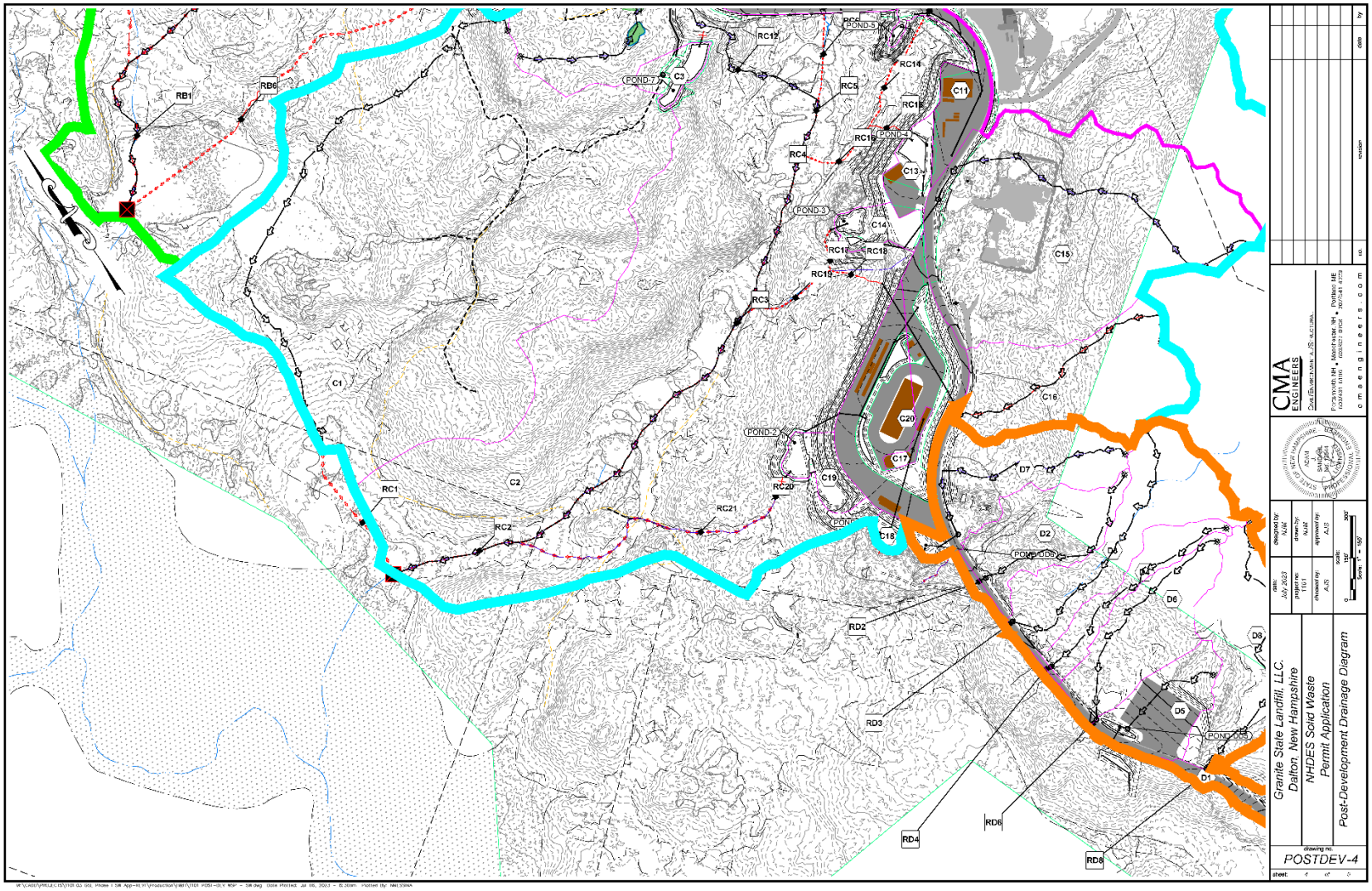
B2
B3
B6
B7
RB2
RB3
RB4
RB5
RB7
C2
C4
C6
C8
C9
C10
C12
RC1
RC7
RC9
RC10
RC13
CMA ENGINEERS
Granite State Landfill, LLC.
Dalton, New Hampshire
NHDES Solid Waste
Permit Application
Post-Development Drainage Diagram
POSTDEV-3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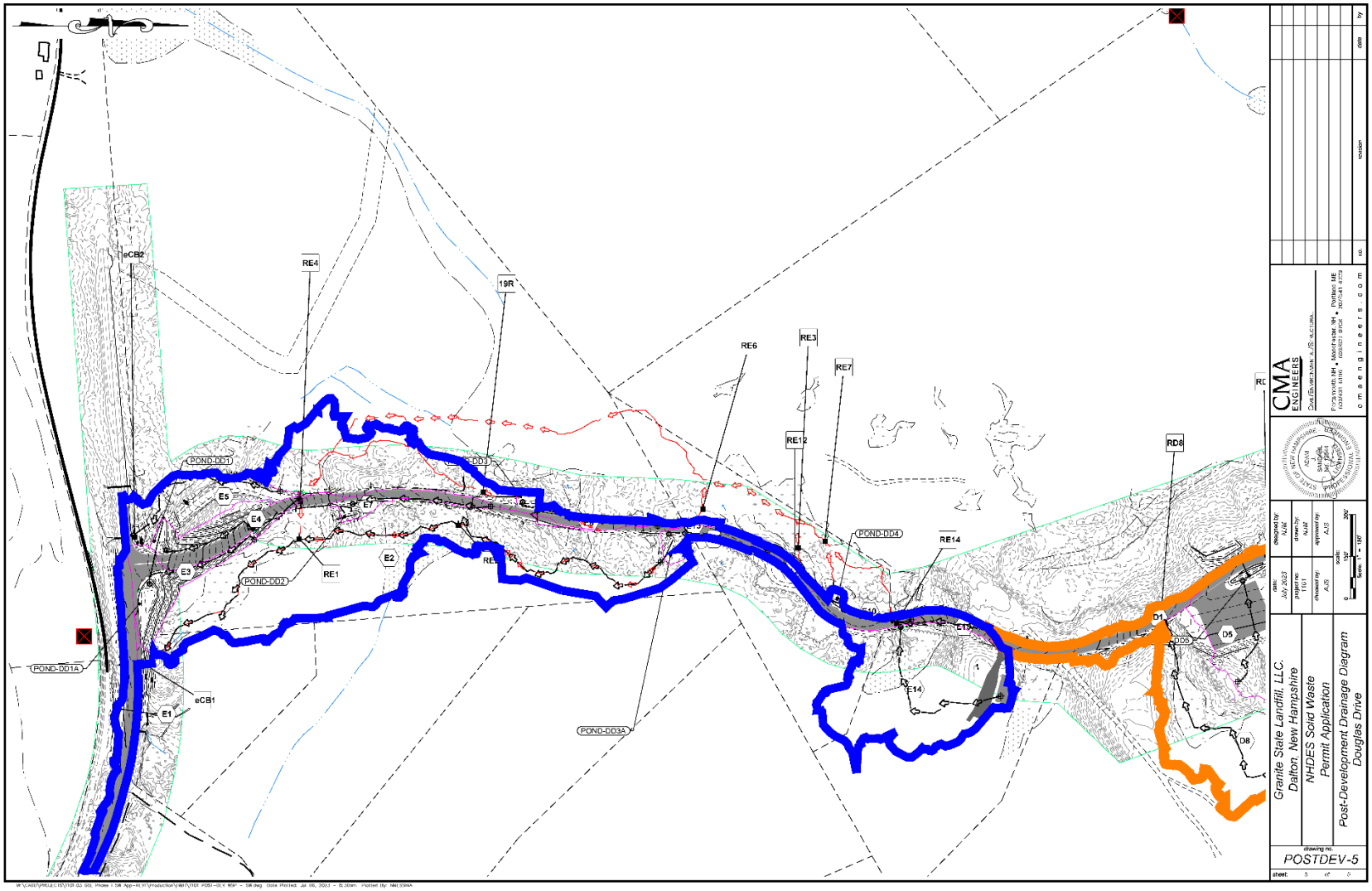
C14
C15
C16
C17
C18
C19
C20
D1
D2
D3
D4
D5
D6
D7
D8
POND-1
POND-2
POND-3
POND-4
POND-5
POND-6
POND-7
POND-8
POND-9
CMA ENGINEERS
Granite State Landfill, LLC.
Dalton, New Hampshire
NHDES Solid Waste
Permit Application
Post-Development Drainage Diagram
POSTDEV-4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RE6
RE3
RE7
RE12
RD8
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DD2
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RE1
POND-DD2
POND-DD4
RE14
POND-DD1A
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D8
CMA ENGINEERS
Granite State Landfill, LLC.
Dalton, New Hampshire
NHDES Solid Waste
Permit Application
Post-Development Drainage Diagram
Douglas Drive
POSTDEV-5

Appendix I: NHDES/GSL Comment and Response on SAP Development

New Hampshire Department of Environmental Services

Comments on the 2022 Granite State Landfill Baseline Environmental Studies:

Sampling and Analysis Plan

June 23, 2022

On June 9, 2022, the Watershed Management Bureau of the New Hampshire Department of Environmental Services (NHDES) received an email from Normandeau Associates, Inc. (Normandeau), on behalf of Granite State Landfill, LLC (GSL), that included a document titled, "2022 Granite State Landfill Baseline Environmental Studies: Sampling and Analysis Plan" (SAP). In its email, Normandeau requested that NHDES review and provide comments on the SAP. NHDES appreciates the opportunity to review and provide comments on the SAP.

In the introduction of the SAP, GSL stated the following: "[GSL], a subsidiary of New England Waste Services, Inc. (NEWS) proposes to develop a modern lined landfill facility off Route 116 in the Town of Dalton, New Hampshire. The project will include activities located in wetlands and will therefore require standard dredge and fill permits from [NHDES] and the United States Army Corps of Engineers (USACE). It is expected the project will require an individual permit from the USACE and therefore will also require project water quality certification (WQC) from NHDES, per Section 401 of the federal Clean Water Act. This [SAP] has been prepared in anticipation of 401 WQC requirements and presents the proposed baseline environmental studies for characterizing the existing fish community, habitat, and water quality in tributaries of Alder Brook, Dalton, NH that may potentially be impacted by the project. This SAP includes descriptions of the study area, the sampling design, and approach for site selection, environmental sample collection methods, analytical techniques, and documentation procedures."

NHDES provides the following comments on the SAP.

1. If GSL chooses to submit a revised SAP to NHDES for review and comment, NHDES recommends the following, which would expedite NHDES' review of a revised SAP:
    a. A response to each of the comments below; and
    b. A marked-up copy of the revised SAP showing any revisions from the current SAP and the revised SAP;
    c. Submit these items to James Tilley, NHDES Water Quality Certification Supervisor, at james.w.tilley@des.nh.gov.

2. NHDES' review of, and comments on, the SAP are limited to the information about the proposed

Project that GSL provided in the SAP. Except for the location of the "Approximate Landfill Footprint" that GSL provided in Figure 3.1 of the SAP, GSL did not include details about the proposed scope and impacts of the Project in the SAP. For example, GSL did not specify in the SAP if and where it proposes to construct roads, buildings, parking lots, other impervious infrastructure, etc., that would support operation of a landfill, and whether GSL proposes that infrastructure to be located in the "Approximate Landfill Footprint" shown in Figure 3.1. As such, NHDES' comments are limited to the generalized areas. GSL's baseline environmental studies proposed in the SAP may not be sufficient to evaluate future environmental effects due to construction and operation of the Project, depending on the final design elements. NHDES may have additional or different comments on the SAP if NHDES receives additional information about the proposed Project.

GSL Response: The proposed infrastructure for supporting landfill operations has been included in the updated Figure 3.1 included in the revised SAP. The final design may change from the current design included in Figure 3.1. The baseline environmental data collected in accordance with this SAP will be used to guide the refinement of the design. The focus of the baseline study is general environmental data collection and the monitoring site locations were selected to represent potentially affected areas from the full project buildout. No significant development will occur outside of the drainage areas captured by the proposed monitoring network. In addition, a reference reach is proposed located in a subwatershed outside of development areas to characterize baseline conditions and provide an opportunity for long-term monitoring of data trends.

3. *3 Monitoring and Data Collection Methods and Locations; Figure 3.1 Proposed Sampling locations and subwatersheds* (pp. 4-6): In a revised SAP, NHDES recommends that GSL provide coordinates and photos of each proposed sampling or monitoring site location, including photos of the benthos at each sampling location to document the characteristics of the benthos (e.g., cobble, gravel, weedy, vegetation, etc.) at each location.

In a revised SAP, NHDES recommends that GSL provide maps that contain more detail than the map provided in Figure 3.1. Maps in the SAP should clearly show the following:

a. Stream segments of different types (i.e., perennial, intermittent, ephemeral);

GSL Response: perennial, intermittent, and ephemeral streams are indicated on Figure 3.1 and have been updated based on the most recent site visit.

b. Areas where stream segments are subsurface, to the extent possible, to provide more clarity on the connections of stream flow;

GSL Response: Figure 3.1 has been updated to indicate the subsurface stream segments.

c. Any stream segments and wetland areas that GSL proposes to impact in forthcoming applications to the NHDES Wetlands Bureau or US Army Corps of
Engineers; and
GSL Response: The stream segments potentially impacted by the project are indicated on the updated Figure 3.1 included in the revised SAP.

d. The locations of all components (e.g., roads, buildings, parking lots, other impervious infrastructure, etc.) of the Project, including the location of the Project's landfill where waste would be stored.
GSL Response: Project infrastructure is included on the updated Figure 3.1 included in the revised SAP.

Figure 3.1 shows a purple line labelled as "PurchaseLots" in the legend of Figure 3.1. NHDES recommends that GSL explain if that line represents the boundary of the property owned or controlled by GSL. If that line represents the GSL's property boundary, GSL should explain why the area labelled "Approximate Landfill Footprint" in Figure 3.1 is outside the property boundary. If it is not the property boundary, GSL should explain what "PurchaseLots" means.
GSL Response: The "PurchaseLots" line is the GSL property boundary. The "Approximate Landfill Footprint" line should not extend past the property line and has been corrected in the revised Figure 3.1.

4. *3.2 Aquatic Habitat and Fisheries Assessments* (p. 7): GSL referenced NHDES' 2018 Section
305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM). On February 18, 2022, NHDES published the 2020/2022 CALM. In a revised SAP, NHDES recommends that GSL reference the most current version of the CALM in the SAP. A copy of the 2020/2022 CALM can be downloaded at the following website: https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdf.

GSL Response: The SAP has been updated to reference the 2020/2022 CALM

5. 3.2.1 *Habitat Assessment* (p. 7): GSL references EPA's *Rapid Bioassessment Protocols for Use in Stream and Wadeable Rivers*, and stated that a copy of the source document is provided in Appendix A of the SAP. However, NHDES could not locate a copy of that protocol in Appendix A or elsewhere in the SAP. In a revised SAP, NHDES recommends that GSL include a copy of that protocol in an appendix of the SAP.
GSL Response: The referenced document has been included as Appendix A of the revised draft SAP

6. *3.2.2 Fish Community Assessment* (p. 7): GSL referenced NHDES' *Protocols for Collection, Identification, and Enumeration of Freshwater Fishes*, revised November

2013, and stated that a copy of that protocol is in Appendix A of the SAP. However, NHDES could not locate a copy of that protocol in Appendix A or elsewhere in the SAP. In a revised SAP, NHDES recommends that GSL include a copy of that protocol in an appendix of the SAP.
GSL Response: The referenced protocol (updated to 2022 version) has been included in the revised SAP.

GSL stated the following: "Sampling will occur **as recommended** from the end of June through September. [**emphasis added**]" NHDES assumes GSL is referring to the NHDES 2013 protocol in that sentence, but it is unclear which recommendation GSL would be following. In a revised SAP, NHDES recommends that GSL clarify how it would conduct sampling and whose recommendations it would follow.
GSL Response: this section has been clarified in the revised SAP

GSL stated the following under *Task 2 Assumptions*: "Normandeau will obtain a valid State of New Hampshire scientific collectors permit for this work" and refences a New Hampshire Scientific Collection Permit under Appendix F, but GSL does not provide a copy of that permit in the Appendix. Under RSA 214:29 and NH Code Admin. Rule Fis 1106.01(a), GSL may be required to obtain a scientific license or waiver from the New Hampshire Fish and Game Department (NHFGD) prior to the fish community assessment. Under Fis 1106.01(b), GSL may be required to submit a study report to NHFGD. If a license or waiver and study reports are applicable to the assessment, NHDES recommends that GSL submit to NHDES a copy of the license or waiver that GSL or its agent obtains from the NHFGD for the assessment, and a copy of any reports submitted to NHFGD for the assessment.

GSL Response: The scientific collector's permit has not yet been obtained but will be provided to NHDES once it is available

In a revised SAP, NHDES recommends that GSL specify that the fish survey length will be 20 times the wetted width and a 150-meter minimum to allow data to be used for NHDES' aquatic life use assessments. NHDES also recommends that GSL add a note to the SAP to not conduct electrofishing near any dataloggers.
GSL Response: The revised SAP includes these recommendations.

In a revised SAP, NHDES recommends that "The Fish Sampling Field Data Sheet" provided in Appendix B of the SAP include the following:

a. Location of assessment relative to fishing reach or sampling and monitoring coordinates;
b. Coordinates of the upstream and downstream extent of assessment;
c. Running time of electrofishing;
d. Specific conductance and flow of surface water during electrofishing;

e. Electrofishing pack model
f. Electrofishing pack settings: frequency, power, and duty cycle; and
g. The length and weight of the specimen should be recorded and not listed as "optional".

GSL Response: The above elements will be recorded as part of the fish assessment protocol. The SAP has been updated to include these elements as part of the protocol.

7. *3.3 Task 2: Benthic macroinvertebrate sampling* (p. 8): GSL referenced NHDES' *Protocols for Macroinvertebrate Collection, Identification and Enumeration* and EPA's Rapid *Bioassessment Protocols Multihabitat Approach*, and implied that copies of the protocols are in Attachment A of the SAP. In a revised SAP, NHDES recommends that GSL include copies of those protocols in an appendix of the SAP.
GSL Response: The identified documents have been included in the revised SAP.

GSL stated the following: "The NHDES protocol specifies the use of artificial habitat samplers ("rock baskets") for the collection of macroinvertebrates; however, for this study we propose to use a kick-net method as described in Barbour et al. (1999). This variation is justified for the substrate and stream types at the study site which include intermittent stream reaches that may not stay wetted consistently enough for a six to eight week deployment and soft bottom substrates throughout much of the lower reaches that are not conducive to rock basket deployment." In a revised SAP, NHDES recommends that GSL use rock baskets where practical so that results can be readily compared to NHDES' indexes of biotical integrity.
GSL Response: The revised SAP includes deployment of rock baskets where suitable as well as kick net collection of substrate samples at all stations.

8. *3.4 Task 3: Continuous Water Quality Monitoring for DO, Temperature, and pH*; *QA/QC Protocols*; *Table 3.1; Dissolved Oxygen* (p. 12)*:* Under *Datasonde Retrieval* of the *Calibration Acceptance Criteria* for dissolved oxygen (DO), GSL stated the following: "The difference between the datasonde instantaneous reading immediately after calibration and the Oxygen Solubility Water Value from Table 4 must be no greater than ±0.5 mg/L)." In a revised SAP, NHDES recommends that GSL revise that sentence to read as follows: "The difference between the datasonde instantaneous reading immediately after calibration and the Oxygen Solubility Water Value from Table 4 **of Appendix A** must be no greater than ±0.5 mg/L **to be considered valid data**. [**emphasis added** shows additional language recommended by NHDES]"
GSL Response: The recommendation above has been included in the revised SAP.

Under *Datasonde Retrieval* of the *Calibration Acceptance Criteria* for pH, GSL stated the following: "Datasonde should measure the two standards used in the calibration. Datasonde readings should be ± 0.3 pH units from both calibration standards." In a revised SAP, NHDES recommends that GSL revise that section to read as follows: "**After**

removal from water, and without cleaning the probe, datasonde should measure the two standards used in the calibration. Datasonde readings should be ± 0.3 pH units from both calibration standards **for the data to be considered valid**. [**emphasis added** shows additional language recommended by NHDES]"

GSL Response: The recommendation above has been included in the revised SAP.

GSL proposed using a HOBO MX2501 for pH and temperature water quality monitoring, and provided specifications for that datalogger (i.e., datasonde) in Appendix C of the SAP. The specifications show that the sample ionic strength of the data logger is ≥ 100 microsiemens per centimeter (µS/cm). NHDES is concerned about this relatively high conductivity because NHDES expects conductivity to be relatively low in the streams in the vicinity of the Project. For example, an average conductivity of 42 µS/cm has been measured in a segment of the Ammonoosuc River (NHDES Assessment Unit Identification NHRIV801030403-03), which is in the vicinity of the Project. The sensitivity of the proposed equipment could result in inaccurate pH data and erroneously low pH readings. Therefore, NHDES recommends using equipment that is rated for < 100 µS/cm.

GSL Response: We reached out to Onset to address the issue of pH measurements in low-conductivity water. The response from Onset follows:

"*Regarding your concerns about the MX2501 logger in low conductivity water. The pH sensor should work, but it will be less accurate, have higher measurement drift, slow pH measurement response time and a reduced sensor life. To assist with accuracy and drift, we would recommend calibrating the logger frequently, once a week, possibly more, and rinsing the sensor in storage solution after calibration. When not used, the sensor should be in storage solution to maintain life. Here is a link that addresses measuring pH in low-conductivity water:* https://assets.fishersci.com/TFS-Assets/LSG/Application-Notes/AN-PHPURE-E-0914-RevA-WEB.pdf."

PH measurement challenges in low conductivity sample water are likely to occur with any field deployable instrument, including the Onset Hobo MX2501. The only pH electrodes appropriate for use with low-conductivity sample water that we could find were for laboratory use rather than field use. We will use the MX2501 for this study as we have already purchased the equipment (new equipment purchased for this study), which we have used successfully in other projects in the state and region, and no reasonable equipment alternative is apparent to us. We will incorporate the Onset manufacturer's recommendations into our procedures including weekly calibrations and rinsing the sensor with storage solution after calibration and these changes have been noted in the revised SAP. In addition, pH measurements from the deployed loggers will be QC-evaluated in the field with simultaneous readings with an independent hand-held logger as described in the SAP.

In a revised SAP, NHDES recommends that GSL clarify if any datalogger data will be adjusted based on the results of comparisons with handheld measurement and corresponding datalogger measurements. If any adjustments for drift occur, the final data report should include, in Excel format, both the raw datalogger data and the adjusted data in a single spreadsheet to allow for comparison between the two data sets.

GSL Response: We don't propose to perform any datalogger data adjustments unless necessary and appropriate. If instrument drift indicates data adjustment is necessary and appropriate (i.e. data errors are due to drift rather than equipment issues) then a weighted linear correction will be applied to the deployment period and both the adjusted and raw data will be presented in the final report, figures, and datasets, as requested. The revised SAP Section 3.4 has been updated to include a discussion of data adjustment for instrument drift and that both adjusted and raw data tables and figures will be provided.

9. *3.5 Task 4: Water Sample Collection and Laboratory Analysis for Color, Turbidity, Nutrients, and Toxic Substances* (p. 14-15):

GSL stated the following: "The proposed study will consist of **periodic** collection and laboratory analysis of surface water samples at each of the seven proposed monitoring sites (including station 3a) during the study period, concurrent with the other proposed studies [**emphasis added**]"; "[t]oxic substance samples will be collected **once** during the study period (with the exception of chloride, which will be collected for a total of 10 samples). Samples will be collected throughout the study period of June through September 2022 [**emphasis added**]"; and that that GSL will collect 10 samples of chlorophyll-a from each of the sampling locations and collect only one sample from each of the seven sampling locations for the following parameters (*indicates GSL plans to measure both dissolved and total concentrations): color; iron*; manganese*; arsenic*; barium*; cadmium*; chromium*; lead*; mercury*; selenium*; silver*; hardness; dissolved organic carbon (DOC); Per- and Polyfluoroalkyl Substances (PFAS) (9 compounds to be analyzed. In Table 4.1, GSL stated it would collect those samples from August 15, 2022 to August 19, 2022

NHDES recommends that GSL collect a minimum of 5 samples to measure hardness and concentrations of toxics; collect samples to measure aluminum in surface waters because soil disturbance caused by construction and operation of the Project is likely to increase the mobility of aluminum; and measure pH at the same time and location where toxics are sampled using a field equipment that is rated for < 100 µS/cm.
GSL Response: The SAP has been revised to increase the number of toxics samples collected from 1 to 5 samples, as requested. Dissolved and total aluminum has also been added to the toxics analytes list in the SAP. The SAP has also been updated to specify

that pH will be measured concurrent with collection of toxics samples using the mobile field meter (YSI ProDSS). The YSI ProDSS does not have a manufacturer-specified sample ionic strength requirement for the pH sensor; however, this meter has been used extensively for previous water quality studies in NH and we do not anticipate any issues with pH measurements using this meter.

Under baseline conditions, concentrations of certain toxics (e.g., metals) and levels of turbidity in surface waters are more likely to increase during and after storm events and under certain seasonal conditions (e.g., during spring melting of snow). Construction of the Project would disturb the landscape and could increase concentrations of metals and levels of turbidity in surface waters in the vicinity of the Project. GSL does not specify in the SAP how it plans to assess water quality standards and criteria during a range of flows caused by seasonal changes and precipitation events. In a revised SAP, NHDES recommends more detail on the timing of sample collection relative to seasonal low, base, high, and peak flows. NHDES also recommends that GSL revise the SAP to characterize how sampling will be characterized as it relates to precipitation events, and how GSL will track those precipitation events (e.g., installation of a rain gage, use of existing rain gages, etc.). NHDES recommends that GSL describe how it will assess baseline conditions of surface water quality that may vary due to changes in seasonal flow, such as during seasonal high flows (i.e., during spring melt and runoff prior to the growing season and late fall after the growing season) and when precipitation events can have a greater impact on water quality because of less water uptake and filtration by vegetation.

GSL Response: The continuous logger deployment will take place during mid-late summer to assess low flow/maximum water temperatures and corresponding low-DO conditions. The samples collected for laboratory analysis and in-situ turbidity measurements can be distributed to represent other flow conditions. We propose collecting samples during summer low flows, base flows, as well as late-season and spring high flow periods - this revision has been added to the revised SAP.

Precipitation will be tracked using the nearest NWS station data at Whitefield. Stream response to precipitation will be monitored at the site with continuous stage data collected near Monitoring station 2. The revised SAP has been updated to include these changes.

NHDES believes it is unnecessary to collect 10 samples for chlorophyll-a at each station and recommends that GSL collect a minimum of 2 samples at each station.
GSL Response: The number of chlorophyll-a samples to be collected has been reduced to 2 samples from each station in the updated SAP.

NHDES recommends that GSL specify which 9 PFAS compounds it plans to analyze and explain why it chose those 9 compounds. NHDES notes that it currently regulates the following 4 PFAS compounds under Env-Dw 705.06 and RSA 485:16-e: Perfluorooctanoic acid; Perfluoroctanesulfonic acid; Perfluorohexanesulfonic acid; and Perfluorononanoic acid.

GSL Response: The SAP included the list of 9 compounds that are typically reported with the isotope dilution method (e.g. we have experience with Eastern Analytical, who report 9 compounds for typical PFAS sampling). After discussion with the project team, this list will be reduced to the 4 PFAS compounds regulated under Env-Dw 705.06. Previous surface water and groundwater sampling for PFAS at the site has resulted in a single detection of any PFAS compound (1 detection of PFOS at a level below the AGQS). The single detection of PFOS was not replicated in follow-up sampling. Therefore, based on the previously collected PFAS data at the site, no presence of PFAS compounds is reasonably expected and, for the purposes of 401 WQC, we propose to sample for the 4 regulated compounds at each monitoring station. This change in sampling approach has been incorporated into the revised SAP.

GSL stated the following: "The proposed surface water sampling study will consist of collection of surface water grab samples at each of the seven proposed monitoring locations using standard sample collection techniques." In a revised SAP, NHDES recommends that GSL describe the standard sample collection techniques it plans to use for each water quality parameter listed in the SAP.

GSL Response: The SAP has been updated to include standard sample collection protocols from the NHDES VLAP Field Manual (WD-07-035).

In a revised SAP, NHDES recommends that GSL list the toxic substances under Env-Wq 1703.21 that may be deposited at the landfill of the proposed Project, and how GSL determined which toxic substances to include and exclude from the SAP to establish existing baseline conditions in surface waters.

GSL Response: The proposed landfill will accept municipal solid waste comparable to other landfills in the state. The list of toxics substances was determined from release detection monitoring programs at other landfill sites in the state as well as recommendations from NHDES at a pre-project coordination meeting in 2022. We have provided a list of sampling parameters considered as well as preliminary results from samples collected at the site in Appendix G.

10. *3.5 Task 4: Water Sample Collection and Laboratory Analysis for Color, Turbidity, Nutrients, and Toxic Substances*; *Table 3.3 Laboratory Methods and Protocols* (p. 16): For the following parameters, GSL lists "TBD [to be determined]" for laboratory method,

container (preservation) hold time, precision (RPD based on field replicates, sensitivity (method detection limit) sensitivity (reporting detection limit): total hardness, DOC, PFAS, color, chloride, and metals. In a revised SAP, NHDES recommends that GSL specify the methods and protocols that are listed as "TBD" in the current SAP. In addition, NHDES recommends that GSL specify sensitivities that are below the associated water quality standard or criteria.

11.

GSL Response: Table 3.3 has been updated as requested.

12. *4 Schedule and Reporting* (p. 19); *Table 4.1*: GSL lists the duration and proposed timeframe of each study and assessment. GSL proposed a start date of June 15, 2022 for a study that involves water quality monitoring of temperature, dissolved oxygen, and pH; and for a study that involves sample collection of chlorophyll-a, specific conductance, and turbidity. GSL stated the following: "This draft SAP is being submitted for NHDES approval with the understanding that studies may commence prior to NHDES review and approval of a final SAP. If any changes are agreed to in project approach, sampling locations, parameters, methods, etc., then it may be necessary to adjust the study(ies) after they have already commenced. In the interest of capturing early summer water quality conditions and avoid delaying the field studies by a full season, we feel it is necessary to commence the water quality study in mid-June with or without a final approved SAP. Any changes or variances from the final approved SAP will be noted in the study reports."

Before beginning the studies, assessments, and monitoring proposed in the SAP, NHDES recommends that GSL provide more details about the proposed scope and impacts of the Project and include details within the SAP that NHDES and GSL mutually agree upon.

GSL stated the following: "Reports will be prepared and submitted to NHDES for the [sic] each of the baseline environmental studies, to include graphics and tables which present the data collected and provide a narrative of our findings using the QC methods outlined in Section 3.0." In a revised SAP, NHDES recommends that GSL provide a list of the graphics, graphs, and tables it plans to include in its reports.

GSL Response: A summary of the graphics, graphs, and tables to be included in the final report has been added to section 4 of the revised SAP.

13. In the revise SAP, NHDES recommends that GSL list the qualifications of those conducting each study or assessment.

GSL Response: A summary of personnel completing each study has been added to the revised SAP

14. Part Env-Wq 1705 specifies water quality standards for flow. In the SAP, GSL does not discuss how it would establish existing baseline conditions of flow of surface waters for comparison of future data to determine if there would be any impact to flow of surface waters caused by construction and operation of the proposed Project. In a revised SAP, NHDES recommends that GSL include a study that would establish existing baseline conditions of flow of surface waters that may be impacted by the Project.

GSL Response: Stream gaging will be conducted on Alder Brook at the Rte 116 culvert, approximately 1 mile below the site boundary. A pressure logger will be installed above the culvert and flow measurements will be completed periodically to develop a stage/flow regression as is presented in the revised SAP (Section 3.5). In addition, a pressure logger will be installed at monitoring station 2 to monitor stream stage in the upper watershed, as presented in Section 3.5 of the revised SAP. No flow gaging is proposed in the upper watershed due to the complicated site hydraulics that would make traditional gaging difficult and inaccurate.

15. In a revised SAP, NHDES recommends that GSL describe if and how it proposes to change drainage area boundaries of any surface waters during construction and operation of the proposed Project. If GSL plans to change drainage boundaries of surface waters, NHDES recommends that GSL include the following information in a revised SAP for each affected surface water:

a. A map showing both existing and proposed drainage areas;
b. Existing drainage area (square miles or square feet);
c. Post Project drainage area (square miles or square feet);
d. Drainage area lost or gained (square miles or square feet); and
e. Drainage area lost or gained (percentage).

GSL Response: When final design plans are available GSL will provide this requested information.

If you have any questions or concerns about these comments, please contact James Tilley, NHDES Water Quality Certification Supervisor, at james.w.tilley@des.nh.gov or 603-271-0699.

New Hampshire Department of Environmental Services Comments on the Revised 2022 Granite State Landfill Baseline Environmental Studies: Sampling and Analysis Plan September 22, 2022

On June 9, 2022, the Watershed Management Bureau of the New Hampshire Department of Environmental Services (NHDES) received an email from Normandeau Associates, Inc. (Normandeau), on behalf of Granite State Landfill, LLC (GSL), that included a document titled, "2022 Granite State Landfill

Baseline Environmental Studies: Sampling and Analysis Plan" (Original SAP) for a proposed landfill in Dalton, New Hampshire (Project). In its email, Normandeau requested that NHDES review and provide comments on the Original SAP. On June 23, 2022, NHDES sent an email to Normandeau and GSL that

included NHDES' comments on the Original SAP. On July 20, 2022, Normandeau, on behalf of GSL, submitted to NHDES via email a revised SAP (Revised SAP) that addressed many of NHDES' comments and a document containing responses to NHDES' comments on the Original SAP. In its email, Normandeau requested NHDES review and provide comments on the Revised SAP. NHDES appreciates Normandeau's and GSL's work to produce the Revised SAP and the opportunity to review and provide comments on the Revised SAP.

NHDES provides the following comments on the Revised SAP.

1. If GSL chooses to submit another revised SAP to NHDES for review and comment, NHDES recommends the following, which would expedite NHDES' review of another revised SAP:
    a. A response to each of the comments below; and
    b. A marked-up copy of a second, revised SAP showing any revisions from the Revised SAP and the second, revised SAP;
    c. Submit these items to James Tilley, NHDES Water Quality Certification Supervisor, at james.w.tilley@des.nh.gov.

2. *3 Monitoring and Data Collection Methods and Locations* (p. 4)

    NHDES notes that GSL did not provide coordinates and photos of each proposed sampling or monitoring site location at each location as NHDES recommended in its comments on the Original SAP. In a revised SAP, NHDES continues to recommend that GSL provide coordinates and photos of each proposed sampling or monitoring site location, including photos of the benthos at each sampling location to document the characteristics of the benthos (e.g., cobble, gravel, weedy, vegetation, etc.) at each location.

GSL response: Coordinates for each monitoring station have been included in the updated SAP. Table 3.1 includes coordinates for long term monitoring stations, and upstream/downstream coordinates for the reach in which fish and macroinvertebrate sampling occurred. Appendix G has been added to include photographs at each monitoring station and include images of the of stream reach and substrate/habitat available at each location.

3. *3.1 Site Selection; Figure 3.1 Proposed Sampling locations and subwatersheds* (pp. 5-6)
Although the revised version of Figure 3.1 in the Revised SAP shows general locations of proposed stormwater ponds, scales and buildings, an equipment staging area, and access road, it is difficult for NHDES to understand the potential impacts of that proposed infrastructure on surface water because of the limited detail of the Project's proposed landfill and infrastructure provided in Figure 3.1. NHDES acknowledges that GSL plans to refine the design of the Project based on the baseline environmental data collected in accordance with the SAP and that GSL does not plan to propose significant development outside the drainage areas captured by the proposed monitoring network. As NHDES concluded in comments on the Original SAP, since details of the proposed landfill and infrastructure of the Project are not provided in the SAP, GSL's baseline environmental studies proposed in the SAP may not be sufficient to evaluate future environmental effects due to construction and operation of the Project depending on the proposed and final design of the Project. NHDES may have additional comments on the SAP if NHDES receives additional details about the proposed Project.

   GSL response: Additional details on the proposed landfill have been provided as figures in Appendix H. These figures show a greater level of detail with regards to the proposed ponds, watershed boundaries, infrastructure areas, and existing wetlands.

   Figure 3.1 in the Revised SAP no longer includes the road names that were included in the Original SAP. In a revised SAP, NHDES recommends that GSL include road names, especially considering GSL repeatedly references "Douglas Drive" to describe the location of monitoring locations in the Revised SAP.

   GSL response: Douglas Drive has been labelled Figure 3.1 and Figure 3.2.

4. *3.2.2 Fish Community Assessment* (p.7)
NHDES acknowledges that GSL included a copy of NHDES' *Protocols for Collection, Identification, and Enumeration of Freshwater Fishes* as NHDES recommended in its comments on the Original SAP. NHDES recommends that GSL correct a minor error in the Revised SAP that refers to a "November 2022" revision date for that document to read "February 2022".
GSL response: The revised SAP includes the correct revision date, as requested.

5. 3.5 Task 4: Water Sample Collection and Laboratory Analysis for Color, Turbidity, Nutrients, and Toxic Substances; *Table 3.3 Laboratory Methods and Protocols* (p. 19)

In section 3.5 of the Revised SAP, GSL added aluminum to the list of analytes and provided detection limits for analytes as requested by NHDES in its comments on the Original SAP. In Table 3.3 of the revised SAP, GSL lists a method detection limit (MDL) and reporting detection limit (RDL) of 0.001 milligrams per liter (mg/L) for cadmium and 0.05 mg/L for aluminum using EPA Method 200.8. Detection limits for aluminum and cadmium can be lower under EPA Method 200.8. In a revised SAP, NHDES recommends that GSL lower the MDL and RDL for cadmium to 0.0001 mg/L, which is 0.1 micrograms per liter (µg/L), because the current surface water quality acute and chronic limits for cadmium under Env-Wq 1703.21(b) and Table 1703-1 are 0.39 µg/L and 0.21 µg/L (expressed as a function of the total hardness), respectively, for the protection of aquatic life in fresh surface waters. NHDES also recommends that GSL lower the MDL and RDL for aluminum to 0.01 mg/L, which is 10 µg/L, because NHDES anticipates that Env-Wq 1700 will be readopted resulting in lower acute and chronic limits for aluminum for the protection of aquatic life in fresh waters based on the estimated DOC, hardness, and pH at a site.

GSL response: We have contacted our analytical laboratory teaming partner and they confirmed they will meet the requested reporting limits for cadmium and aluminum. The revised SAP includes the reporting limits for cadmium and aluminum.

6. *4 Schedule and Reporting*; *Table 4.1* (pp. 21-22)
GSL lists the proposed timeframe of each study and assessment, which range from July 15, 2022 to September 15, 2022. NHDES notes that in section 3.5 of the Revised SAP, GSL stated that toxics samples will be collected during the summer of 2022, autumn of 2022, late autumn of 2022 and winter/spring 2023. NHDES recommends that GSL revise Table 4.1 to reflect that schedule.

Baseline environmental conditions of surface can vary seasonally and annually depending on temperature and precipitation, among other factors. NHDES recommends that GSL plan to collect baseline environmental data during at least one additional field season to estimate baseline conditions in surface waters that may be impacted by the proposed Project to account for annual variability. Collecting baseline environmental data during more than one field season helps ensure there is sufficient data for NHDES to make appropriate decisions while reviewing applications for the proposed Project.

GSL response: The timeframe (Table 4.1) for study and assessment has been updated to include observed sampling times during 2022 as well as the estimated timeframe for sampling during 2023. The additional sampling during the 2023 season will address the request for a second year of baseline sampling.

New Hampshire Department of Environmental Services Additional Comments on the Revised 2022 Granite State Landfill Baseline Environmental Studies: Sampling and Analysis Plan

January 30, 2023

On June 9, 2022, the Watershed Management Bureau of the New Hampshire Department of Environmental Services (NHDES) received an email from Normandeau Associates, Inc. (Normandeau), on behalf of Granite State Landfill, LLC (GSL), that included a document titled, "2022 Granite State Landfill Baseline Environmental Studies: Sampling and Analysis Plan" (Original SAP) for a proposed landfill in Dalton, New Hampshire (Project). In its email, Normandeau requested that NHDES review and provide comments on the Original SAP. On June 23, 2022, NHDES sent an email to Normandeau and GSL that included NHDES' comments on the Original SAP. On July 20, 2022, Normandeau, on behalf of GSL, submitted to NHDES via email a revised SAP (Revised SAP) that addressed many of NHDES' comments and a document containing responses to NHDES' comments on the Original SAP. In its email, Normandeau requested NHDES review and provide comments on the Revised SAP. On September 22, 2022, NHDES sent an email to Normandeau and GSL that included NHDES' comments on the Revised SAP. On October 13, 2022, Normandeau requested that NHDES staff visit the Project site to confirm the representativeness of the surface water quality monitoring network that Normandeau and GSL proposed in the Revised SAP. On November 22, 2022, NHDES staff visited the property and met with staff of Normandeau and GSL. NHDES provides the following additional comments on the Revised SAP after observing the proposed surface water quality monitoring stations.

1. If GSL chooses to submit another revised SAP to NHDES for review and comment, NHDES recommends the following, which would expedite NHDES' review of another revised SAP:
    a. A response to each of the comments below; and
    b. A marked-up copy of a second, revised SAP showing any revisions from the Revised SAP and the second, revised SAP;
    c. Submit these items to James Tilley, NHDES Water Quality Certification Supervisor, at james.w.tilley@des.nh.gov.

2. *3.1 Site Selection; Figure 3.1 Proposed Sampling locations and subwatersheds* (pp. 5-6)

    a. NHDES recommends adding a baseline environmental sampling station on Hatch Brook to measure flow, assess physical habitat, and monitor surface water quality (i.e., dissolved oxygen, pH, and temperature) in a flowing stream segment of Hatch Brook (i.e., not a wetland segment) approximately 0.3 to 0.5 miles upstream of the confluence of Hatch Brook and Alder Brook (see the red circle in the modified version of Figure 3.1, below). NHDES understands that GSL may select an appropriate station location on a lower reach of Hatch Brook based on the criteria that GSL provided in this section of the Revise SAP. Hatch Brook appears to be relatively unaffected by the mining activities that have occurred, and continue to

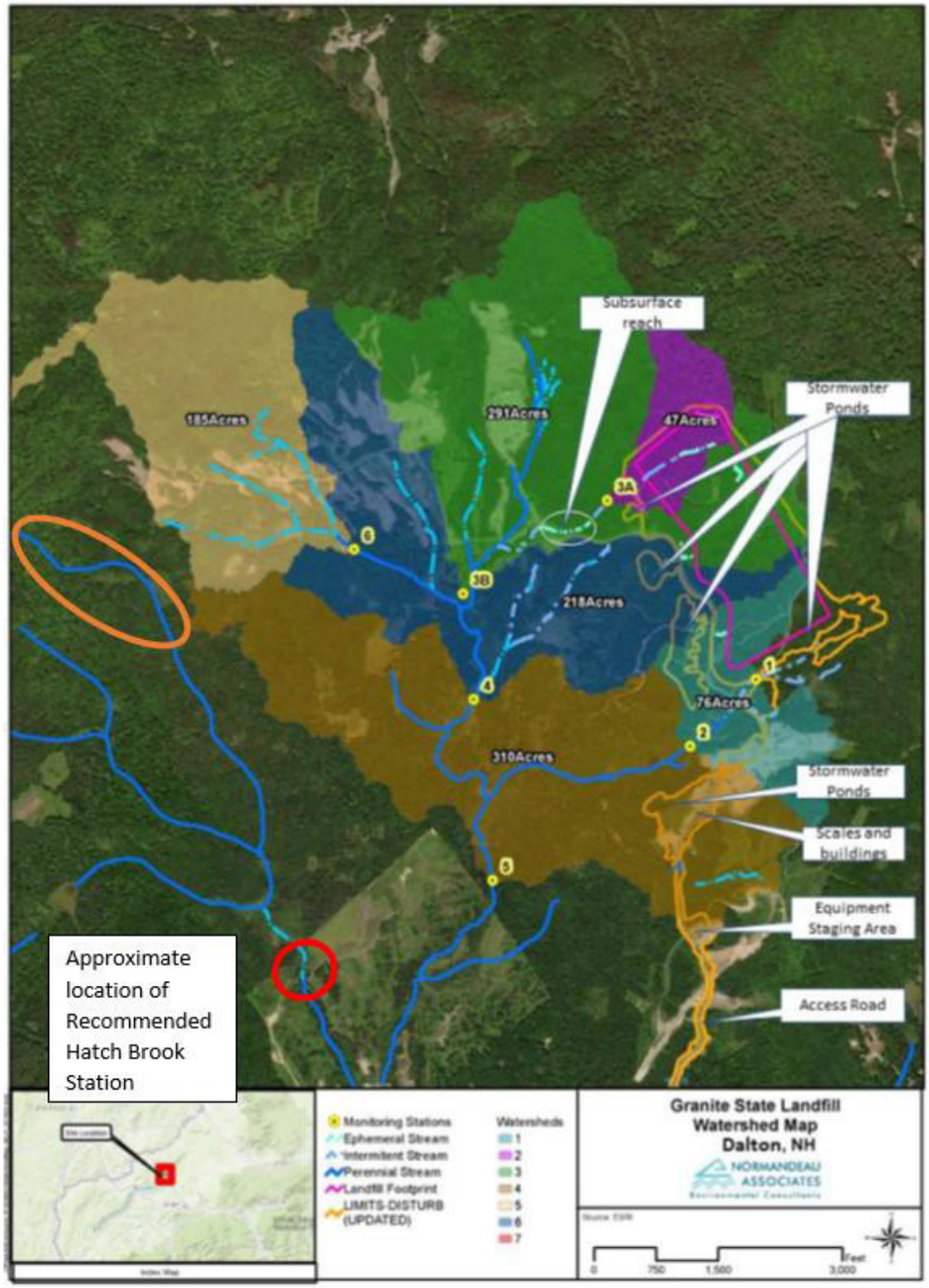
occur, in the vicinity of the proposed Project location. In addition, the proposed Project would likely not affect water quality-related parameters of Hatch Brook because Hatch Book is not in the drainage area of the Project. Therefore, an environmental sampling station located on a lower reach of Hatch Book could be used to characterize baseline environmental conditions that are more representative of natural conditions than other stations proposed in the Revised SAP. If the Project is constructed and implemented, an environmental sampling station on Hatch Brook could be used to collect environmental data that would be unaffected by construction and implementation of the Project to compare against data collected at stations on streams that could be affected by the Project.

GSL response: An additional baseline environmental monitoring station on Hatch Brook (station HB-7) has been included with the revised SAP. The suggested location was used for siting the new station and the exact location is provided in the SAP. The suggested monitoring data will be collected beginning with the 2024 baseline study.

b. NHDES recommends removing environmental sampling Station 6 and replacing it with a sampling station at a flowing stream segment of Hatch Brook watershed that is of the same stream order as Station 2 or Station 3b (see the orange circle in the modified version of Figure 3.1, below, for example locations). In the Revised SAP, GSL describes Station 6 as a "reference reach" that is "outside the drainage area of the proposed project but is within the drainage area of other industrial site uses including gravel operations and timber harvesting by the current landowner." Station 6 is within the drainage area of industrial uses that could affect baseline environmental data. An environmental sampling station located in the upper watershed of Hatch Brook would provide a reference reach to collect environmental baseline data that would likely not be affected by industrial uses and could be used to characterize baseline environmental conditions that are more representative of natural conditions than Station 6. NHDES understands that GSL may select an appropriate station location on an upper reach Hatch Brook based on the criteria that GSL provided in this section of the Revise SAP. If the Project is constructed and implemented, an environmental sampling station at an upper reach of Hatch Brook could be used to collect environmental data that would be unaffected by construction and implementation of the Project to compare against data collected at stations on streams of the order that could be affected by the Project.

GSL response: Station 6 will be removed and a new monitoring station in the upper Hatch Brook watershed (HB-7) will be established, as suggested. The revised SAP includes these updates and provides further information on the proposed Upper Hatch Brook monitoring station.

Modified Figure 3.1 of the Revised SAP showing the approximate location of the environmental sampling station recommended by NHDES.



c. If GSL decides to retain Station 6 despite NHDES' recommendation to replace Station 6 in comment 1.b, above; NHDES notes that a small portion of the watershed area that GSL depicted for Station 6 that extends southwest to the edge of Figure 3.1 may not be accurate. NHDES recommends that GSL review the drainage area depicted for Station 6 to confirm the accuracy of the drainage area and make any revisions to Figure 3.1, if necessary, to correct the drainage area depicted for Station 6.

GSL response: Station 6 will be removed for the 2023 monitoring season as detailed in the revised SAP. The watershed map has been reviewed and is accurate for the Station 6 drainage area as based on the available DEM for the watershed.

d. NHDES recommends removing environmental sampling Station 1 because NHDES believes it is unnecessary due to its proximity to sampling Station 2.

GSL response: Station 1 will be removed, as suggested, as detailed in the revised SAP.

e. In Figure 3.1, GSL does not show a watershed in the southeast corner of the area labelled as "Landfill Footprint". NHDES recommends that GSL revise Figure 3.1 to show the watershed of that area.

GSL response: Figure 3.1 had an error and did not correctly depict the watershed area for monitoring station 1. The site map has been updated with corrected watershed layers and is included in the revised SAP.

f. NHDES recommends that GSL include a table in this section to clearly identify which environmental parameters would be evaluated at each station. NHDES recommends the following type of table, which NHDES provides as an example:

Station ID	Task 1: Habitat & Fisheries Assessment	Task 2: Benthic Macroinvertebrate Sampling	Task 3: Continuous Water Quality Monitoring	Task 4: Sample Collection for Color, Turbidity, Nutrients, Toxic Substances	Flow Monitoring or Habitat Assessment Measurements
2	X	X	X	X	X
3A	X (as possible)	X (as possible)	(discrete samples)	X	X (as Part of Habitat Assessment)
3B	X	X	X	X	X (as Part of Habitat Assessment)
4	X	X	X	X	X (as Part of Habitat Assessment)
5	X	X	X	X	X
Hatch Brook Lower Reference Reach	X	X	X	X	X
Hatch Brook Upper Reference Reach	X	X	X	X	X

GSL response: A Table like the example provided above has been included in the revised SAP (See Table XXX).

Based on the Revised SAP, NHDES understands that GSL plans to collect various physical data from stream segments at each station during habitat assessments to establish baseline environmental characteristics, and GSL would use the data sheets provided in Appendix B of the Revised SAP to collect that data. Those data sheets include fields to enter various geomorphic data as well as data for stream depth, stream velocity, and inorganic substrate components (i.e., substrate composition type by percentage). NHDES understands that GSL would be able to use that data to characterize flow at all stations. NHDES recommends that GSL revise the SAP to clarify that it would characterize flow at stations using the data it collects during habitat assessments.

GSL response: Flow will be collected at each station during habitat assessments, as recommended and is detailed in the revised SAP. A flow meter will be used to measure flow velocity and channel cross section geometry will be measured at each site utilizing standard stream gaging techniques to determine a flow rate during each habitat assessment.

g. NDHES recommends that GSL include a table in this section to provide the coordinates, drainage areas, elevation, and average basin slope as a percent.
GSL response: Monitoring station coordinates, drainage areas, elevation, and average basin slope have been determined and are included in Table 3.2 in the revised SAP.

3. *3.5 Task 4: Water Sample Collection and Laboratory Analysis for Color, Turbidity, Nutrients, and Toxic Substances* (p. 16)

a. Regarding streamflow measurements, GSL proposes to deploy a HOBO U20-001 pressure datalogger at surface water quality monitoring Station 2 and at an unnumbered station below the confluence of Alder and Hatch Brook and immediately before the culvert at New Hampshire Route 116. GSL also proposes to utilize qualitative (i.e., visual) streamflow measurements at Station 2 and conduct quantitative streamflow measurements at the unnumbered flow station. Station 2 captures flow from only the southern portion of the landfill. The unnumbered flow station measures flow in a watershed that captures areas unaffected by the proposed Project, which would mask the effects of the proposed Project on flow. Considering these limitations, NHDES recommends relocating streamflow monitoring from the unnumbered flow station to Station 5 and measuring flow at new environmental sampling station on Hatch Brook that NHDES recommends in item 1.a., above. If the Project is constructed and implemented, a flow station on Hatch Brook could be used as a reference station that would collect flow data that would be unaffected by construction and implementation of the Project to compare against flow data collected at Station 5, which could be affected by construction and implementation of the Project.
GSL response: Streamflow monitoring will be discontinued at the RTE 116 culvert and will be relocated to Station 5, as recommended. An additional flow monitoring station will be established at the lower Hatch Brook monitoring station (HB-7), as recommended. Streamflow monitoring at a modified monitoring station 2 location (ABT-2b) will also be conducted (a modified station 2 location was discussed with NHDES and guidance from NHDES was provided in revised comments on 3/30/23). These changes along with further stream gaging details (to address additional NHDES comments provided 3/30/23) are provided in the revised SAP.

Regarding the details of the proposed streamflow monitoring, NHDES recommends that a staff gage be installed at each streamflow monitoring station (i.e., Station 2, Station 5, and the new environmental sampling station on Hatch Brook) and, at each station, a pressure datalogger be surveyed to its related staff gage and a nearby permanent benchmark so that the station can create a continuous stream stage record and be recovered if lost. In addition, because future changes to the stage-discharge relationship will be a primary means to evaluate streamflow changes, NHDES recommends that a minimum of 10 streamflow measurements, instead of the five measurements proposed by GSL, be made at a variety of

stream flows (including a pair of "duplicates" at different times that approximate previous measurements) in order to develop a statistically robust stage-discharge relationship for each station. Five streamflow measurements are inadequate to identify the three typical portions of the stage-discharge relationship (i.e., channel, bankfull, and flood flows) and internal inconsistencies within the stage-discharge dataset that would indicate the need for further data.

GSL response: Staff gages will be installed at the flow monitoring stations, permanent benchmarks will be established, and logger placements and staff gages will be surveyed to the benchmarks, as recommended. The number of streamflow measurements at each flow monitoring station will be increased to a minimum of 10, including a pair of duplicate flows, as recommended. These changes are detailed in the revised SAP.

New Hampshire Department of Environmental Services Follow-Up Items and Comments on the Revised 2022 Granite State Landfill Baseline Environmental Studies: Sampling and Analysis Plan

March 30, 2023

On June 9, 2022, the Watershed Management Bureau of the New Hampshire Department of Environmental Services (NHDES) received an email from Normandeau Associates, Inc. (Normandeau), on behalf of Granite State Landfill, LLC (GSL), that included a document titled, "2022 Granite State Landfill Baseline Environmental Studies: Sampling and Analysis Plan" (Original SAP) for a proposed landfill in Dalton, New Hampshire (Project). In its email, Normandeau requested that NHDES review and provide comments on the Original SAP. On June 23, 2022, NHDES sent an email to Normandeau and GSL that included NHDES' comments on the Original SAP. On July 20, 2022, Normandeau, on behalf of GSL, submitted to NHDES via email a revised SAP (Revised SAP) that addressed many of NHDES' comments and a document containing responses to NHDES' comments on the Original SAP. In its email, Normandeau requested NHDES review and provide comments on the Revised SAP. On September 22, 2022, NHDES sent an email to Normandeau and GSL that included NHDES' comments on the Revised SAP. On October 13, 2022, Normandeau requested that NHDES staff visit the Project site to confirm the representativeness of the surface water quality monitoring network that Normandeau and GSL proposed in the Revised SAP. On November 22, 2022, NHDES staff visited the property and met with staff of Normandeau and GSL. On January 30, 2023, NHDES provided the additional comments on the Revised SAP after observing the proposed surface water quality monitoring stations. GSL requested a meeting to discuss NHDES' comments on the revised SAP and, on March 6, 2023, NHDES met with staff of Normandeau and GSL to discuss NHDES' comments. NHDES provides the following items and additional comments on the Revised SAP to follow-up on the March 6, 2023 meeting.

1. NHDES understands that GSL proposes to relocate Station 2, where GSL collected environmental data in 2022 (Old Station 2), to the same tributary of Alder Brook of Old Station 2, but several hundred meters downstream of Old Station 2 (New Station 2). Considering this relocation, NHDES recommends that GSL revise the Revised SAP to address the following items:

    a. At New Station 2:
        i. Locate the new station and associated survey reach, at least 150 meters upstream of the downstream confluence with Alder Brook.
        ii. Rename New Station 2 to something other than "Station 2", for clarity.
        iii. Collect continuous flow monitoring data and data for all parameters of Tasks 1 through 4 that are described in the Revised SAP.

        GSL response: The new monitoring station name, location, and monitoring parameters for the station 2 replacement are included in the revised SAP.

For clarity – "old station 2" is now monitoring station ABT-2a and "new station 2" is now monitoring station ABT-2b.

b. At Old Station 2:
   i. Collect data for all parameters of Task 1, Task 2, and Task 4 that are described in the Revised SAP.
   ii. According to GSL, collecting continuous flow monitoring data and continuous water quality monitoring of dissolved oxygen and pH is not practical or possible at this location because of the size of the tributary and other environmental factors. Therefore, NHDES recommends removing reference to these parameters for the station from the Revised SAP.
   iii. If possible, collect continuous water temperature data.

   GSL response: Water quality data for Tasks 1, 2, and 4 will be collected at the old Station 2 (ABT-2a), while flow monitoring and continuous water quality data logging will not be collected, as recommended. In addition, a water temperature logger will be deployed at old station 2 (ABT-2a), as requested. These changes are detailed in the revised SAP.

c. At Station 1:
   i. As NHDES recommended in its January 30th comments, NHDES continues to recommend removing Station 1 because NHDES believes it is unnecessary due to its proximity to Old Station 2. NHDES' recommendation is based on NHDES' assumption that GSL will conduct the sampling at Old Station 2 as NHDES recommends in comment 1.b., above.

   GSL response: No further monitoring will be completed at monitoring station 1 and, instead, monitoring will focus on old station 2 (ABT-2a) and a new station 2 (ABT-2b) further downstream on the same tributary to Alder Brook, as detailed in the revised SAP.

2. NHDES understands that GSL plans to establish two environmental sampling stations in the Hatch Brook watershed as NHDES recommended in its January 30th comments. For the station that GSL proposes in an upper reach of the Hatch Brook watershed, NHDES recommends that GSL locate this station so that the drainage area of the station is approximately equal to, and does not exceed, the drainage area of New Station 2. NHDES further recommends that GSL, to a practicable extent, locate this station so that the stream and watershed characteristics of the station (e.g., elevation, stream elevation drop, basin slope, aspect, etc.) are approximately equal to the characteristics of New Station 2.

GSL response: Several potential monitoring locations in the upper Hatch Brook watershed were identified in a desktop review of the watershed and then field-reviewed for suitability in the Spring of 2023. The original proposed monitoring location was on a Hatch Brook tributary located generally north of the main stem of Hatch Brook as identified by NHDES in the January 30, 2023 comments. That tributary was reviewed during high water conditions in Spring 2023 and determined to be unsuitable for monitoring due to the lack of a defined stream channel and dominance of subsurface flow through boulder voids throughout the

tributary (no suitable reaches were identified anywhere on that tributary). A new monitoring station was proposed by GSL on the main stem of Hatch Brook located at the furthest upstream point of the property boundary (HB-9). This new location was discussed with NHDES and was determined to be undesirable due to the much larger watershed area compared to old station 2 (station ABT-2a) and station 3b (station ABT-3b). A new monitoring location on a tributary generally to the south of the main stem of Hatch Brook was discussed with NHDES and field-reviewed and was determined to be the most suitable monitoring location for the upper Hatch Brook watershed (now referred to as station HBT-10). The final location, coordinates, site photos, and site description for the upper Hatch Brook monitoring station HBT-10 are included in the revised SAP.

3. During the meeting, NHDES and GSL discussed antidegradation requirements under Part Env-Wq 1708. NHDES stated that it would provide GSL with a copy of NHDES' antidegradation schematic, which is at the end of this document.

GSL response: The antidegradation schematic is helpful and will be used in our antidegradation analysis.

4. During the meeting, GSL expressed concern that applying EPA's Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers, published in 1999 with document number EPA 841-B-99-002 (EPA RBP), to habitat assessments and macroinvertebrate sampling at environmental sampling stations on small tributaries may not be feasible. NHDES explained that it would follow-up with GSL by recommending alternative procedures. On March 8, 2023, NHDES provided GSL with a hyperlink to EPA's National Rivers & Streams Assessment 2018-19 Field Operations Manual Wadeable, document number EPA-841-B-17-003a (EPA NRSA), which includes procedures for habitat assessments and macroinvertebrate sampling that may be more appropriate than procedures described in EPA RBP. If GSL decides to change any procedures identified in the Revised SAP, NHDES recommends that GSL either revise the Revised SAP to reflect those changes or describe those changes in a final environmental baseline study report. In addition, NHDES expects that GSL will use the same procedures at each station.

GSL response: Overall, habitat and macroinvertebrate sampling conducted per EPA RBP methodology is feasible for use in small streams. GSL understands the primary concerns brought up at the March 2023 meeting included a more quantitative assessment of habitat (NHDES specifically mentioned bottom substrate counts) and the preference by NHDES to utilize rock baskets (per the NHDES macroinvertebrate collection SOP [2013] that is used to calculate the NH BIBI) which was unfeasible due to the width/depth of tributaries. GSL received and reviewed the EPA NRSA field operations manual and has integrated the following aspects into the revised SAP.

Habitat assessment and macroinvertebrate sampling plans for 2023 have been updated and are included in the most recent version of the revised SAP. The habitat assessment in 2023 will be completed using the RBP methods (used during 2022) and supplemented with parts of the NRSA methodology to incorporate greater detail on substrate type, embeddedness, woody debris, and bank characteristics.

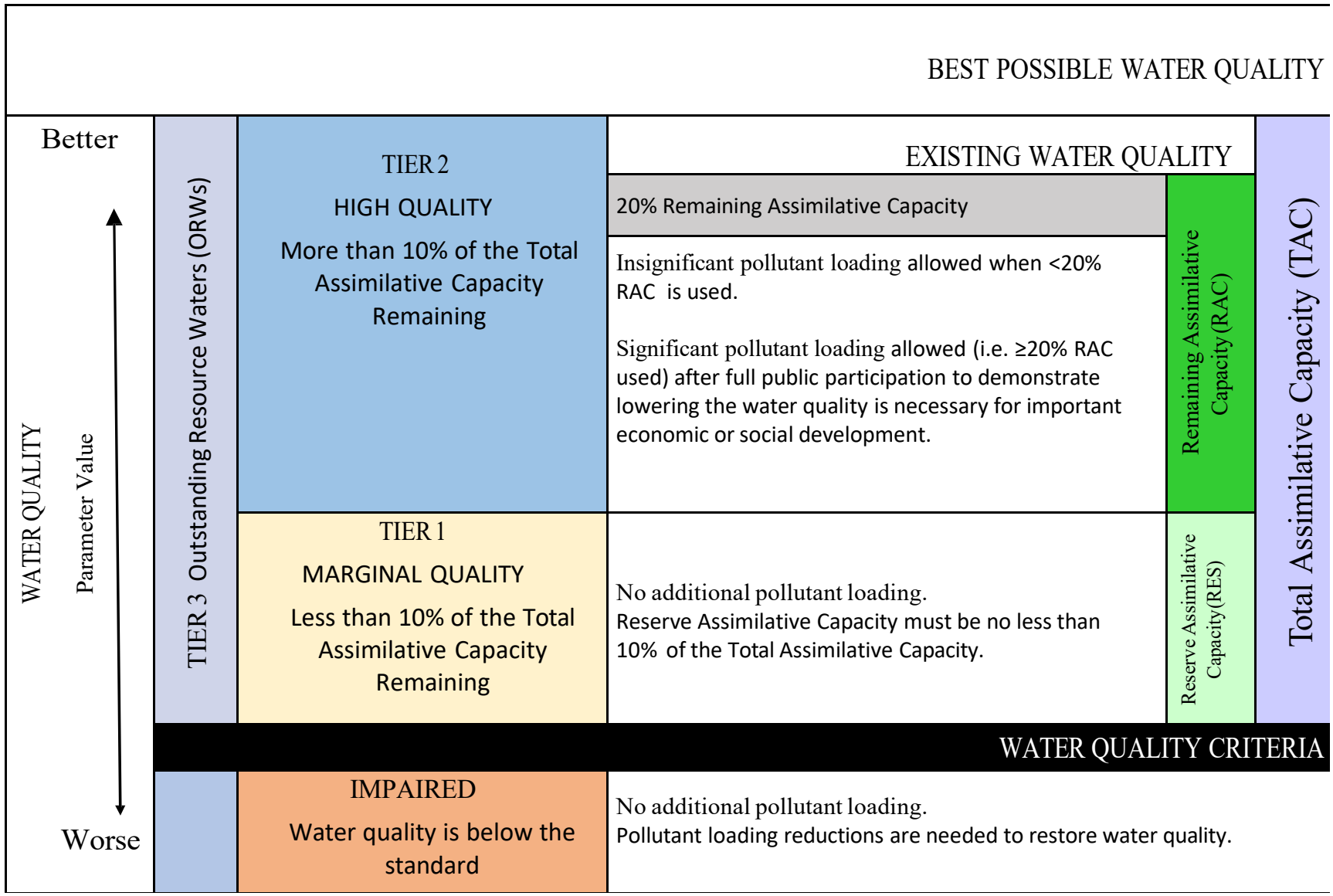
Macroinvertebrate sampling will include the RBP multihabitat sampling at all locations (in order to provide a standard procedure at each station) and rock bags in place of rock basket sampling at the lower Alder Brook Station (Station AB-5) and the lower Hatch Brook Reference Station (Station HB-7). Rock bag sampling will be conducted at these two stations only due to stream size constraints and/or habitat restrictions at the upstream sites.

5. NHDES understands that GSL plans to monitor streamflow with a pressure/level logger deployed at New Station 2, Station 5, a station at a lower reach of the Hatch Brook watershed, and at a station at an upper reach of the Hatch Brook watershed. NHDES recommends that GSL specify that pressure/level loggers will collect data at least every 15 minutes. NHDES expects that GSL will evaluate streamflow at every station as part of its habitat assessments. During the meeting, NHDES explained that it would clarify the latter expectation based on procedures that GSL referenced in the Revised SAP.

In section 3.2.1 *Habitat Assessment* of the Revised SAP, GSL referenced the Habitat Assessment Field Data Sheet and Physical Characterization/Water Quality Field Data Sheet of the EPA RBP. These datasheets include the following scores or fields, among others, that would describe streamflow at the stations: velocity/depth regime; sediment deposition; channel flow status; channel alteration; estimated stream width; estimated stream depth; surface velocity; inorganic substrate components; pebble counts, etc. If GSL decides to use EPA NSRA instead of EPA RBP for its assessments, EPA NRSA contains sample data sheets that include similar scores or fields to evaluate streamflow.

GSL Response: The revised SAP specifies that pressure loggers will collect water elevation data at 15 minute intervals, consistent with other continuous logging data, as requested by NHDES. Stream gaging will occur at each station during the habitat assessment (August 2023).

The Habitat Assessment Field Data Sheet and Physical Characterization/Water Quality Field Data Sheet will be completed in 2023. NRSA methods and data forms (Thalweg Profile and Woody Debris and portions of the Channel/Riparian Cross Section data form) will be included to provide additional information on thalweg depth, wetted width, substrate, woody debris, substrate embeddedness, as well as bankfull width, height, and incision. In-stream substrate will be evaluated and recorded at multiple locations within each station to provide an estimate of proportionate availability, but no specific pebble counts will be made.


BEST POSSIBLE WATER QUALITY
Better
WATER QUALITY
Parameter Value
Worse
TIER 3 Outstanding Resource Waters (ORWs)
TIER 2
HIGH QUALITY
More than 10% of the Total Assimilative Capacity Remaining
EXISTING WATER QUALITY
20% Remaining Assimilative Capacity
Insignificant pollutant loading allowed when <20% RAC is used.
Significant pollutant loading allowed (i.e. ≥20% RAC used) after full public participation to demonstrate lowering the water quality is necessary for important economic or social development.
Remaining Assimilative Capacity(RAC)
TIER 1
MARGINAL QUALITY
Less than 10% of the Total Assimilative Capacity Remaining
No additional pollutant loading.
Reserve Assimilative Capacity must be no less than 10% of the Total Assimilative Capacity.
Reserve Assimilative Capacity(RES)
Total Assimilative Capacity (TAC)
WATER QUALITY CRITERIA
IMPAIRED
Water quality is below the standard
No additional pollutant loading.
Pollutant loading reductions are needed to restore water quality.