Vermont Ambient Biomonitoring Network QAPP

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Version Date: 2024-07-19
Revision: 1
Estimated Project Start and End Dates: September 2024 – October 2029

EPA Grant/Contract/Task Order: PPG
EPA QA Tracking #: QA#24152

Approval Page (A2)

Project Name: Vermont Ambient Biomonitoring Network QAPP

Version Date: 2024-07-19

Plan prepared by: Michelle Graziosi, Vermont Department of Environmental Conservation

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List of Acronyms

ABN – Ambient Biomonitoring Network
ANR – Agency of Natural Resources
BASS – Biomonitoring and Aquatic Studies Section
DQI – Data quality indicators
DQO – Data quality objective
EI – Environmental information
EIO – Environmental information operations
EPA – Environmental Protection Agency
GMNF – Green Mountain National Forest
IWIS – Integrated Watershed Information System
NELAC – National Environmental Laboratory Conference
PARCCS – Precision, accuracy, representativeness, comparability, completeness, sensitivity
PPE – Percent Picking Efficiency
PO – Project Officer
QA – Quality assurance
QAM – Quality assurance manager
QAPP – Quality Assurance Project Plan
QC – Quality control
RPD – Relative percent difference
RSD – Relative standard deviation
SOP – Standard Operating Procedure
SQL – Structured Query Language
VAEL – Vermont Agriculture and Environmental Laboratory
VTAAFM – Agency of Agriculture, Food, and Markets
VTDEC – Vermont Department of Environmental Conservation
VWQS – Vermont Water Quality Standards
WDP – Watershed Data Portal
WSMD – Watershed Management Division
WQX – Water Quality Data Exchange (EPA)
WWTF – Wastewater Treatment Facility

A. Project Management and Data Quality Objectives

1. Project Organization and Personnel (A7 - A10)

The Ambient Biomonitoring Network (ABN) is administered by the Biomonitoring and Aquatic Studies Section (BASS) within the River Science Section of the Vermont Department of Environmental Conservation (VTDEC) Watershed Management Division (WSMD) Rivers Program.

Michelle Graziosi, Supervising Aquatic Biologist for BASS, serves as the Project Manager for this QAPP. Michelle is responsible for general oversight and supervision of ABN activities. She is responsible for maintaining and distributing the QAPP and serves as the primary USEPA contact.

Jim Deshler, Aquatic Biologist for BASS, serves as the Project Operations Manager for this QAPP. He is responsible for conducting and managing ABN operations in the field and in the laboratory.

Meaghan Hickey, Environmental Analyst for BASS, and Connor Quinn, Environmental Technician for BASS, serve as core staff for the project and carry out field and laboratory operations. They also coordinate with internal and external partners on communicating results and data usage.

Aaron Moore, Aquatic Biologist with VTAAFM, serves as the Project Quality Assurance Manager for this QAPP. Aaron is responsible for assessing project compliance with the QAPP and has oversight authority of ABN field and laboratory operations.

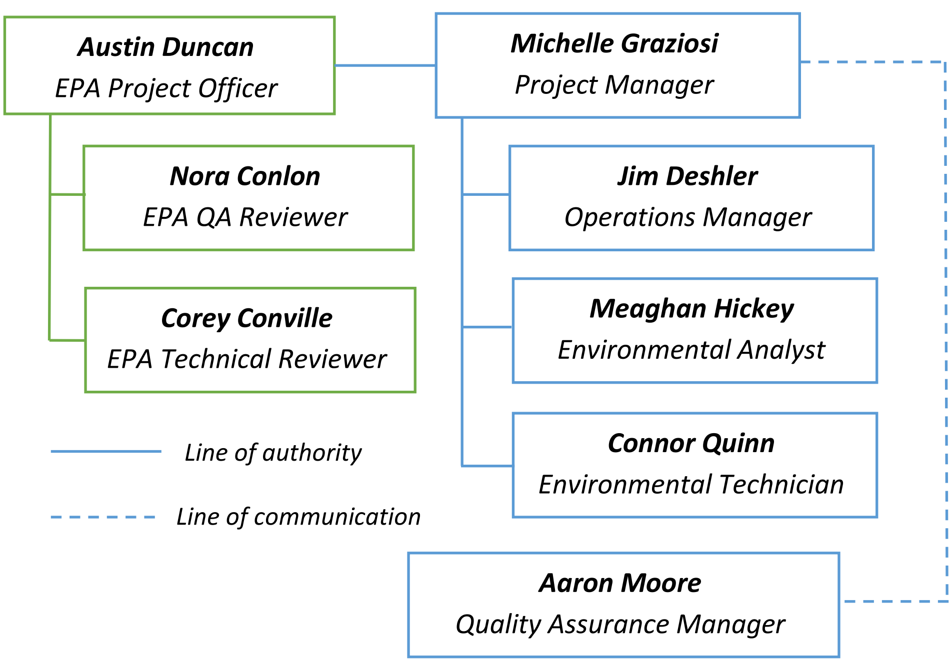

FIGURE 1 VERMONT AMBIENT BIOMONITORING NETWORK ORGANIZATION CHART

TABLE 1 QAPP DISTRIBUTION LIST

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2. Personnel Training and Certifications (A11)

TABLE 2 REQUIRED TRAININGS FOR PROJECT STAFF

Training	Purpose	Staff Required to Participate	Frequency & Timing
Annual ABN Field Training	Review field methods and protocols prior to field season. Review field safety protocols, including electrofishing safety. Ensure consistency and replicability between field staff.	ABN Field Staff	Once per year in late August before the start of the ABN field season.
Annual ABN Lab Training	Review laboratory methods and protocols prior to lab season. Ensure consistency and replicability between lab staff.	ABN Lab Staff	Once per year after field season ends and before lab season begins, typically in late October.
Annual ABN Lab Safety Training	Review laboratory safety protocols including Safety Data Sheets and emergency procedures. Ensure all lab staff are following the Chemical Hygiene Plan.	ABN Lab Staff	Once per year in late spring/early summer
CPR, First Aid & AED Training	Equip staff with CPR, First Aid, and AED skills.	ABN Field Staff	Recertification is needed every two years.

Table 3 Additional Training Encouraged But Not Required

Training	Purpose	Staff Encouraged to Participate	Frequency & Timing
Wilderness First Aid Training	Equip staff with additional first aid skills to handle emergencies in remote situations	ABN Field Staff	Recertification schedule is every two years.
Society for Freshwater Science Taxonomic Certification	Demonstrate staff taxonomic proficiency with specialized groups	ABN Taxonomists	Recertification schedule is every five years.

3. Project Purpose, Problem Definition, and Background (A4)

Project:

The Vermont Ambient Biomonitoring Network (ABN) collects water chemistry samples, records physical habitat information, and conducts surveys of two aquatic biological community types: macroinvertebrates and fish.

Purpose:

The Vermont Ambient Biomonitoring Network monitors and evaluates water quality status and trends of Vermont's flowing wadeable waters through surveying two aquatic biological community types: macroinvertebrates and fish. Water chemistry and physical habitat data are also collected to inform biological assessments. The purpose of these monitoring activities is to increase our understanding of the biological condition of Vermont's flowing waters to inform data-driven policy and management efforts to protect and restore stream ecosystems.

Problem Definition:

The Clean Water Act of 1972 (CWA, 2018) requires that states establish water quality standards to "restore and maintain the chemical, physical, and biological integrity of the nation's waters". Vermont Water Quality Standards require streams and rivers in Vermont to meet minimum biological criteria for macroinvertebrate and fish communities (VTDEC, 2022a) as determined by assessments completed by ABN. Freshwater ecosystems are under constant threat from multiple anthropogenic stressors at the riparian, watershed, and atmospheric scale. ABN serves the critical function of assessing the condition of flowing waters in Vermont and meeting the objectives of the Clean Water Act.

Goal:

The goal of the Vermont Ambient Biomonitoring Network is to conduct scientifically rigorous assessments of biological condition that inform data-driven policy, management, and remediation actions that lead to the protection and restoration of Vermont's stream ecosystems.

Objectives:

1) Determine if streams or rivers meet Vermont Water Quality Standards for Aquatic Biota Use based on biological assessments of macroinvertebrates and fish. Waters that fail to meet biocriteria standards are put on the 303(d) List of Impaired Waters.
2) Evaluate impacts to Vermont's flowing waters from permitted direct and indirect discharges, development projects, non-point sources, spills, agricultural and urban runoff, acidification and other disturbances affecting freshwater ecosystems.
3) Monitor long-term trends in water quality based on changes in aquatic biological communities through the maintenance of a statewide sentinel site network, participation in the EPA Regional Monitoring Network, and implementation of a 5-year rotational approach to statewide monitoring.
4) Assess statewide status and trends in biological condition of Vermont's wadeable streams and identify major stressors impacting waters statewide through annual probabilistic monitoring.
5) Identify waters in or near their natural condition based on our database of Vermont-specific reference streams and use these reference streams to update our Vermont-specific biological criteria to enhance our ability to identify stressors impacting aquatic biological communities.

Background:

Vermont Department of Environmental Conservation (VTDEC) biologists began implementing a statewide wadeable stream biomonitoring program in the early 1980's, and adopted standardized, quantitative macroinvertebrate and fish field collection and sample processing methodologies in 1985 (VTDEC, 2004). These same protocols have been in use for over 35 years with no significant changes, resulting in high-quality and consistent biological data from thousands of sampling events within a small geographical area compared to most other states.

In 2004, VTDEC biologists published numerical biological criteria (i.e., biocriteria) for assessing biological integrity in wadeable hard-bottom streams (VTDEC, 2004). This was followed by the development of biocriteria for wadeable, low gradient streams in 2013. Vermont established this tiered framework for assessing biological integrity in State statute in the 2017 Vermont Water Quality Standards (VWQS) and subsequent revisions (VTDEC, 2022a). Aquatic biota can be categorized as not attaining minimum standards, meeting minimum standards (B(2), a moderate departure from the natural condition), or can meet higher classification levels (B(1), a minimal departure, or A(1), resembling the natural condition). Macroinvertebrate communities in Vermont are subsequently assessed along a scale from 'Poor' (severely degraded and not attaining minimum standards) to 'Excellent' (meeting A(1) biological condition). BASS is currently working on an update to our macroinvertebrate biocriteria based on an additional twenty years of biological and chemical sampling.

4. Project Task Description and Schedule (A5)

ABN monitoring activities follow a statewide five-year rotating basin approach. Each year, three of Vermont's 15 major river basins are targeted for biomonitoring; with this approach, each watershed is prioritized every five years. BASS staff collaborate with internal and external partners to identify and prioritize sites for biomonitoring for a variety of purposes such as data gaps, potential impairments, identification of reference sites, determining permit compliance, evaluating land use impacts, and special studies. Additional monitoring is conducted outside the target basins each year for a variety of purposes, such as the statewide sentinel stream network of 12 reference streams that are monitored annually, the statewide probabilistic survey of 16 randomly selected sites throughout the state (VTDEC, 2021), and additional high-priority monitoring sites for time-sensitive permit renewals or impairment issues. BASS staff also review biological data submitted by consultants for a variety of projects. In total, approximately 150-200 sites per year are assessed for macroinvertebrates, and approximately 50-70 sites per year are assessed for fish. Macroinvertebrate samples are processed by BASS staff at the Vermont Agriculture and Environmental Laboratory at 163 Admin Drive, 05060. Assessments are completed and data are reported to the interested parties listed in Table 5 before the start of the next field season. Field and laboratory methods and protocols are described in detail in the WSMD Field Methods Manual (VTDEC, 2022b).

Table 4 ABN Project Schedule

Project Task	*June 2024*	*July 2024*	*Aug 2024*	*Sep 2024*	*Oct 2024*	*Nov 2024 – April 2025*	*May 2025*	*June 2025*	*July 2025*	*August 2025*
QAPP Preparation and Approval	■	■	■							
ABN Fieldwork & Sample Collection				■	■					
Laboratory Sample Processing					■	■	■			
Data Validation and Review							■	■		
Assessment Complete									■	■

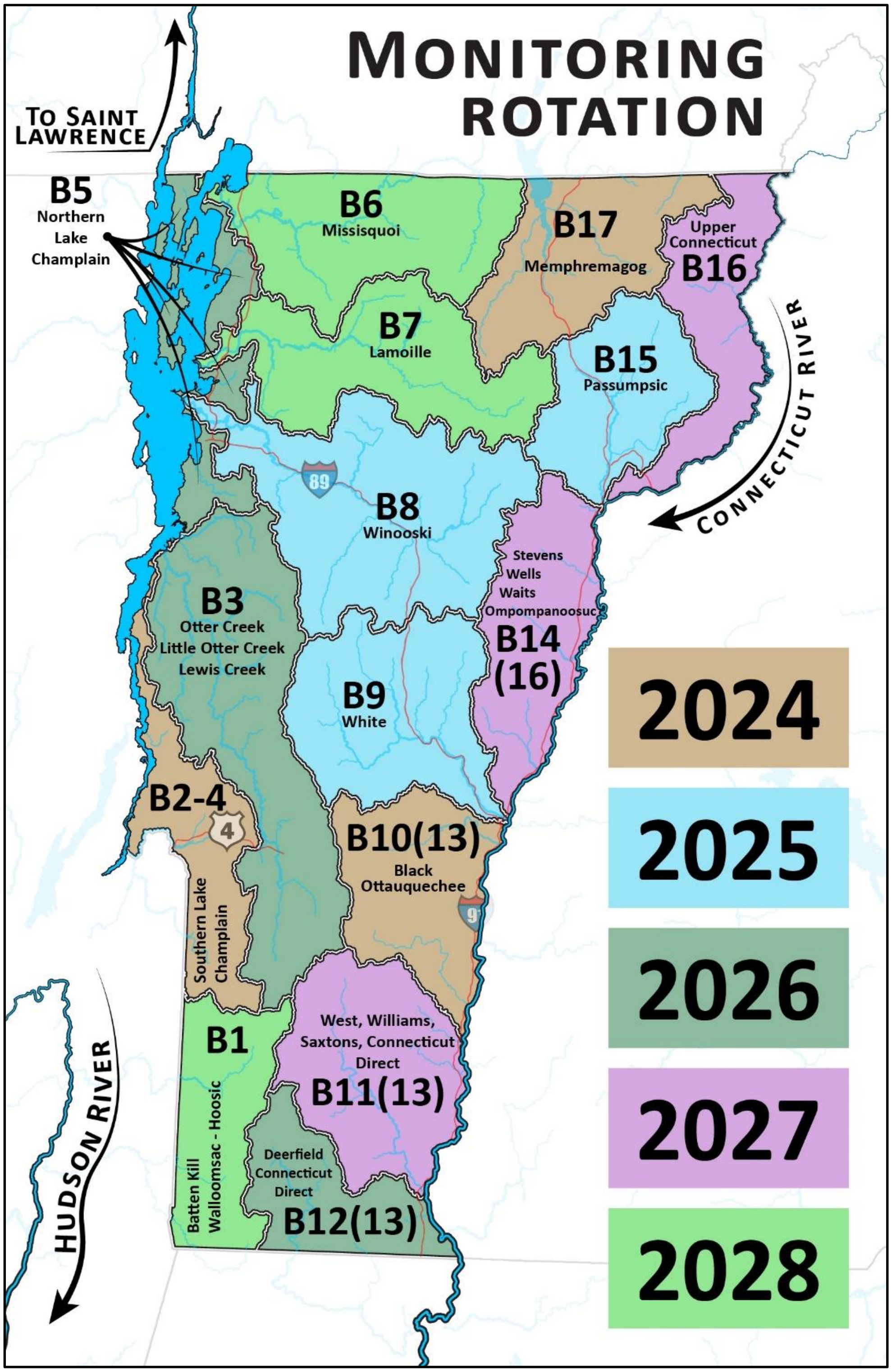

FIGURE 2 MAP OF VERMONT BASINS AND MONITORING ROTATION 2024-2028

TABLE 5 MAIN ABN DATA USERS

User	Purpose
WSMD Wastewater Management Program	Reasonable potential determinations, assessing impacts from direct discharges, evaluating permit compliance with VWQS
WSMD Stormwater Program	Evaluating impacts from stormwater on streams
WSMD Rivers Program	Evaluating the relationship between physical habitat, geomorphic condition, and biological condition
WSMD TMDLs, Assessment, Standards, and Compliance Program	Evaluating attainment status with VWQS, identifying impaired waters for the 303(d) list, gathering data on potential compliance and enforcement issues
WSMD Wetlands Program	Comparing low gradient stream data to wetlands bioassessment data
VTDEC Water Investment Division	Describing condition and characteristics of waters monitored in Tactical Basin Plans, identifying potential protection and restoration projects.
VTDEC Waste Management & Prevention Division	Evaluating impacts from hazardous waste sites and spill events
VTDEC Drinking Water & Groundwater Protection Division	Determine compliance with indirect discharge rules and permits
Vermont Fish and Wildlife Department	Evaluating conservation status of aquatic invertebrates and distributions of various fish species
External partners, local watershed organizations, consultants	Evaluate water quality status for a variety of projects related to development, protection, or restoration
Researchers and collaborators	Conduct analyses to explore various stream ecology research questions

5. Data Quality Objectives (A6)

The goal of the Ambient Biomonitoring Network is to generate high-quality and defensible biological and chemical data that can be used to support program objectives. This is accomplished through regular training and review of established field and laboratory methods. Data quality and defensibility are measured using the data quality indicators described below.

5.1 Macroinvertebrate Data

To ensure that all BASS staff are collecting and processing macroinvertebrate samples in a consistent and replicable manner, the Annual ABN Field training and Annual ABN Lab training (Table 2) occur at the start of the field and laboratory season, respectively. These provide an opportunity for experienced and newer members of the team to discuss and practice field and laboratory methods and resolve any discrepancies to ensure maximum levels of precision, accuracy, replicability, and completeness. Biomonitoring staff are considered qualified once they can successfully perform field and laboratory tasks in a manner that meets the data quality objectives for the below indicators. VTDEC field and laboratory methods for macroinvertebrate sample collection and processing are described in detail in Section 6.5 of the WSMD Field Methods Manual (VTDEC 2022). The data quality indicators below are ways in which BASS measures and quantifies the quality of macroinvertebrate data generated by the ABN project. Data quality indicators are analyzed on an annual basis and results have been summarized in an annual Biomonitoring Quality Assurance and Quality Control Report since 2010 in accordance with the previous version of the ABN QAPP (VTDEC 2018).

Table 6 Data Quality Indicators For Macroinvertebrate Data

Data Quality Indicator	PARCCS Parameters	Metric	QC Activities	DQI Criteria
Sample Method Precision	Accuracy, Precision, Comparability, Representativeness	Relative Percent Difference (PRD)	Collection of macroinvertebrate samples and field replicates	10% of all samples collected analyzed for RPD annually No greater than 40% RPD in density No greater than 20% RPD in richness
Sample Method Precision	Accuracy, Precision, Comparability, Representativeness	Bray-Curtis Dissimilarity Index	Collection of macroinvertebrate samples and field replicates	TBD based on evaluation in future years
Picking Completeness and Accuracy	Accuracy, Completeness, Comparability	Percent Picking Efficiency (PPE)	Laboratory processing of macroinvertebrate samples	10% of all samples analyzed for PPE annually No greater than 10% PPE for samples analyzed
Taxonomic Count Precision	Accuracy, Precision, Comparability, Completeness, Representativeness	Percent Difference in Enumeration (PDE)	Taxonomic identification of macroinvertebrate samples	5% of all samples analyzed for PDE annually No greater than 5% PDE for samples analyzed
Taxonomic Identification Precision	Accuracy, Precision	Percent Taxonomic Agreement	Taxonomic identification of macroinvertebrate samples	5% of all samples analyzed for PTA annually A minimum of 85% PTA for samples analyzed

5.1.1 Sample Method Precision

All macroinvertebrate samples are collected using standardized protocols as described in the WSMD Field Methods Manual (VTDEC 2022) to assure representativeness of true biological condition and comparability between samples. For hard-bottom streams, samples are collected from riffles where the water velocity is greater than 0.2 feet/second and the depth is less than 1 meter. For low gradient reaches, samples are collected from best available habitat in that reach with sub-habitat types noted during collection.

Macroinvertebrate sample replicates are collected during the same sampling event at the same site. Macroinvertebrate sample duplicates are collected under identical field conditions from riffles in hard-bottom reach habitats or sweeps in best available low gradient habitats. Replicates from a minimum of 10% of sites sampled are targeted for laboratory processing and analysis of RPD. Sampling method precision is determined by calculating the relative percent difference (RPD) between replicates, with the data quality objective (DQO) maximum set at 40% for density, and 20% for total richness.

Relative Percent Difference (RPD) = $|x1 - x2| / [(x1 + x2) / 2] \times 100$
x1 = value (richness or density) calculated from primary sample
x2 = value (richness or density) calculated from field replicate

Data for each sample collection are entered into electronic biomonitoring field forms (Appendix A). Field replicates at a given site can either be collected by the same biologist or by different biologists. Analyzing replicates collected by the same biologist can help quantify the inherent natural variability in the macroinvertebrate community, as well as inconsistencies in the collector's sampling technique. Conversely, replicates collected by different biologists quantify inconsistencies in sampling technique between two biologists using the same methodology. When a new staff member joins the BASS team, they must demonstrate the comparability of their replicates to primary samples collected by experienced staff to ensure replicability and consistency between sample collectors.

During the RPD analysis, if replicates are found to exceed DQO criteria for density and/or richness, the QA manager identifies and documents the cause and corrective action. At the time of sampling, supplemental information such as sub-habitat types (for low gradient samples), in-situ water chemistry measurements and qualitative physical habitat observations are recorded in the field sheet. These data provide valuable context to analyzing and interpreting results from macroinvertebrate samples and can help to identify potential causes for variation between replicates such as limited habitat or challenging flow conditions. The collector(s) who did not meet DQI criteria for RPD may require additional training and calibration with other staff to show that corrective actions are employed and the DQI criteria are met during the next sampling season.

While analyzing RPD for density and richness between field replicates provides a reliable method of evaluating sample method precision, QAQC analyses conducted over the past several years using VTDEC biomonitoring data suggest that there might be limitations to using just these DQIs. To more holistically evaluate differences between replicates and determine the implications of any variations on the ABN project objectives, replicates were assessed separately using VTDEC biocriteria for the community type that the sample represents. In many cases, no relationship was found between replicates that exceeded the DQI criteria for density and/or richness and replicates with assessments that varied significantly (defined as differing by one or more assessment 'step'). To more holistically evaluate the degree of similarity between replicates, the 2020 Biomonitoring QAQC Report recommended incorporating the Bray-Curtis Dissimilarity Index (Bray & Curtis, 1957, Bobbitt, 2022) into future analyses of sample method precision (VTDEC 2021b). Future QAQC analyses will explore the utility of the Bray-Curtis Dissimilarity Index in comparing field replicates. A dissimilarity index of zero represents replicates that are identical, while a dissimilarity index of one represents replicates that are completely dissimilar.

Bray-Curtis Dissimilarity Index (B_{ab}) = 1-(2*C_{ab}) / S_a S_b)

C_{ab} = sum of lesser values for the species found in each replicate

S_a = the total number of specimens counted in replicate A

S_b = the total number of specimens counted in replicate B

5.1.2 Picking Completeness and Accuracy

The first step in macroinvertebrate sample processing is the removal (picking) of organisms from sediment, leaf litter, and other detritus in the sample. After the organisms have been initially removed, the remaining material is checked by a qualified biomonitoring staff member who was not the initial picker. To ensure picking completeness and accuracy by the sample checker, 10% of all macroinvertebrate samples are randomly selected for a second quality control (QC) check. The first sample checker does not know whether the sample will be subject to a second quality assurance check until they have completed their removal of organisms. For samples selected for a QC check, a third qualified biomonitoring staff member searches the subsample and counts any organisms left behind. The data quality indicator (DQI) for picking completeness and accuracy is measured by Percent Picking Efficiency (PPE). The DQI criterion for PPE is no greater than 10% of the total number of organisms in the subsample are recovered during the QC check.

Percent Picking Efficiency (PPE) = (Nr / (N_o + Nr)) x 100

N_o = original number of organisms found by picker and checker

Nr = number of organisms missed and found during QA check

If a sample is found to have greater than 10% of the total number of organisms remaining, the QA Manager identifies and documents the cause and corrective action. Causes may include rushing through the sample check, tendency to overlook a cryptic organism, too much detritus or sand in the picking tray, too much water in tray, and or incorrect use of subsample blocks in the picking tray. The sample checker who did not meet the DQI criterion for PPE needs to be QC checked on their next sample to show that corrective actions are employed at the 10% criterion is met.

Subsample size, presence of major taxonomic groups, and the names of the picker, checker, and (if applicable) QC checker are indicated for each sample on the Benthos Lab Sheet (Appendix B). The organisms are then sorted by taxonomic order for further identification and this information is then entered into the Benthos Excel Data Sheet (Appendix C) where taxonomists enter their taxonomic data as the sample is processed.

5.1.3. Taxonomic Count Precision

Taxonomic count precision is quantified by enumeration (counts) of samples designated for taxonomic precision analysis, which is 5% of total samples collected each year. Samples are chosen for taxonomic precision analysis so that a wide variety of macroinvertebrate community types and water quality conditions are represented. Specimens are processed in the biomonitoring laboratory, then enumerated and identified by BASS biomonitoring taxonomists. Specimens are then sent to an independent taxonomic laboratory to be enumerated and identified again. The datasets generated by the two labs are compared and analyzed for taxonomic count precision.

Determining count precision can identify tally errors or problems with loss of organisms while handling samples. This also helps to identify differences in counting specimens that are damaged or missing certain body parts.

Variability in counting precision is determined by calculating the total percent difference in enumeration (PDE) between two sets of taxonomic identifications, with the DQI criterion set at a maximum of 5% difference in counts for each sample.

Percent Difference in Enumeration (PDE) = ((n1 – n2) / (n1 + n2)) x 100
n1 = number of organisms counted in sample by primary taxonomist
n2 = number of organisms counted in sample by secondary taxonomist

Based on previous Biomonitoring QAQC Reports, the DQI criterion of 5% for PDE is almost always met (VTDEC 2023). However, if the QA Manager finds that the DQI criterion for PDE is not met, they can analyze the sample information on a case-by-case basis to determine the cause of the error and determine corrective actions, which may include taking greater care in accounting for, transporting, and analyzing specimens.

5.1.4. Taxonomic Identification Precision

Taxonomic identification precision is calculated by determining the number of positive agreements between two taxonomists and dividing that by the total number of organisms in the sample. The DQI criteria for percent taxonomic agreement (PTA) is no less than 85%

Percent Taxonomic Agreement (PTA) = ($Comp_{pos}$ / N) x 100
$Comp_{pos}$ = number of positive comparisons (agreements resolved to lowest possible taxonomic resolution)
N = total number of specimens in the larger of the two counts

VTDEC generally aims for the lowest possible taxonomic level at which biologists can provide accurate information. This can vary depending on the taxonomic group and the taxonomist's level of comfort with the organisms. However, there are consistent expectations pertaining to which groups can be identified to a particular taxonomic level. For example, most Trichoptera are identified to genus, however some genera (i.e. Hydropsyche sp., Brachycentrus sp., and Rhyacophila sp.) are typically identified to species.

Stribling and Moulton (2003) recommend that taxonomic agreements only be counted when they are found at a "targeted" level of identification. For example, if genus level taxonomy is the target, Heptageniidae imm. and Epeorus sp. would not count as an agreement. This very conservative measure of precision, referred to here as "PTA_{exact}", requires that both taxonomists have resolved the identification to the exact same lowest possible taxonomic level. PTA_{exact} does not allow for much personal judgement in level of identification. For this reason, VTDEC uses a second measure of precision, "$PTA_{combined}$", which allows for agreements to be tallied at different hierarchical levels (e.g. Heptageniidae imm. and Epeorus sp. would count as an agreement). While $PTA_{combined}$ is used to assess the DQI, looking at both measures of PTA provides an indication on the specific nature of any taxonomic inconsistencies between the two laboratories.

Higher PTA values indicate greater overall taxonomic precision and agreement between taxonomists and laboratories. If disagreements affect specimens in either single or multiple samples throughout the entire data set, then those samples can be isolated and evaluated further for corrective reidentifications. Most disagreements are hierarchical in taxonomic level and have a relatively small effect on the biological assessment outcome. While the DQI criteria is calculated across the entire sample, the QA Manager also calculates PTA differences by taxonomic order to identify groups in need of improvement regardingtaxonomic precision. The corrective action is to establish the critical taxonomic characteristics necessary to correctly identify organisms and/or to determine the lowest practical taxonomic level, and come to an agreement between laboratories. After a discussion between laboratories to resolve discrepancies, samples are archived by sample ID number and major taxonomic groupings to insure a long-term record.

Taxonomic accuracy is achieved using published taxonomic keys for each taxonomic order. VTDEC updates this list annually to reflect the most recent scientific literature and taxonomic groupings. An identification confidence level is assigned to each determination by the taxonomist following the recommendation of USEPA BIOS. A reference collection of all identified taxa is maintained at the VAEL, assuring consistent identifications. Once a BASS staff member has demonstrated consistent proficiency in correctly identifying a taxonomic order of aquatic macroinvertebrates to an experienced BASS staff member, they are cleared to independently conduct identifications. Two BASS biologists are trained in each taxonomic group for in-house identification. BASS staff keep current with taxonomic changes regularly by consulting the Integrated Taxonomic Identification System (ITIS), participating in the regional annual NAB conferences and discussion with other professional regional taxonomists, and by pursuing taxonomic certifications through the Society for Freshwater Science when possible. Finally, all samples are permanently archived by sample log-in identification number and major taxonomic groupings to insure a long-term record. All archived specimens are curated by BASS in locked fireproof storage cabinets located at the Vermont Agriculture and Environmental Laboratory at 163 Admin Drive, Randolph Center, VT.

After taxonomic identification of macroinvertebrate samples is complete, data are then analyzed using VTDEC biocriteria for assessing macroinvertebrate communities, described in Appendix G of the Vermont Water Quality Standards (VTDEC, 2022a) to assess biological integrity of the macroinvertebrate community. Assessment data re then utilized to achieve BASS project objectives. Macroinvertebrate data sensitivity to changes in the environment is well-documented and analyzed in depth in Wadeable Stream Biocriteria Development and Implementation Methods for Fish and Macroinvertebrate Assemblages in Vermont Wadeable Streams and Rivers (VTDEC, 2004).

5.2 Fish Data

To ensure that all BASS staff are conducting fish surveys in a consistent and replicable manner, the Annual ABN Field training (Table 2) occurs at the start of the field season. This provides an opportunity for all crew members to review standard protocols for selecting a representative reach at a given stream site, conducting a fish survey in a consistent and replicable way, and ensuring precision and accuracy in fish enumeration and identification. Fish surveys are conducted via backpack electrofishing using standard methods. Fish are enumerated and identified in the field by qualified BASS staff members who have demonstrated proficiency in fish species identification under the guidance of the BASS Fish Biologist. Site comparability and replicability is evaluated by re-sampling of known reaches or comparing new reaches to a database containing 40 years of fish community survey data. Photos are taken when fish identification is unclear for further review by fish biologists external to BASS to ensure precision and accuracy. Detailed information about the sample reach, including flow category, physical habitat observations, and proportion of sub habitat types (riffle, run, pool) help to further contextualize the results and understand factors impacting survey efficacy. VTDEC methods for fish community surveys are described in detail in Section 6.7 of the WSMD Field Methods Manual (VTDEC, 2022b) and safety protocols are described in the

VTDEC Safety Policy for Electrofishing Operations (VTDEC, 2018). Vermont Indices of Biotic Integrity for assessing fish communities are described in Appendix G of the Vermont Water Quality Standards (VTDEC, 2022a).

5.3 Chemistry Data

TABLE 7 DATA QUALITY INDICATORS FOR CHEMISTRY DATA

Data Quality Indicator	PARCCS Parameters	Metric	QC Activities	DQI Criteria
Sample Method Precision	Accuracy, Precision, Comparability, Representativeness	Relative Percent Difference (RPD)	Collection of water chemistry sample replicates	10% of all samples collected analyzed for RPD annually Field replicates are analyzed by parameter. Results with >10% RPD are investigated for potential causes and flagged with a qualifier indicating the RPD threshold was not met.
Sample Method Precision	Accuracy, Precision, Comparability, Representativeness	Results Out of Range	Evaluation of results from in situ measurements and laboratory analyses and comparison to historical data for a given site	Results Out of Range is a test that flags results that are either very high or very low for a given parameter and compares the newly collected result to historical ranges. Results Out of Range are evaluated on a case by case basis to determine if the data point requires a qualifier or if the cause is attributable to environmental conditions (i.e. freshet event) or sampler error.
Result Validation	Accuracy, Precision, Comparability, Completeness, Representativeness	Conductivity Check	In-situ measurements of pH and conductivity are checked against the calculated values for conductivity based on laboratory analyses of cations and anions	The measured conductivity must be within 10% of the calculated conductivity based on the laboratory analyses of cations and anions.

In Situ Measurements	Accuracy, Precision, Comparability	Calibration Record	All water quality monitoring sondes and meters are calibrated using standard calibrants once per week to ensure accurate measurements. Pre and post calibration readings are recorded in a calibration record. Regular maintenance of sondes ensures measurement of quality results.	Regular calibration of each parameter measured in-situ by water quality monitoring sondes creates reliable and accurate in-situ measurements when procedures in the WSMD Field Methods Manual (VTDEC, 2022b) are followed. Calibration issues are addressed weekly. Consistency between sondes are checked by collecting in situ measurements with multiple units simultaneously at regular intervals.
Laboratory Analyses	Accuracy, Precision, Comparability	VAEL Data Review and Validation Process	Sample blanks and matrix spikes in addition to other QC measures are performed by VAEL staff to ensure proper equipment functioning and production of quality results.	Meet criteria for data validation specified in the VAEL Quality Systems Manual (VAEL 2021)

Water chemistry data are collected to help identify factors impacting aquatic biological communities (macroinvertebrates and fish). Water chemistry data are also collected in streams and rivers where biological communities are not sampleable using established VTDEC methods. Water chemistry data provide valuable insights into the chemical characteristics of a waterbody. This information directly contributes to the objectives of the ABN project.

The quality of water chemistry data collected by BASS staff is ensured by following the collection procedures described in Section 4 (In Situ Water Chemistry Measurements) and Section 5 (Water Sample Collection Methods) in the WSMD Field Methods Manual (2022b). Precision and accuracy of in situ measurements are achieved through following the established calibration and maintenance schedule for field probes, and by comparing in situ measurements to laboratory-analyzed samples for the same parameter (i.e., turbidity). Replicability and comparability are achieved by following the same standard protocols at each monitoring site. For water samples collected for laboratory analysis, a target of 10% of sampling events are targeted for field replicates of water chemistry samples. These data are then analyzed along with any outliers to determine consistency and precision in field sampling technique. Nearly all water chemistry samples collected by BASS are analyzed at the Vermont Agriculture and Environmental Laboratory (VAEL). Measurement performance criteria are calculated following methods provided by the VAEL Quality Systems Manual (VAEL 2021).

The quality of chemistry data are assured per the data quality indicators described above in Table 7. In-situ chemistry data are uploaded to DEC databases shortly after measurements are recorded in the field along with all field data entered through the Electronic Field Form. Results from laboratory analyses can take up to 30 days from the day of collection to be finalized by VAEL. Once the results from laboratory analyses have been fully validated and approved by VAEL, results are retrieved by BASS staff using the WINLims online laboratory management system. These data are then staged in QC review tables where the PRD, Results Out of Range, and Conductivity Check are evaluated. Alignment of sample location and collection time between in situ and laboratory results are also ensured during the chemistry QC review process. Once the QC review is complete, data are uploaded to the DEC Watershed Data Portal and EPA WQX. Data are flagged if the DQI criteria are not met.

6. Documentation and Records Management (A12)

The Project Manager is responsible for maintaining the QAPP. Updates or revisions will be communicated to people on the Distribution List (Table 1) via email. The table below describes the location of data, records, and documents related to the ABN project. Data located on the VTDEC Internal Server is available to BASS staff and is continually updated and backed up by IT staff for VTDEC.

TABLE 8 DOCUMENTATION AND RECORDS LOCATION AND MANAGEMENT SCHEDULES

Record or Document	Location(s)	Update/Backup Schedule
ABN QAPP	VTDEC QAPP Archive VTDEC Internal Server (Y: Drive)	Every 5 Years
Biomonitoring QAQC Report	VTDEC Internal Server (Y: Drive)	Annually
Probabilistic Monitoring Report	VTDEC Internal Server (Y: Drive)	Annually
Additional Reports	VTDEC Internal Server (Y: Drive)	As needed
WSMD Field Methods Manual	WSMD Website VTDEC Internal Server (Y: Drive)	As needed
VAEL Quality Systems Manual	VAEL Website	As needed
ABN Macroinvertebrate Data	Benthos Excel Sheets on Y:Drive SQL Database VTDEC Watershed Data Portal	Uploaded and backed up as samples are completed
ABN Fish Data	Biomonitoring Electronic Field Forms SQL Database VTDEC Watershed Data Portal	Uploaded and backed up as samples are completed
ABN Water Chemistry Data (in situ)	Biomonitoring Electronic Field Forms VAEL WinLIMS Lab Information System	Uploaded and backed up as samples are completed
ABN Water Chemistry Data (laboratory analysis)	SQL Database VTDEC Watershed Data Portal	Semi-annually

	EPA WQX	
ABN Physical Habitat Observations	Biomonitoring Electronic Field Forms SQL Database VTDEC Watershed Data Portal	Uploaded and backed up as samples are completed

B. Environmental Information Operations

1. Project/Sampling Design and Rationale (B1)

The scope of ABN is to evaluate biological condition using macroinvertebrate and fish communities in Vermont's wadeable rivers and streams. Based on an analysis of river miles in Vermont categorized by stream order, it is estimated that this includes approximately 90% of all river and stream miles in Vermont. Currently VTDEC does not have established methods for sampling or evaluating biological integrity of non-perennial or non-wadeable rivers. Data collection in non-perennial or non-wadeable rivers is limited to water chemistry collection. VTDEC also does not currently have methods for utilizing algae and/or periphyton communities for purposes of biological assessment.

With a small team to cover the entire state, VTDEC seeks to maximize the most efficient use of available resources to collect high quality environmental data. ABN sampling design utilizes targeted sampling based on collaboration with external stakeholders and watershed planners, except for a small percentage of sites each year that are randomly selected through the statewide probabilistic survey. Sites are targeted for monitoring for a variety of reasons, such as to determine attainment with VWQS, to identify stressors, to gather evidence for 303(d) impairment listings, to evaluate impacts of direct and indirect discharges, to study long-term trends, or to assess the impacts of land use changes such as logging, agriculture, or development. Section A4 (above) describes the rotational basin approach to monitoring that allows the entire state to be covered every five years. Figure 2 (above) shows a map of Vermont's major watersheds and the rotational monitoring schedule for the duration of this QAPP, 2024-2028. The final site list for each sampling season represents the highest monitoring priorities out of a list of over 400 sites that are nominated for monitoring annually based on various requests from stakeholders and involvement in ongoing monitoring projects. The site selection is on-going as sites are requested or identified for monitoring need through tactical basin plans or other statewide analyses. The site lists are compiled in February-March prior to each sampling season as part of a Division-wide effort to map and coordinate monitoring sites in all waterbody types. The site list is then prioritized and finalized from April – August prior to the sampling season by BASS staff, who evaluate each site for monitoring need and current data availability. Sites are assigned a priority value based on sampling purpose to narrow down site lists to what can be accomplished in a sampling season.

Since sample locations vary year to year and the process of site selection is on-going giving the needs of the Watershed Management Division and involvement in various projects, exact locations for the next five years of this project are not yet determined. ABN monitoring activities are tracked using a master spreadsheet referred to as a Monitoring Matrix, which specifies sample location, the type of sampling that will occur, the purpose for the site selection, as well as additional details about site prioritization. Please see Appendix D. ABN Monitoring Site List Example for an example from a previous year of site locations, sampling rationale/purpose, and types of samples that are collected during a typical sampling year. Note that this list changes from year to year based on the rotational basin and other pressing monitoring needs for reasons described earlier in this QAPP.

Macroinvertebrate and fish samples can only be assessed using VTDEC biocriteria when samples were collected during the index period of late August – mid October. Additional biological samples are collected outside of this window for special studies. Water chemistry sampling always accompanies biological sampling to provide supplemental information about instream condition impacting aquatic biological communities. Additional water chemistry samples are also collected from May – October, largely to help inform reasonable potential analyses for direct discharge permits or to determine potential stressors of the biological community. Additional samples are collected outside of focus basins each year for a variety of purposes. In total, water chemistry samples are collected at approximately 275-325 sites per year, with 150-200 of those sites surveyed for macroinvertebrates, and approximately 50-70 sites surveyed for fish. Water chemistry samples include a suite comprising all parameter listed in Table 9, except Dissolved Phosphorus, Lab Conductivity, Total Suspended Solids, and Dissolved Organic Carbon. These parameters are added to water chemistry sample suites on a case-by-case basis but are not always collected like the other parameters listed.

Sites are chosen for macroinvertebrate field replicates based on data needs for a particular site and to make sure that each combination of biologists on the BASS team can be evaluated to ensure data quality and consistency using the DQIs in Table 6. Water chemistry sample replicates are planned to occur once every ten sampling events to ensure RPD can be evaluated for each parameter collected for 10% of all samples. Quality assurance analysis of macroinvertebrate data occur once the data from a sampling season have been analyzed, typically during the spring and summer following a sampling season. This analysis is completed before the next sampling season. Quality assurance of water chemistry data occurs twice per year; once in January to review data collected from August 1-December 31 of the previous year, and once in August to review data collected January 1 – June 30 of that year.

Existing data are used to supplement our understanding of environmental conditions that are impacting aquatic biological communities. Data sources beyond VTDEC historical data that help accomplish project objectives include continuous flow information from the USGS stream gage network, land use and land cover information from the most recent edition of the National Land Cover Database, and watershed characteristics from USGS Stream Stats.

2. Methods (B2)

All field methods pertaining to the ABN project and examples of fields sheets used by ABN can be found in the WSMD Field Methods Manual (VTDEC 2022b). All laboratory methods pertaining to water chemistry samples analyzed by VAEL for ABN are described in the VAEL Quality Systems Manual (VAEL, 2021).

3. Integrity of Environmental Information (B3)

Samples are collected and analyzed according to the procedures described in the WSMD Field Methods Manual (VTDEC, 2022b). The table below summarizes the field collection method, equipment, container, preservative and holding time for water chemistry parameters collected during each ABN sampling event. More information on analytical methods can be found in the VAEL Quality Systems Manual (VAEL, 2021). Chain of custody procedures are described in the WSMD Field Methods Manual (VTDEC, 2022b) and VAEL Quality Systems Manual (VAEL, 2021). All samples are securely stored and analyzed at VAEL.

TABLE 9 WATER CHEMISTRY PARAMETER COLLECTION & ANALYSIS INFORMATION

Parameter	Field Collection Method/Equipment	Container	Preservative	Holding Time
Alkalinity	Grab Sample	P, 250 ml square	Cool, 4º C	14 days
Chloride	Grab Sample	P, 50 ml cylindrical	Cool, 4º C	28 days
Dissolved Organic Carbon	Grab Sample	P, 125 ml cylindrical	Cool, 4º C	14 days
Nitrate+ Nitrite	Grab Sample	P, 50 ml cylindrical	Cool, 4º C H_2SO_4 to pH ≤ 2	28 days
Phosphorus, Dissolved	Grab Sample	G, 75 ml test tube	None	28 days
Phosphorus, Total	Grab Sample	G, 75 ml test tube	None	28 days
Total Nitrogen	Grab Sample	P, 50 ml cylindrical	Cool, 4º C H_2SO_4 to pH ≤ 2	28 days
Sulfate	Grab Sample	P, 50 ml cylindrical	Cool, 4º C	28 days
Aluminum	Grab Sample	P, 125 ml cylindrical	Filter* Cool, 4º C HNO_3 to pH ≤ 2	6 months
Calcium	Grab Sample	P, 125 ml cylindrical	Filter* Cool, 4º C HNO_3 to pH ≤ 2	6 months
Magnesium	Grab Sample	P, 125 ml cylindrical	Filter* Cool, 4º C HNO_3 to pH ≤ 2	6 months
Potassium	Grab Sample	P, 125 ml cylindrical	Filter* Cool, 4º C HNO_3 to pH ≤ 2	6 months
Sodium	Grab Sample	P, 125 ml cylindrical	Filter* Cool, 4º C HNO_3 to pH ≤ 2	6 months
Iron	Grab Sample	P, 125 ml cylindrical	Filter* Cool, 4º C HNO_3 to pH ≤ 2	6 months
Manganese	Grab Sample	P, 125 ml cylindrical	Filter* Cool, 4º C HNO_3 to pH ≤ 2	6 months
Hardness	Calculated	NA	Cool, 4º C	6 months

Parameter	Field Collection Method/Equipment	Container	Preservative	Holding Time
Specific Conductivity, field	In-situ measurement using Hydrolab Sonde	NA	None	Analyze immediately
Specific Conductivity, field	In-situ measurement using Hydrolab Sonde	NA	None	Analyze immediately
pH, field	In-situ measurement using Hydrolab Sonde	NA	None	Analyze immediately
Temperature, Field	In-situ measurement using Hydrolab Sonde	NA	None	Analyze immediately
TSS	Grab Sample	P, 1L	Cool, 4º C	7 days
Turbidity	Grab Sample	P, 250 ml	Cool, 4º C	48 hours
Turbidity, field	In-situ measurement using Hydrolab Sonde	NA	None	Analyze immediately
Oxygen, dissolved, field	In-situ measurement using Hydrolab Sonde	NA	None	Analyze immediately
Total Visual Color	Lovibond Ecomparator 2000 Series Colorimeter	P, 50 ml	Cool 4º C	48 hours

4. Environmental Information Management (B7)

Data are stored and uploaded to VTDEC and VAEL databases and servers as soon as possible after field data collection. Water chemistry samples are submitted according to VTDEC and VAEL protocols (VTDEC 2022b, VAEL 2021). Data collected using the biomonitoring electronic field sheets are reviewed and submitted upon returning from the field and the data is automatically available and viewable through the Watershed Data Portal, which is accessible to BASS staff. This includes in-situ water chemistry measurements, sample information, physical habitat characteristics, and fish survey data. Macroinvertebrate samples are stored in the BASS laboratory at VAEL, where they are labeled for processing at the end of the lab season. Benthos Lab Sheets and Benthos Excel Sheets (Appendices B and C) are used to track macroinvertebrate sample information before it is uploaded to VTDEC's SQL database, which is backed up daily. Once results are uploaded, the data are available via the Watershed Data Portal (internal) and the VTDEC Integrated Watershed Information System (IWIS), which is public. Data are also connected to the ANR Atlas, where monitoring sites are mapped and linked to the information in IWIS. Water chemistry data are reviewed twice annually to ensure that field data and lab data match up with the correct sampling site and event. During this process RPDs between duplicates are analyzed and outliers are reviewed and investigated. Once the review process is complete, the data are uploaded to WDP/IWIS and later to WQX by the VTDEC database manager. ABN data are available through a variety of sources and have multiple levels of backup. This facilitates effective data retrieval and analysis in support of meeting the ABN project objectives.

5. Quality Control (B4)

Quality control measures for biological data including corrective actions are described in detail in Section A5 (Element A6) of this QAPP. Quality control measures for water chemistry data are also described in the section above for water chemistry sample collection. Quality control measures for laboratory analyses are described in the VAEL Quality Systems Manual (VAEL 2021).

6. Equipment/Instrument Calibration, Testing, Inspection, and Maintenance (B5)

Procedures for instrument calibration, testing, inspection and maintenance for in-situ water chemistry measurements are described in Section 4 of the WSMD Field Methods Manual (VTDEC 2022b). BASS contracts with service providers to complete annual maintenance and calibration of microscopes and field probes. Procedures for maintenance of biological sampling equipment are described in Section 6. For procedures related to equipment used by the VAEL to analyze water chemistry samples, refer to the VAEL Quality Systems Manual.

7. Inspection/Acceptance of Supplies and Services (B6)

The Operations Manager is responsible for inspecting and accepting supplies and services related to field and laboratory operations. These include field and laboratory supplies needed to perform sampling protocols (VTDEC 2022b), contract services to maintain and calibrate microscope and field probes, and contract services for repairing specialized monitoring equipment such as backpack electro fishers.

The QA Manager is responsible for evaluating the quality of macroinvertebrate data produced by consultants collecting field samples and independent taxonomy contractors that are used for assessment under the VWQS.

C. Assessment, Response Actions, and Oversight

1. Assessments, Oversight, and Response Actions (C1 & C2)

The Ambient Biomonitoring Network was assessed by the EPA Region 1 QA Branch as part of a quality system assessment (QSA) of the Vermont Department of Environmental Conservation in 2021. This was the fourth QSA of the VTDEC. The report found that quality systems were integrated into operations of all VTDEC programs reviewed, including ABN. The assessment found no nonconformances to quality assurance requirements and no corrective action was required (EPA Region 1, 2021). ABN continues to implement and improve upon its quality assurance measures to produce high quality data. All VAEL analyses are accredited by the National Environmental Laboratory Accreditation Conference (NELAC), which conducts an on-site audit every two years.

Annual performance evaluations are conducted for BASS staff to evaluate individual achievement of training requirements and adoption of quality assurance protocols. New staff are evaluated on an individual basis to ensure consistency and replicability with more experienced staff. Experienced staff are continually evaluated to ensure consistent performance. Any corrective actions are documented in quarterly meeting notes and progress is discussed at the following quarterly meeting. Results of corrective actions are documented in annual performance evaluations. Corrective action tracking and implementation is the responsibility of the Project Manager and QA Manager.

2. Reports to Management (C2)

Progress and achievement of ABN goals and objectives are evaluated on a regular basis. In addition to weekly and monthly reports to the Supervisor of the River Science Section and Manager of the Rivers Program, of which BASS is a part, data are shared with internal and external partners and stakeholders after validation and review stages are complete. Progress on ABN objectives is integrated across multiple WSMD programs and initiatives and is reported to Division, Department and Agency leadership on a regular basis. Data are uploaded to internal and external database as the data are validated and reviewed. The Project Manager is responsible for reporting progress on ABN activities to higher levels of management within VTDEC.

Data from the DEC Watershed Data Portal are uploaded to the EPA WQX data portal with assistance from the DEC Database Manager on an annual basis. A list of waters that fail to meet Vermont Water Quality Standards are reported to the EPA via the 303(d) List of Impaired Waters on a biannual basis. A report of monitoring activities including program deliverables is reported annually to Tom Faber at EPA R1 as part of the Monitoring Initiative guidelines. This includes the Part A budget and narrative workplan for monitoring activities receiving PPG funds. Additional reports on biological condition, including assessment summaries, results from probabilistic studies, quality assurance repots, and any other results from data produced through biomonitoring data are available to EPA upon request.

D. Data Review and Usability

1. Data Review (D1)

Macroinvertebrate data are reviewed as samples are processed, identified, and uploaded to the database. Any potential issues with the data are addressed as soon as the issue is detected with the goal of determining the cause and a resolution. Many improvements have been made to macroinvertebrate data processing workflow that decrease the potential for errors during processing. This includes the implementation of improved Benthos Lab Sheets (Appendix B) that ensure all pertinent laboratory processing info, such as subsample size and taxa present, are recorded during processing. Section A5 (Element A6) describes all quality assurance measures and metrics that are used to evaluate the quality of macroinvertebrate data on an annual basis, and the procedures for corrective actions. The QA Manager is responsible for continually reviewing results and communicating issues to the Project Manager, who is responsible for implementing a corrective action plan. Fish data are reviewed in real-time in the field and prior to the submission of electronic field sheets. This provides a significant advantage in being able to review the data shortly after it was collected, helping to identify any potential issues or inconsistencies. Any identification discrepancies are investigated and resolved before the field data are submitted. Photos and collected specimens of unknown species are used to verify the results. Field sheets used by ABN and VAEL ensure proper tracking and transfer of custody of water chemistry samples. Issues are identified by the QA Manager and relayed to the Project Manager for corrective action. All procedures related to data verification and validation of water chemistry samples once they have been received by VAEL are documented in the VAEL QSM (VAEL, 2021).

2. Project Evaluation – Usability Determination (D2)

Methods used to analyze data have remained consistent since the inception of ABN. It is the responsibility of the QA Manager to conduct and document data usability. With each year of data collection, the historical database grows more robust and provides detailed and valuable records of stream conditions throughout the entire state. Taxonomic protocols have remained relatively unchanged except for keeping up with changes in current accepted scientific nomenclature. Various tools provide valuable context and additional information to evaluate data usability, such as satellite imagery, land use and land cover information, and watershed and riparian characteristics at the sampling site. All these data provide ample methods of evaluating data usability and applicability to project objectives. At the end of each laboratory season, once samples have been assessed, a comprehensive report of all biomonitoring results is produced which includes the reason for monitoring each site and is linked to ABN objectives. Limitations of the data are communicated whenever the data are shared, and the scope and significance of the data is an important aspect of data usability.

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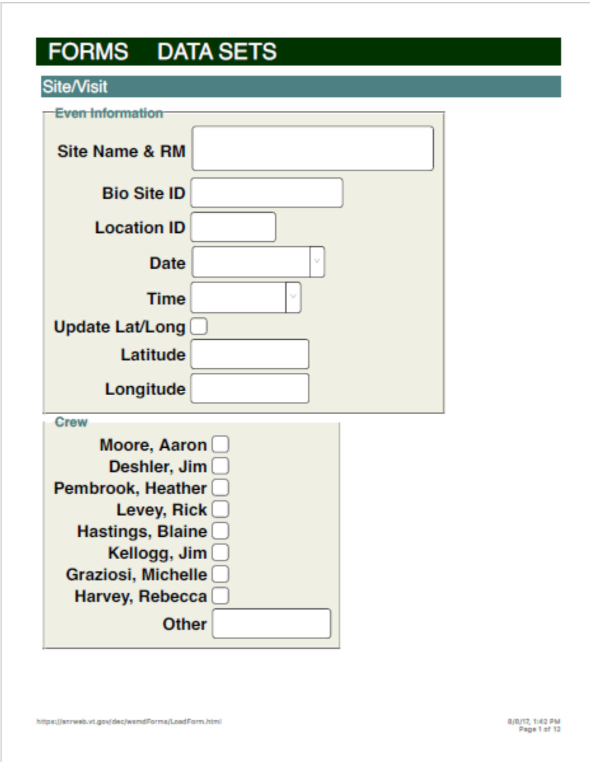
Appendices

Appendix A. Electronic Biomonitoring Field Form



FORMS DATA SETS

Site/Visit

Even Information

Site Name & RM

Bio Site ID

Location ID

Date

Time

Update Lat/Long

Latitude

Longitude

Crew

Moore, Aaron

Deshler, Jim

Pembrook, Heather

Levey, Rick

Hastings, Blaine

Kellogg, Jim

Graziosi, Michelle

Harvey, Rebecca

Other

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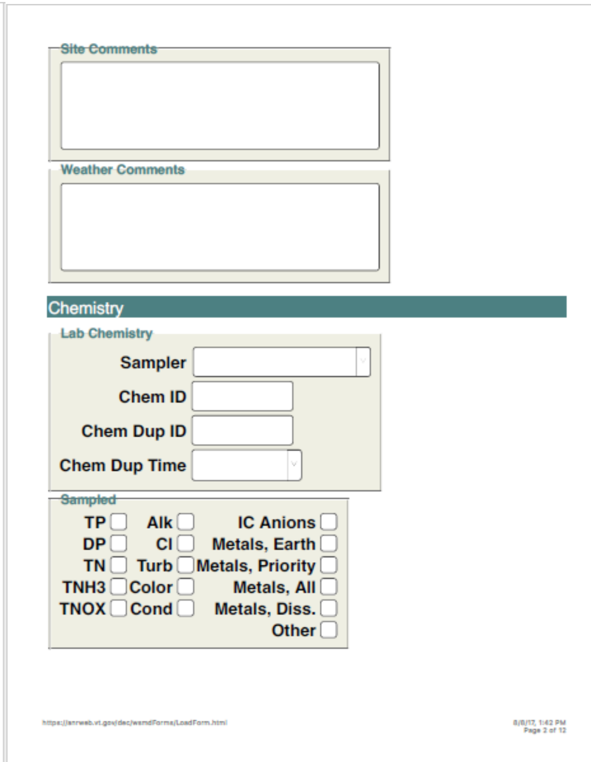

Site Comments

Weather Comments

Chemistry

Lab Chemistry

Sampler

Chem ID

Chem Dup ID

Chem Dup Time

Sampled

TP | Alk | IC Anions
DP | Cl | Metals, Earth
TN | Turb | Metals, Priority
TNH3 | Color | Metals, All
TNOX | Cond | Metals, Diss.
Other

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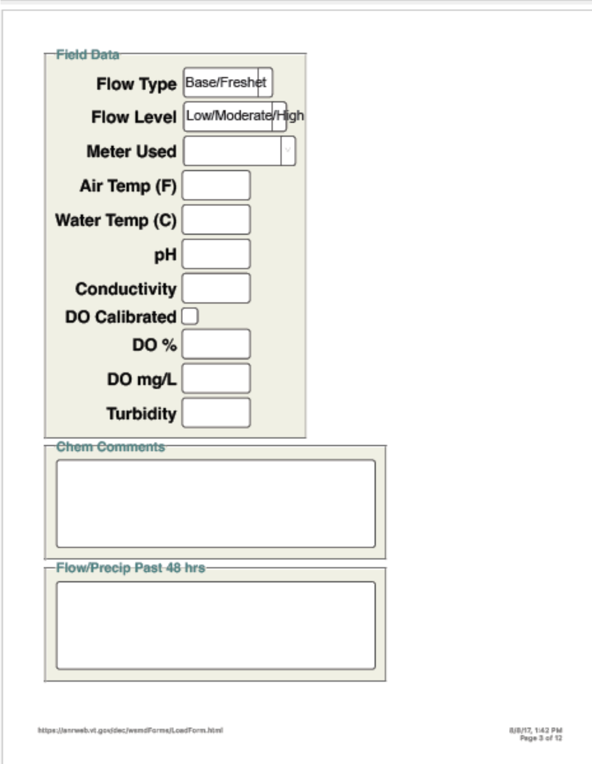

Field Data

Flow Type: Base/Freshet

Flow Level: Low/Moderate/High

Meter Used

Air Temp (F)

Water Temp (C)

pH

Conductivity

DO Calibrated

DO %

DO mg/L

Turbidity

Chem Comments

Flow/Precip Past 48 hrs

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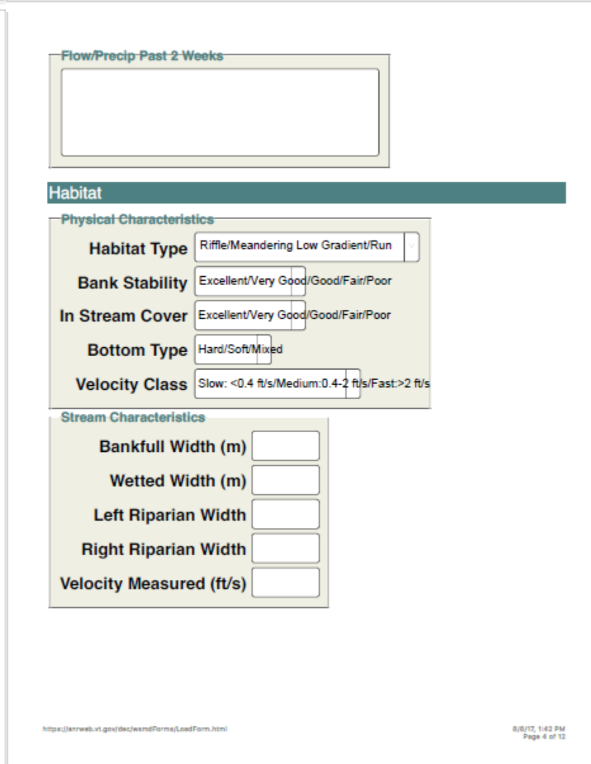

Flow/Precip Past 2 Weeks

Habitat

Physical Characteristics

Habitat Type: Riffle/Meandering Low Gradient/Run

Bank Stability: Excellent/Very Good/Good/Fair/Poor

In Stream Cover: Excellent/Very Good/Good/Fair/Poor

Bottom Type: Hard/Soft/Mixed

Velocity Class: Slow: <0.4 ft/s/Medium:0.4-2 ft/s/Fast:>2 ft/s

Stream Characteristics

Bankfull Width (m)

Wetted Width (m)

Left Riparian Width

Right Riparian Width

Velocity Measured (ft/s)

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Vegetation

- Softwood Overstory %
- Hardwood Overstory %
- Shrub Understory %
- Herbaceous Understory %
- Grass Understory %
- Canopy %

Substrate

- Embeddedness Est. %
- Silt Rating (0-5)
- CPOM Rating (0-5)
- Iron Precipitates %
- Calcareous Deposits %
- Large Woody Debris #/100m

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Periphyton Cover

- Diatom %
- Filamentous Green %
- Blue Green %
- Moss %
- Green %
- Other Peri %
- Macrophyte %

Habitat Comments

Estimated Substrate

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Estimated Substrate

- Ledge %
- Boulder %
- Cobble %
- Coarse Gravel %
- Gravel %
- Sand %
- Silt %
- Clay %

Pebble Counter

Show/Hide Didymo Show/Hide Iron

Pebble Type	Moss	Macro Algae	Micro Algae	Didymo	Iron
Ledg	0 0%	0 0%	0 none	0 none	0 none
Bould	1 <5%	1 <5%	1 slimy	1 <5%	1 <5%
Cobbl	2 5 to 25%	2 5 to 25%	2 draw line	2 5 to 25%	2 5 to 25%
Coars Grave	3 >25%	3 >25%	3 0.5 to 1 mm	3 25 to 75%	3 25 to 75%

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Grave	4 1 to 5 mm	4 >75%	4 >75%
Sand	5 5 to 20 mm		
Silt			
Clay			

Ledge:	Moss 0:	Macro Algae 0:	Micro Algae 0:	Didymo 0:	Iron 0:
Boulder:	Moss 1:	Macro Algae 1:	Micro Algae 1:	Didymo 1:	Iron 1:
Cobble:	Moss 2:	Macro Algae 2:	Micro Algae 2:	Didymo 2:	Iron 2:
Coarse Gravel:	Moss 3:	Macro Algae 3:	Micro Algae 3:	Didymo 3:	Iron 3:
Gravel:			Micro Algae 4:	Didymo 4:	Iron 4:
Sand:			Micro Algae 5:		
Silt:					
Clay:					
Total:					

Bugs

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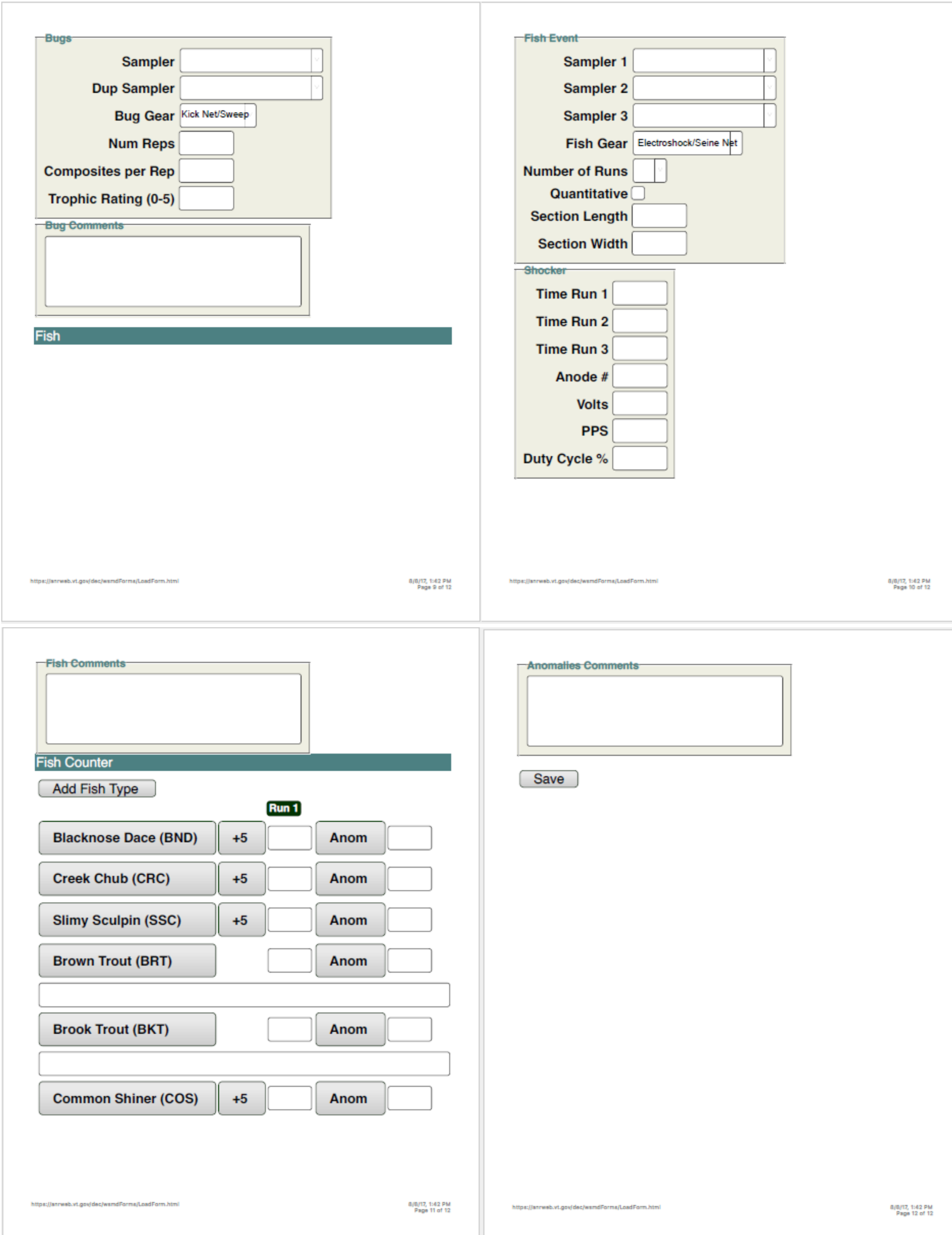

Bugs
Sampler
Dup Sampler
Bug Gear: Kick Net/Sweep
Num Reps
Composites per Rep
Trophic Rating (0-5)

Bug Comments

Fish

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Fish Event
Sampler 1
Sampler 2
Sampler 3
Fish Gear: Electroshock/Seine Net
Number of Runs
Quantitative
Section Length
Section Width

Shocker
Time Run 1
Time Run 2
Time Run 3
Anode #
Volts
PPS
Duty Cycle %

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Fish Comments

Fish Counter
Add Fish Type
Run 1
Blacknose Dace (BND) | +5 | Anom
Creek Chub (CRC) | +5 | Anom
Slimy Sculpin (SSC) | +5 | Anom
Brown Trout (BRT) | Anom
Brook Trout (BKT) | Anom
Common Shiner (COS) | +5 | Anom

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Anomalies Comments
Save

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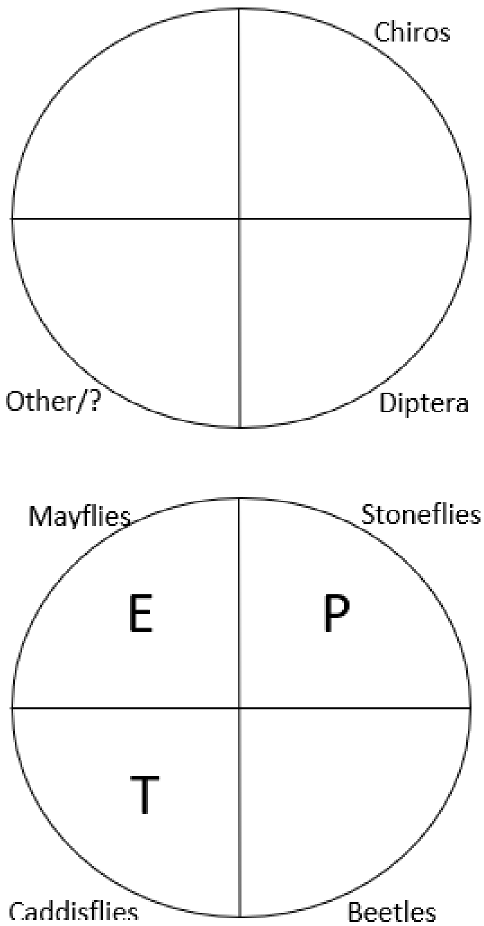
Appendix B. Benthos Lab Sheet

Site Name: ______________________________ **Lab ID:** ____________________



CIRCLE WHICH REP:	A or B	
NUMBER OF SQUARES PICKED		
PICKED BY:		
DATE PICKED:		
CHECKED BY:		
GRAVEL CHECKED?		
SORTED BY & DATE SORTED:		
QAQC BUGS FOUND: (IF APPLICABLE)		
***CHECKER:** Mark which taxa are present or absent. **SORTER:** Verify taxa presence/absence, enter data into excel and initial at the bottom of page.*		
	PRESENT	*ABSENT*
Ephemeroptera		
Plecoptera		
Trichoptera		
Chironomidae		
Diptera		
Coleoptera		
Odonata		
Megaloptera		
Oligochaeta		
Hemiptera		
Hydrachnidea		
Lepidoptera		
Gastropoda		
Bivalvia		
Amphipoda		
Isopoda		
Decapoda		
Tricladida		
Hirudinea		
Caudata		
Nematomorpha		
DATA ENTERED INTO EXCEL:		

Appendix C. Benthos Excel Sheet

Lab ID	2023.000
Stream	
Station	
Bio Site ID	

SORTERS are responsible for filling in picking data and taxa present COMPLETELY.

Indicate what orders were found in which reps and highlight. If common taxa such as EPT are ABSENT, note that below.

Taxonomists should copy and paste the taxa from the library tabs and include their initials, confidence, and counts.

Please double check your work. Unhighlight the order once you've completed data entry.

REPS:	Rep 1	Rep 2
# Squares picked		
Picked By / Date		
Checked By		
Sorted By / Date		

TAXA:

Ephemeroptera	Oligochaeta	Decapoda	Chaoboridae
Plecoptera	Hemiptera	Tricladida	Nemertea
Trichoptera	Hydrachnidea	Hirudinea	Polychaeta
Chironomidae	Lepidoptera	Caudata	Podocopa
Diptera	Gastropoda	Neuroptera	Conchostraca
Coleoptera	Bivalvia	Anostraca	Nematomorpha
Odonata	Amphipoda	Anura	Neorhabdocoela
Megaloptera	Isopoda	Fish	

QA is confidence of ID. A = 99%, B = 90%,C = 7

Count- only report a 0, in case of **large/rare** t

ExpandedKey	Order	Family	SubFamilyOrTribe	GenusGroup	Genus	SpeciesGroup	Species	Rep1 ID	Rep1 QA	Rep1 Count	Rep2 ID	Rep2 QA	Rep2 C

Appendix D. ABN Monitoring Site List Example

Type indicates the type of monitoring that was planned for each site. B = Bugs (Macroinvertebrates), F = Fish, WQ = water quality samples only. Water chemistry samples are always collected with macroinvertebrate and fish surveys.

Location Name	River Mile	Lat	Long	WBID	Bio Site ID	Town	Type	Purpose
Marshfield Brook	0.1	44.34762	-72.35803	VT08-08	497300000001	Marshfield	F	Reclass
Nasmith Brook	0.8	44.29811	-72.38746	VT08-08	496900000008	Marshfield	F	Reclass
North Branch Winooski River	16.1	44.43772	-72.53668	VT08-13	495400000161	Worcester	F	Sentinel
Batten Kill	55.5	43.22697	-73.01054	VT01-04	590000000555	Dorset	F	Reclass
Lye Brook	2.5	43.14453	-73.04108	VT01-05	592500000025	Manchester	B&F	Impaired/GMNF
Mill Brook	NEW	43.11135	-73.10262	VT01-05	59XX000000XX	Sunderland	F	Data Gap
Wing Brook	0.2	43.85359	-72.83901	VT09-07	135402000002	Rochester	B&F	Special Study/GMNF
Ottauquechee River	34.4	43.65948	-72.77076	VT10-05	120000000344	Killington	WQ	WWTF
Ottauquechee River	34.3	43.65787	-72.76936	VT10-05	120000000343	Killington	B	WWTF
Ottauquechee River	20.3	43.58697	-72.62341	VT10-03	120000000203	Bridgewater	WQ	WWTF
Ottauquechee River	15.0	43.62911	-72.50758	VT10-01	120000000150	Woodstock	WQ	WWTF
Townsend Brook Trib #2	0.2	43.75443	-72.84169	VT09-07	134609020002	Chittenden	B&F	Probability/GMNF
Second Branch White River	0.2	43.82781	-72.56738	VT09-05	132900000002	Royalton	B	Special Study
Nulhegan Pond Trib	NEW	44.80560	-71.83151	VT16-11	28XXXX0000XX	Brighton	B&F	Probability
Nulhegan River	0.3	44.75569	-71.63664	VT16-11	280000000003	Bloomfield	B&F	Sentinel
Connecticut River	NEW	44.96990	-71.52638	VT16-01	CT1600003###	Canaan	B	Wastewater
Branch Pond Brook	0.1	43.05394	-73.05449	VT01-06	591410000001	Sunderland	B	Impaired
Roaring Branch	3.3	43.05734	-73.11898	VT01-06	591700000033	Sunderland	B&F	Data Update
Connecticut River	371.1	44.99519	-71.53526	VT16-01	CT1600003711	Canaan	WQ	Wastewater
Bog Brook	0.2	44.52960	-71.81540	VT15-09	211226000002	Victory	B	Sentinel

Moose River	25.7	44.57756	-71.78429	VT15-09	211200000257	Victory	B&F	Sentinel
Goodman Brook	0.6	43.23591	-73.09704	VT01-05	592815000006	Dorset	B&F	Reclass
West Branch Moose River	0.1	44.63426	-71.81177	VT15-09	211251000001	East Haven	B	Special Study
East Branch Moose River	0.1	44.63433	-71.81100	VT15-09	211252000001	East Haven	B	Special Study
Water Andric	6.6	44.41299	-72.12968	VT15-03	210500000066	Danville	WQ	WWTF
Passumpsic River	8.6	44.41074	-72.01412	VT15-01	210000000086	St. Johnsbury	WQ	WWTF
Passumpsic River	14.3	44.48191	-72.01202	VT15-01	210000000143	St. Johnsbury	WQ	WWTF
Passumpsic River	6.7	44.39318	-72.02213	VT15-01	210000000067	Waterford	B	Special Study
Moose River	0.1	44.42327	-72.00934	VT15-09	211200000001	St. Johnsbury	B	Special Study
Spaulding Brook	NEW	44.42570	-71.97969	VT15-09	2112XX0000XX	St. Johnsbury	B&F	Probability
Bolles Brook	1.6	42.91028	-73.11694	VT01-03	600702000016	Woodford	B&F	Stressed
Bickford Hollow Brook	0.4	42.91333	-73.12079	VT01-03	600702010004	Woodford	B&F	Stressed
Passumpsic River	18.5	44.52835	-72.00350	VT15-01	210000000185	Lyndon	WQ	WWTF
Winooski River	43.0	44.34420	-72.76631	VT08-05	490000000430	Waterbury	WQ	WWTF
Winooski River	43.3	44.34093	-72.76228	VT08-06	490000000433	Waterbury	WQ	WWTF
Winooski River	54.3	44.25820	-72.60649	VT08-05	490000000543	Montpelier	B	Special Study
Winooski River	54.7	44.25629	-72.59861	VT08-05	490000000547	Montpelier	WQ	WWTF
Winooski River	70.9	44.27582	-72.42869	VT08-07	490000000709	Plainfield	WQ	WWTF
Winooski River	81.8	44.35014	-72.35657	VT08-07	490000000818	Marshfield	WQ	WWTF
Winooski River	84.7	44.39060	-72.3308	VT08-09	490000000847	Cabot	WQ	WWTF
McCabes Brook	1.4	44.38272	-73.23914	VT05-11	520100000014	Shelburne	WQ	WWTF
Ladd Brook	0.3	42.76510	-73.23734	VT01-02	610900000003	Pownal	B	Impaired
Mud Hollow Brook	0.1	44.35363	-73.19455	VT05-11	520300000001	Charlotte	B&F	Stressed
Green River	NEW	43.15351	-73.18627	VT01-05	5909000000XX	Sandgate	B&F	Data Gap
Hopper Brook	NEW	43.15277	-73.18641	VT01-05	5909XX0000XX	Sandgate	B&F	Data Gap

Bourn Brook	NEW	43.16271	-73.03503	VT01-05	5926000000##	Manchester	B&F	Reclass
Mud Hollow Brook	NEW	44.34916	-73.19304	VT05-11	5203000000XX	Charlotte	B&F	Stressed
Holmes Creek	0.0	44.33261	-73.28071	VT05-12	LCT170100000	Charlotte	B	Stressed
Holmes Creek	0.5	44.33225	-73.27657	VT05-12	LCT170100005	Charlotte	B	Stressed
Holmes Creek Trib #1	0.5	44.32638	-73.27750	VT05-12	LCT170101005	Charlotte	B&F	Stressed
Lewis Creek	3.7	44.24849	-73.22869	VT03-08	530000000037	Ferrisburgh	B&F	Sentinel
White River	2.5	43.66598	-72.35730	VT09-01	130000000025	Hartford	B	Special Study
White River	15.4	43.79296	-72.49437	VT09-01	130000000154	Sharon	B	Special Study
White River	16.4	43.50566	-72.50143	VT09-03	130000000164	Royalton	WQ	WWTF
Hewitt Brook	#.#	42.90550	-73.20067	VT01-03	6006010000XX	Bennington	B&F	Stressed
West Branch Ompomp River	6.0	43.83789	-72.34768	VT14-02	150400000060	Strafford	B	Special Study
Batten Kill	47.0	43.14559	-73.05911	VT01-04	590000000470	Manchester	B	WWTF
Batten Kill	48.2	43.16189	-73.05584	VT01-04	590000000482	Manchester	B	WWTF
Batten Kill	54.9	43.21987	-73.01138	VT01-04	590000000549	Dorset	B	Reclass
Munson Brook	0.4	43.16924	-73.05966	VT01-05	592700000004	Manchester	B&F	Impaired
West Branch Batten Kill	NEW	43.18311	-73.05148	VT01-05	5928000000XX	Manchester	B&F	Data Update
Green River	0.1	43.10173	-73.21176	VT01-05	590900000001	Arlington	B&F	Special Study
Mill Brook	NEW	43.11135	-73.10262	VT01-05	59XX000000XX	Sunderland	B&F	Data Gap
Poultney River	23.0	43.52468	-73.24668	VT02-04	570000000230	Poultney	B	WWTF
Poultney River	23.1	43.52319	-73.24788	VT02-04	570000000231	Poultney	B	WWTF
Hopper Brook	NEW	43.13920	-73.15939	VT01-05	59XX00000XXX	Sandgate	B&F	Probability
Terry Brook	NEW	43.16111	-73.25400	VT01-07	59XXXXXX00XX	Sandgate	B&F	Data Gap
South Stream	2.1	42.85567	-73.17449	VT01-03	601100000021	Bennington	WQ	WWTF
Jewett Brook	1.4	42.86001	-73.19517	VT01-03	601200000014	Bennington	B&F	Impaired
Bump School Brook	0.8	43.69125	-73.26862	VT02-02	570709000008	Benson	B&F	Stressed

Castleton River	0.5	43.59332	-73.28553	VT02-03	571100000005	Fair Haven	B	WWTF
Jewett Brook	2.3?	42.84993	-73.20222	VT01-03	601200000023	Bennington	B	Impaired
Castleton River	6.0	43.60249	-73.21243	VT02-03	571100000060	Castleton	B	WWTF
Hoosic River	37.2	42.80918	-73.28625	VT01-02	610000000372	Pownal	B	WWTF
Hoosic River	38.9	42.79766	-73.26702	VT01-02	610000000389	Pownal	B	WWTF
Roaring Brook	2.4	42.77843	-73.08594	VT01-01	612506000024	Stamford	B	GMNF$
Walloomsac Trib #9	NEW	42.87871	-73.20039	VT01-03	60090000000X	Bennington	B&F	Data Gap
Walloomsac River	9.2	42.91885	-73.26857	VT01-03	600000000092	Bennington	B	WWTF/Impaired
East Creek South Fork	5.2	43.80224	-73.31803	VT04-03	560000000052	Orwell	B	WWTF
Walloomsac River	10.1	42.91259	-73.25493	VT01-03	600000000101	Bennington	B	WWTF/Impaired
Paran Creek	0.1	42.91398	-73.24579	VT01-03	600500000001	Bennington	B	Stressed
Furnace Brook	1.5	42.89648	-73.20121	VT01-03	600600000015	Bennington	B&F	Reclass
Roaring Branch	NEW	42.90241	-73.12382	VT01-03	6007000000##	Woodford	B&F	Stressed/GMNF
City Stream	NEW	42.88534	-73.11471	VT01-03	6007040000##	Woodford	B&F	Reclass/GMNF
Warm Brook	0.1	43.06271	-73.14551	VT01-06	591402000001	Arlington	B	WWTF
Warm Brook	0.2	43.06178	-73.14594	VT01-06	591402000002	Arlington	WQ	WWTF
Kidder Brook	0.9	43.09168	-72.87833	VT11-15	032804080009	Stratton	B	Special Study
Styles Brook	0.7	43.10989	-72.88577	VT11-15	032804140007	Stratton	B	Special Study
Winhall River	8.1	43.14003	-72.93389	VT11-16	033500000081	Winhall	B	Sentinel/GMNF$
Cook Brook Trib	NEW	43.22216	-72.88300	VT11-16	033501XX0XXX	Peru	B&F	Probability/GMNF
Trib to Walloomsac	0.5	42.93817	-73.25906	VT01-03	600200000005	Shaftsbury	B&F	Stressed
Potash Brook Trib 3	0.8	44.45760	-73.18978	VT05-11	5003000000XX	South Burlington	B	Special Study
Airport Brook	0.1	42.91305	-73.25737	VT01-03	600400000001	Bennington	B&F	Data Gap
Cold Spring Brook	0.2	42.94302	-73.22165	VT01-03	600503000002	Shaftsbury	B	Stressed
Carman Brook	1.9	44.96922	-73.08530	VT05-01	LCT910100019	Highgate	B	Reclass

Little White Creek	NEW	43.03044	-73.22135	VT01-07	600100000###	Shaftsbury	B	GMNF$
Missisquoi River	18.2	44.92700	-72.98800	VT06-01	420000000182	Highgate	B	Data Update
Missisquoi River	72.6	44.94975	-72.40046	VT06-08	420000000726	Troy	B	WWTF
Missisquoi River	73.1	44.94212	-72.40143	VT06-08	420000000731	Troy	B	WWTF
Paran Creek	NEW	42.96750	-73.19310	VT01-03	6005000000XX	Shaftsbury	B&F	Data Gap
North Branch Winooski River	16.1	44.43772	-72.53668	VT08-13	495400000161	Worcester	B	Sentinel
Little River	12.2	44.46301	-72.69258	VT08-11	493200000122	Stowe	WQ	WWTF
Hungerford Trib 4	0.1	44.90953	-73.05067	VT06-03	422104000001	Sheldon	B	Stressed
Cotton Brook	0.2	44.42107	-72.75744	VT08-11	493213000002	Waterbury	B	Special Study
Cotton Brook	1.2	44.42510	-72.77270	VT08-11	493213000012	Waterbury	B&F	Special Study
Ranch Brook	1.5	44.50361	-72.78194	VT08-12	493238200015	Stowe	B	Sentinel
Wanzer Brook	1.4	44.83109	-72.90799	VT06-05	423108000014	Fairfield	B	Impaired
Inn brook	0.6	44.50889	-72.76472	VT08-12	493238201006	Stowe	B	Impaired
Thatcher Brook	6.7	44.39333	-72.69917	VT08-06	493400000067	Waterbury	WQ	WWTF
Winooski River	16.3	44.47653	-73.12456	VT08-01	490000000163	Essex	B	Special Study
Winooski River	30.2	44.40151	-72.99746	VT08-03	490000000302	Richmond	WQ	WWTF
Huntington River	0.7	44.37773	-72.94696	VT08-10	492300000007	Richmond	B	Special Study
Black Falls Brook	0.9	44.90755	-72.63361	VT06-07	425312000009	Montgomery	B&F	Reclass
Hannah Clark Brook	0.9	44.88225	-72.58711	VT06-07	425322000009	Montgomery	B	Reclass
Wade Brook	0.1	44.87510	-72.57916	VT06-07	425325000001	Montgomery	B&F	Reclass
Jay Brook	0.3	44.87638	-72.57473	VT06-07	425326000003	Montgomery	B&F	Reclass
Godin Brook	0.4	44.96907	-72.69923	VT06-04	425600000004	Berkshire	B&F	Impaired
Loveland Brook	0.9	44.98112	-72.67489	VT06-04	425900000009	Richford	B&F	Reclass
Berry Brook	0.2	44.99594	-72.68492	VT06-04	426000000002	Richford	B&F	Impaired
North Branch Berry Brook	0.1	45.00483	-72.69280	VT06-04	426001000001	Richford	B&F	Impaired

Mud Creek	4.0	44.99861	-72.36056	VT06-08	427400000040	Troy	B&F	Impaired
Mud Creek Trib 10	0.2	44.96944	-72.31532	VT06-08	427410000002	Newport Town	B&F	Stressed
Huntington River	8.6	44.32610	-72.98538	VT08-10	492300000086	Huntington	B	Special Study
South Mountain Branch	1.2	44.93843	-72.47885	VT06-08	427807000012	Jay	B	Impaired
Alder Brook	3.?	44.51264	-73.05800	VT08-02	4907000000##	Essex	B&F	Probability/Stressed
Texas Hill Brook	NEW	44.33726	-73.02546	VT08-10	4923##0000##	Huntington	B&F	Probability
Alder Brook	0.4	44.01582	-73.01377	VT03-12	551503070004	Ripton	B	Sentinel/GMNF
White River	31.9	43.76667	-72.74389	VT09-02	130000000319	Stockbridge	B	Sentinel
Mill Brook	1.2	44.89101	-72.43289	VT06-08	428401000012	Westfield	B&F	Reclass
Bingo Brook	1.8	43.87133	-72.89522	VT09-07	135404000018	Rochester	B&F	Sentinel/GMNF$
Ace Brook	0.6	44.77320	-72.45257	VT06-08	429306000006	Lowell	B	Impaired
Smith Brook	1.3	43.85550	-72.94577	VT09-07	135411000013	Rochester	B&F	Sentinel/GMNF$
Elm Brook	#.#	44.79289	-72.87672	VT06-05	42311400000X	Fairfield	B	Reclass
Hubbardton River Trib 7	2.6	43.70286	-73.31643	VT02-02	570707000026	Benson	B	WWTF
Kings Hill Brook	#.#	44.74739	-72.82370	VT06-05	4231XX0000XX	Bakersfield	B&F	Data Gap
The Branch	#.#	44.82475	-72.79827	VT06-06	4238040000XX	Bakersfield	B&F	Data Gap
Beaver Meadow Brook	#.#	44.85538	-72.74181	VT06-06	4238040400XX	Enosburgh	B&F	Data Update
Hubbardton River Trib 7	2.7	43.70307	-73.31646	VT02-02	570707000027	Benson	WQ	WWTF
Trout River	#.#	44.87744	-72.60444	VT06-07	4253000000XX	Montgomery	B&F	Data Gap
South Branch Trout River	#.#	44.85915	-72.61261	VT06-07	4253210000XX	Montgomery	B&F	Data Gap
Stanhope Brook	#.#	44.99480	-72.61420	VT06-04	42630000000#	Richford	B&F	Data Gap
Beaver Meadow Brook	0.1	43.06995	-73.13147	VT01-06	591701000001	Sunderland	B&F	Data Gap
Gilbert Brook	0.9	43.24152	-73.10775	VT01-05	592818000009	Dorset	B	Stressed
Barney Brook	0.3	42.87893	-73.18073	VT01-03	601000000003	Bennington	B	Impaired
Little Mad Tom Brook	#.#	43.22531	-73.00550	VT01-05	5934000000XX	Dorset	B&F	Data Gap

South Stream	#.#	42.86730	-73.17495	VT01-03	6011000000XX	Bennington	B&F	Stressed
Youngman Brook	1.8	44.95639	-73.10667	VT06-03	LCT910300018	Highgate	B&F	Stressed
Roaring Branch	#.#	42.83629	-73.16438	VT01-03	6011XX0000XX	Pownal	B&F	Data Gap
Cedar Hill Brook	#.#	42.80467	-73.24628	VT01-02	6104000000##	Pownal	B&F	Stressed
Browns Brook	#.#	42.87376	-73.28044	VT01-07	61XX000000XX	Hoosick (NY)	B	Data Gap
Cowan Brook	#.#	42.74867	-73.11926	VT01-01	61XXXXXX00XX	Stamford	B&F	Data Gap
Hubbardton River Trib 7	2.8	43.70348	-73.31685	VT02-02	570707000028	Benson	B	WWTF
Hubbardton River Trib 7 Trib 2	0.1	43.70347	-73.31625	VT02-02	570707020001	Benson	WQ	WWTF
East Creek South Fork	6.8	43.79199	-73.31255	VT04-03	560000000068	Orwell	WQ	WWTF
Jones Brook	NEW	43.86263	-73.30177			Shoreham	B&F	Probability
Stream A	0.2	44.57778	-72.77750	VT07-13	462112010002	Cambridge	WQ	Stressed
Gihon River	0.3	44.63570	-72.68275	VT07-15	463200000003	Johnson	WQ	WWTF
Stevensville Brook	2.1	44.50583	-72.84583	VT07-11	461143000021	Underhill	B&F	Stressed
Brewster River	0.#	44.64357	-72.82532	VT07-13	4621000000##	Cambridge	B&F	Stressed
Mill Brook	5.0	44.69806	-72.98694	VT07-09	461200000050	Fairfax	B&F	Stressed
Calavale Brook	NEW	44.77231	-72.60975	VT07-14	4624350000##	Belvidere	B&F	Reclass
Castleton River	1.0	43.59080	-73.28193	VT02-03	571100000010	Fair Haven	WQ	WWTF
Pike River	2.0	44.99677	-72.82678	VT05-02	400000000020	Berkshire	B&F	Stressed
North Branch Lamoille River	11.0	44.75023	-72.68570	VT07-14	462400000110	Belvidere	B&F	Reclass
Basin Brook	0.1	44.74915	-72.68546	VT07-14	462428000001	Belvidere	B&F	Reclass
Foote Brook	2.7	44.66192	-72.69041	VT07-06	462900000027	Johnson	F	Data Update
Gihon River	0.1	44.63389	-72.68472	VT07-15	463200000001	Johnson	B	WWTF
Castleton River	6.5	43.60343	-73.20781	VT02-03	571100000065	Castleton	WQ	WWTF
Groat Brook	1.8	44.99139	-72.91222	VT05-02	400200000018	Franklin	B&F	Stressed
Gihon River	10.3	44.68583	-72.58806	VT07-15	463200000103	Eden	B&F	Data Update

Wild Brook	0.3	44.66597	-72.61391	VT07-15	463211000003	Eden	B	Reclass
Hutchins Brook	2.1	44.74750	-72.54250	VT07-15	463225010021	Eden	F	Impaired
Waterman Brook	1.2	44.60917	-72.68444	VT07-06	463300000012	Johnson	B&F	Reclass
Castleton River	8.9	43.61420	-73.17706	VT02-03	571100000089	Castleton	B&F	Probability
Tenney Brook	1.0	43.62046	-72.97690	VT03-14	553801000010	Rutland City	B&F	Special Study
Ryder Brook	0.8	44.55472	-72.61611	VT07-17	464300000008	Morristown	F	Stressed
Deerfield River	45.6	42.77086	-72.93882	VT12-01	650000000456	Readsboro	B&F	Probability
East Branch North River	11.7	42.74664	-72.74740	VT12-07	660600000117	Halifax	B	Special Study
Wild Branch	1.2	44.57197	-72.47808	VT07-19	465200000012	Wolcott	B&F	Data Update
Green River	16.6	42.75880	-72.66223	VT12-06	670000000166	Guilford	B	Sentinel
Tucker Brook	0.4	44.54986	-72.37654	VT07-21	466403000004	Hardwick	B&F	Reclass
Broad Brook	4.1	42.80124	-72.59884	VT13-15	010000000041	Guilford	B	Special Study
Haynesville Brook	0.3	44.49757	-72.32157	VT07-21	466800000003	Hardwick	B	Reclass
Perkins Meadow Brook	0.7	44.47269	-72.28973	VT07-21	466804000007	Walden	F	Reclass
Whetstone Brook	1.0	42.85060	-72.56880	VT13-14	020000000010	Brattleboro	B	Special Study
Stannard Brook	0.3	44.54075	-72.26313	VT07-22	467500000003	Stannard	B&F	Data Update
Sawmill Brook	1.8	44.60409	-72.25068	VT07-22	468000000018	Greensboro	B	Reclass
Sacketts Brook	0.7	42.97134	-72.51865	VT13-12	040000000007	Putney	WQ	Stressed
Browns River	#.#	44.51980	-72.85658	VT07-11	461100000###	Underhill	B&F	Data Update
Marsh Brook	0.4	44.96167	-72.87167	VT05-02	400102000004	Franklin	B&F	Stressed
McGowan Brook	1.0	44.90233	-72.93999	VT06-03	422800000010	Sheldon	B	Reclass
Dead Creek	0.9	44.85094	-72.94445	VT06-05	423105000009	Fairfield	B&F	Stressed
Morrow Brook	0.1	44.90619	-72.90460	VT06-03	423200000001	Sheldon	B	Impaired
Beaver Brook	#.#	44.60200	-72.93433	VT07-05	4616000000##	Westford	B&F	Data Gap
Dead Creek	NEW	44.84952	-72.97389	VT06-05	4231050000XX	Fairfield	B&F	Stressed

Settlement Brook	#.#	44.60048	-72.87376	VT07-12	4619##0000##	Cambridge	B&F	Data Gap
Seymour River	#.#	44.57605	-72.86398	VT07-12	4619000000##	Cambridge	B&F	Data Gap
West River	22.4	43.07282	-72.73165	VT11-10	030000000224	Jamaica	B&F	Probability
Swamp School Brook	0.9	44.78792	-73.01326	VT06-05	423105060009	Fairfield	F	Stressed
Bell Brook	#.#	44.64017	-72.65635	VT07-15	4632040000##	Johnson	B&F	Data Gap
Fairfield River	1.9	44.80155	-72.94041	VT06-05	423109000019	Fairfield	B&F	Stressed
Cobb Brook	4.3	43.17617	-72.74680	VT11-13	033000000043	Windham	B	Special Study
Green River	#.#	44.57370	-72.51647	VT07-18	4650000000##	Wolcott	B&F	Data Gap
Goodsell Brook	0.9	44.89667	-72.86333	VT06-03	423600000009	Sheldon	B&F	Stressed
Cold Brook	0.1	42.89883	-72.85755	VT12-05	651403000001	Wilmington	B&F	Probability
Tate Brook	#.#	44.59650	-72.31741	VT07-22	4672####00##	Greensboro	B?	Data Gap
Sawmill Brook	#.#	44.59567	-72.23363	VT07-22	4680000000##	Greensboro	B&F	Data Gap
West Hill Brook	0.2	44.90056	-72.64944	VT06-07	425310000002	Montgomery	B&F	Stressed
Winooski River	29.9	44.40290	-73.00332	VT08-03	490000000299	Richmond	B	WWTF
Oak Brook	0.1	42.92536	-72.88734	VT12-05	651403050001	Wilmington	B	QAQC
Jay Branch Trib 12	0.2	44.94083	-72.51222	VT06-08	427812000002	Jay	B&F	Reclass
Beetle Brook	1.1	44.89833	-72.39194	VT06-08	428200000011	Troy	B&F	Reclass
Coburn Brook	0.3	44.90141	-72.40869	VT06-08	428300000003	Troy	B&F	Impaired
Winooski River	70.7	44.27326	-72.43186	VT08-07	490000000707	Plainfield	B	WWTF
Giddings Brook	0.1	44.90647	-72.81285	VT06-04	424000000001	Enosburgh	B	Impaired
Winooski River	81.6	44.34722	-72.36028	VT08-07	490000000816	Marshfield	B	WWTF
Taft Brook	0.3	44.88471	-72.41631	VT06-08	428400000003	Westfield	B&F	Stressed
Mineral Spring Brook	0.2	44.86213	-72.41800	VT06-08	428600000002	Westfield	B&F	Reclass
Jay Branch	8.3	44.93942	-72.48858	VT06-08	427800000083	Jay	B	QAQC
Joiner Brook	3.8	44.40739	-72.87137	VT08-04	492700000038	Bolton	B	QAQC
Little River	11.8	44.45709	-72.69598	VT08-11	493200000118	Stowe	B	WWTF

Whiteland Creek	#.#	44.78298	-72.85269	VT06-05	4231160000XX	Fairfield	B&F	Data Gap
Coburn Brook	1.6	44.91141	-72.42361	VT06-08	428300000016	Westfield	F	Impaired
Lucas Brook	#.#	45.00999	-72.58594	VT06-04	4265000000XX	Richford	B&F	Data Gap
Crook Brook	#.#	44.96339	-72.44243	VT06-08	4278030000XX	Jay	B&F	Data Gap
Snider Brook	#.#	44.85258	-72.45930	VT06-08	4288000000XX	Westfield	B&F	Data Gap
Hazen Notch Brook	#.#	44.81736	-72.47326	VT06-08	4294000000XX	Lowell	B&F	Data Gap
Trib to Trout River	NEW	44.90806	-72.65537	VT06-07	4253##00000#	Montgomery	B&F	Probability
Lamoille River	8.8	44.63602	-73.12191	VT07-01	460000000088	Milton	WQ	WWTF
Lamoille River	19.3	44.66080	-73.01020	VT07-02	460000000193	Fairfax	WQ	WWTF
Morgan Brook	1.0	44.60017	-73.00421	VT07-10	461102000010	Westford	B	Stressed
The Creek	NEW	44.52381	-72.94732	VT07-11	4611150000##	Underhill	B&F	Data Update
Stevens Branch	11.9	44.13336	-72.53298	VT08-16	495600000119	Williamstown	B	WWTF
Stevens Branch	12.1	44.13138	-72.53315	VT08-16	495600000121	Williamstown	B	WWTF
Stones Brook	~0.2	44.65891	-72.98734	VT07-03	4613000000##	Fairfax	WQ	Impaired
Gunner Brook	0.8	44.21142	-72.50247	VT08-16	495611000008	Barre City	B	Impaired
Lamoille River Trib #4	0.5	44.63065	-73.13210	VT07-01	460400000005	Milton	B&F	Impaired
Stones Brook	4.#	44.67345	-72.93471	VT07-03	4613000000##	Fairfax	WQ	Impaired
Browns River	20.4	44.50498	-72.99893	VT07-11	461100000204	Jericho	B&F	Data Update
Potash Brook	4.3	44.45611	-73.16944	VT05-11	500000000043	South Burlington	B	Special Study
Lee River	2.8	44.48139	-72.96556	VT07-11	461111000028	Jericho	B&F	Reclass
Sucker Brook	NEW	44.11104	-73.12337	VT08-02	4905080000XX	Williston	B	Special Study
Snipe Island Brook	2.5	44.41795	-72.93860	VT08-04	4922000000XX	Richmond	B	Special Study
Mill Brook	0.6	44.66849	-73.00740	VT07-09	461200000006	Fairfax	B&F	Stressed
Stones Brook	5.2	44.67391	-72.92772	VT07-03	461300000052	Fletcher	B	Impaired
Seymour River	2.0	44.62418	-72.86992	VT07-12	461900000020	Cambridge	B	Data Gap
Brewster River Trib 10	0.4	44.58652	-72.78714	VT07-13	462110000004	Cambridge	B	Impaired

Johnnie Brook	NEW	44.39417	-73.04468	VT08-04	49XXXX0000XX	Richmond	B	Special Study
Saxe Brook	0.9	44.98371	-73.06127	VT05-01	410200000009	Highgate	F	Impaired
Gihon River	7.4	44.66233	-72.61450	VT07-15	463200000074	Johnson	B&F	Data Update
Third Branch White River	21.5	44.05337	-72.74436	VT09-06	133300000215	Roxbury	B	WWTF
Kenfield Brook	0.2?	44.57194	-72.62056	VT07-16	464200000002	Morristown	F	Reclass
Kenfield Brook	1.5	44.56028	-72.63278	VT07-16	464200000015	Morristown	B&F	Reclass
Green River	2.9	44.60152	-72.53454	VT07-18	465000000029	Hyde Park	B&F	Reclass
Wild Branch	11.2	44.66937	-72.42968	VT07-19	465200000112	Craftsbury	B&F	Reclass
Ottauquechee River	14.8	43.63086	-72.51085	VT10-01	120000000148	Woodstock	B	WWTF
Ottauquechee River	19.9	43.58490	-72.61710	VT10-03	120000000199	Woodstock	B	WWTF
Porter Brook	0.1	44.50399	-72.33881	VT07-21	466700000001	Hardwick	B&F	Reclass
Greensboro Brook	1.6	44.54675	-72.28145	VT07-22	467200000016	Hardwick	B&F	Reclass
Morrison Brook	0.9	44.60167	-72.20194	VT07-22	468300000009	Wheelock	B&F	Data Update
Browns River	#.#	44.51649	-73.04003	VT07-10	461100000###	Essex	B	Data Gap
Rock River	7.9	44.97933	-73.02513	VT05-01	411300000079	Highgate	F	Impaired
Kelly Brook	1.2	44.93111	-73.07472	VT06-03	421200000012	Highgate	B&F	Stressed
Hungerford Brook	0.8	44.92028	-73.05750	VT06-03	422100000008	Highgate	B&F	Stressed
Beaver Brook	#.#	44.63995	-72.93779	VT07-05	4616000000##	Westford	B&F	Data Gap
Hungerford Brook	2.2	44.91098	-73.05206	VT06-03	422100000022	Sheldon	B	Stressed
Youngman Brook	1.4?	44.95849	-73.11327	VT06-03	LCT9103000##	Highgate	B&F	Probability
Beaver Meadow Brook	NEW	44.55782	-72.68770	VT07-16	4642060000##	Morristown	B&F	Data Gap
Elmore Pond Brook	NEW	44.56792	-72.52654	VT07-08	4649000000##	Wolcott	B&F	Data Gap
Tamarack Brook	NEW	44.59622	-72.46577	VT07-19	4652090000##	Wolcott	B&F	Data Gap
Elmore Branch	NEW	44.53002	-72.45906	VT07-20	4656000000##	Wolcott	B&F	Stressed
Sacketts Brook	0.5	42.96889	-72.51787	VT13-12	040000000005	Putney	B&F	Stressed

Allen Brook	0.9	44.57508	-73.15805	VT05-09	470100000009	Colchester	B	Stressed
Indian Brook	3.1	44.54291	-73.15296	VT05-09	480000000031	Colchester	B&F	Stressed
Winooski River	43.0	44.34420	-72.76631	VT08-05	490000000430	Waterbury	WQ	WWTF
Winooski River	43.3	44.34093	-72.76228	VT08-06	490000000433	Waterbury	WQ	WWTF
Streeter Brook	0.6	44.65583	-73.14750	VT07-01	460300000006	Milton	B&F	Stressed
Deer Brook	1.8	44.69587	-73.10548	VT07-03	460600000018	Georgia	B&F	Impaired
Dog River	9.0	44.16199	-72.65721	VT08-17	495100000090	Northfield	WQ	WWTF
Stevens Branch	2.8	44.21199	-72.52572	VT08-16	495600000028	Barre City	B	WWTF
Stevens Branch	3.3	44.21061	-72.51803	VT08-16	495600000033	Barre City	B	WWTF
Water Andric	6.5	44.41238	-72.12876	VT15-03	210500000065	Danville	B	WWTF
Gunner Brook	0.4	44.20566	-72.50613	VT08-16	495611000004	Barre City	B	Stressed
Stevens Branch Trib 23	0.1	44.13142	-72.53288	VT08-16	495623000001	Williamstown	WQ	WWTF
Nasmith Brook	2.7	44.27739	-72.37712	VT08-08	496900000027	Marshfield	B&F	Probability
Ranch Brook	1.5	44.50361	-72.78194	VT08-12	493238200015	Stowe	B	Sentinel
North Branch Winooski River	16.1	44.43772	-72.53668	VT08-13	495400000161	Worcester	B	Sentinel
White River	31.9	43.76667	-72.74389	VT09-02	130000000319	Stockbridge	B	Sentinel
Mile Brook	0.2	43.29949	-72.48092	VT10-12	080700000002	Springfield	B&F	Stressed
Bloody Brook	0.2	43.70587	-72.30779	VT16-21	140000000002	Norwich	B&F	Stressed
Saxtons River	4.5	43.14059	-72.50064	VT11-05	060000000045	Rockingham	B	WWTF
Saxtons River	5.0	43.13672	-72.50536	VT11-05	060000000050	Rockingham	B	WWTF
Sacketts Brook	0.9	42.97367	-72.51706	VT13-12	040000000009	Putney	B	Stressed
Bingo Brook	1.8	43.87133	-72.89522	VT09-07	135404000018	Rochester	B&F	Sentinel/GMNF$
Barton River	9.7	44.81714	-72.20418	VT17-08	380000000097	Barton	B	WWTF
Wells River	6.8	44.19102	-72.14624	VT14-07	190000000068	Ryegate	WQ	WWTF
Smith Brook	1.3	43.85550	-72.94577	VT09-07	135411000013	Rochester	B&F	Sentinel/GMNF$
Kidder Brook	0.9	43.09168	-72.87833	VT11-15	032804080009	Stratton	B	Special Study

Winhall River	8.1	43.14003	-72.93389	VT11-16	033500000081	Winhall	B	Sentinel/GMNF$
Rugg Brook	NEW	44.78617	-73.11742	VT05-07	44020000000#	Georgia	B&F	Probability/Impaired
Bonnie Oaks	NEW	43.93030	-72.13790	VT16-20	16##000000##	Fairlee	B	Stressed
Missisquoi River	7.8	44.92083	-73.12639	VT06-01	420000000078	Swanton	WQ	WWTF
Barton River	15.6	44.75634	-72.18751	VT17-08	380000000156	Barton	WQ	WWTF
Missisquoi River	46.8	44.99197	-72.68248	VT06-02	420000000468	Richford	WQ	WWTF
Lamoille River	70.6	44.51655	-72.37881	VT07-07	460000000706	Hardwick	WQ	WWTF
Rodman Brook	0.6	44.57000	-72.55722	VT07-08	464700000006	Morristown	WQ	Impaired
Third Branch White River	22.2	44.06418	-72.74320	VT09-06	133300000222	Roxbury	WQ	WWTF
Waits River	0.3	43.99651	-72.12235	VT14-04	170000000003	Bradford	WQ	WWTF
Dunne Mountain Trib	NEW	44.59426	-72.15642	VT15-06	2123130000XX	Wheelock	B&F	Probability
Barton River	9.8	44.81508	-72.20511	VT17-08	380000000098	Barton	WQ	WWTF