1.0 PROJECT MANAGEMENT – ORGANIZATION & RESPONSIBILITIES

1.1 Title and Approval Page

Primary Data Quality Assurance Project Plan (QAPP) for the Canoe River Aquifer Resilience Project: Sam Wright Field Wetland Restoration

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Prepared for:
SNEP Network

August 26, 2021

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Jennifer Carlino, Environmental Planner, Town of Easton	Date
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Kate McPherson, Save the Bay	Date
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James Houle, University of New Hampshire	Date
_____	_____
Elizabeth Buschert, University of New Hampshire	Date
_____	_____
Suzanne Flint, Massachusetts Department of Environmental Protection	Date
_____	_____
Nora Conlon, USEPA Region 1 Quality Assurance Officer	Date

1.2 Table of Contents

1.0 PROJECT MANAGEMENT – ORGANIZATION & RESPONSIBILITIES 1
1.1 Title and Approval Page 1
1.2 Table of Contents 2
1.3 Distribution List 4
1.4 Project Organization 4
1.5 Purpose of Study, Background Information, and Problem Definition 6
1.6 Overview of Project Tasks 9
1.7 Quality Objectives and Criteria 10
1.8 Special Training and Certification 12
1.9 Documentation and Records 12
2.0 PRIMARY DATA GENERATION AND ACQUISITION 12
2.1 Sampling Process Design 13
2.2 Sampling Methods 16
2.3 Sample Handling and Custody 18
2.4 Analytical Methods 19
2.5 Quality Control 20
2.6 Instrument/Equipment Testing, Inspection and Maintenance 22
2.7 Instrument/Equipment Calibration and Frequency 23
2.8 Inspection/Acceptance of Supplies and Consumable 23
2.9 Data Management 24
3.0 SECONDARY DATA SELECTION AND MANAGEMENT 25
3.1 Data Acquisition 25
3.2 Data Management 27
3.3 Intended Use of Existing Data 27
3.4 Limitation on the Use of Existing Data 27
4.0 ASSESSMENTS AND OVERSIGHT 27
4.1 Project Oversight 27
4.2 Project Documentation 28
4.3 Corrective Actions 28
5.0 Data Validation and Usability 29
5.1 Data Verification and Validation 29
5.2 Reconciliation with User Requirements 30
6.0 PROJECT REPORTING 30
7.0 REFERENCES 30

Appendices

APPENDIX A: Sam Wright Field Sampling and Analysis Plan
APPENDIX B: Laboratory Standard Operating Procedures for the Sam Wright Field

List of Tables

Table 1. Quality Assurance Project Plan (QAPP) distribution list. 4
Table 2. Project roles and responsibilities....4
Table 3. Water Quality Monitoring Sample Analytical Precision, Accuracy and Project Criteria.... 10
Table 4. Secondary Data Acceptance Criteria. 12
Table 5. Sampling Stations for Level Loggers. 13
Table 6. Water quality monitoring sampling sites.... 15
Table 7. Sample collection, preservation and holding methods. 17
Table 8. Measurement performance criteria. 21
Table 9. Field quality control requirements for water quality monitoring. 21
Table 10. Laboratory quality control procedures for water quality monitoring. 22
Table 11. Field equipment testing, inspection and maintenance. 22
Table 12. Field sampling equipment calibration. 23
Table 13. Sources of existing data. 26

List of Figures

Figure 1. Project organization chart. 6
Figure 2. Sam Wright Field, Easton, MA locus map. 8
Figure 3. Wetland restoration (areas 1-4) and proposed no mow zone (areas 5-7).... 15
Figure 4. Water quality sampling locations. 16
Figure 5. Example Sample Label. 18
Figure 6. Example Chain of Custody. 19

1.3 Distribution List

This QAPP, along with any amendments, will be distributed to the key personnel listed in Table 1, as well as to all federal, state, contractor, subcontractor, and volunteer personnel involved in projects that employ this QAPP.

Table 1. Quality Assurance Project Plan (QAPP) distribution list.

Name, Title, Organization	Contact Information	Mailing Address
Kimberly Groff SNEP Network	508-932-5528 kimberlygroffma@gmail.com	27 Pearl Street Marblehead, MA 01945
Jennifer Carlino Environmental Planner Town of Easton	508-230-0630 jcarlino@easton.ma.us	136 Elm Street North Easton, MA 0235
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Nora Conlon U.S. Environmental Protection Agency	Phone: 617-918-8335 Conlon.nora@epa.com	Chelmsford, MA
Citizen science volunteers, coordinated through Easton Environmental Planner	carol@garden-911.com rory.kallfelz@gmail.com jcchace@comcast.net m7spades@gmail.com edh1620@gmail.com	

1.4 Project Organization

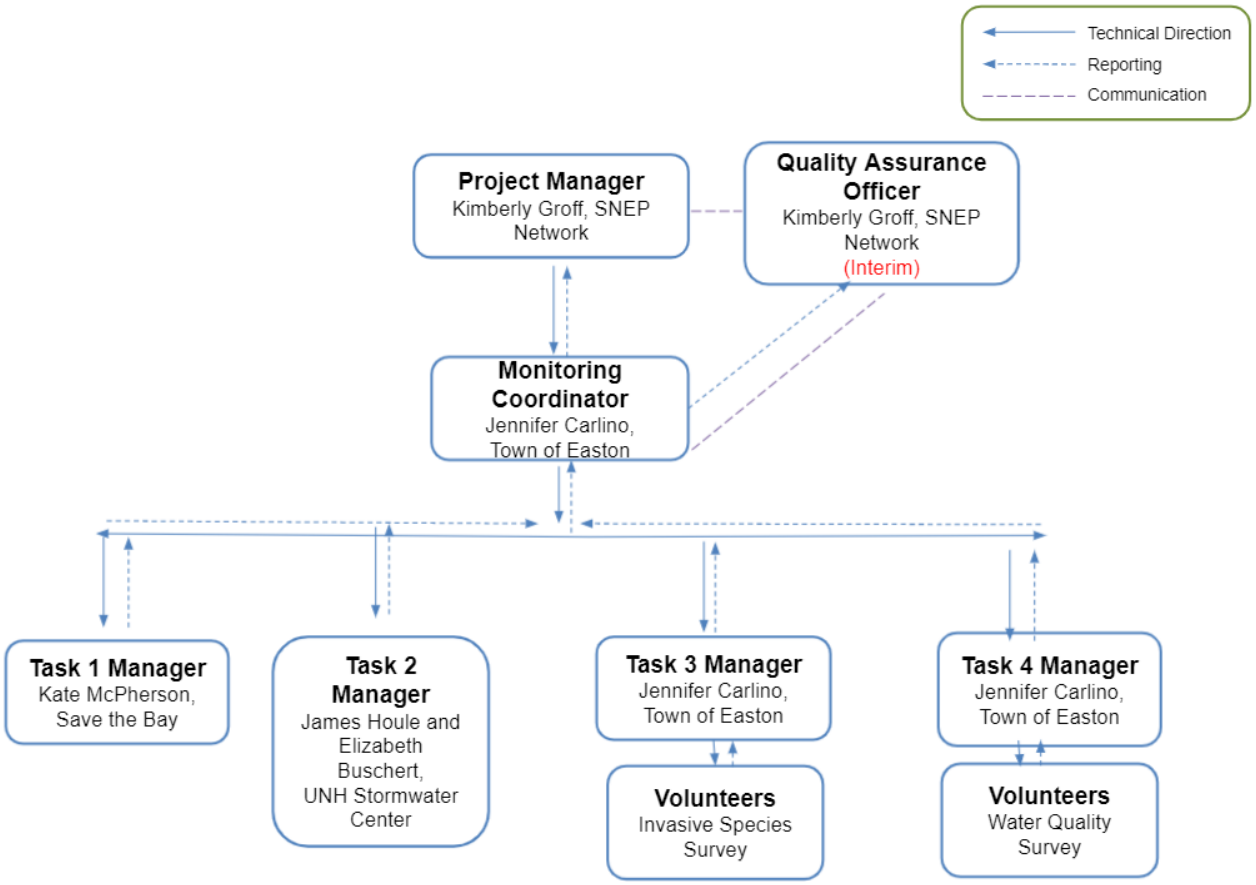
Project organization for this QAPP involves key personnel at the Southeast New England Network (SNEP), USEPA Region 1 and the Town of Easton, as well as by those who will be conducting data collection and analysis by personnel from the Town of Easton, Save the Bay, University of New Hampshire, and Easton volunteers (Table 2, Figure 1).

Table 2. Project roles and responsibilities.

Project Personnel	Responsibility
Project Manager: Kimberly Groff, SNEP Network	Ensure all project deliverables are completed and documented in a timely manner and that adequate resources are made available to the project.
Project QA Officer: Kimberly Groff, SNEP Network (interim)	Responsible for project quality assurance and control oversight, as well as reviewing the QAPP and any subsequent amendments to ensure data of known

Project Personnel	Responsibility
	and documented quality will be collected and produced.
Monitoring Coordinator: Jennifer Carlino, Town of Easton, Environmental Planner	Responsible for coordination and communications to project team as well as volunteers, responsible for maintaining data repository
Lab Coordinator: Jennifer Carlino, Town of Easton, Environmental Planner	Responsible for coordination and communications between the project team and the laboratory; responsible for checking laboratory reports
Wetland Aerial Extent: Kate McPherson, Save the Bay	Responsible for monitoring the extent of bordering vegetated and meadow wetland (after construction and after vegetation is reestablished), design of invasive species monitoring protocol, assistance with wetland data analysis
Wetland Invasive Species Jennifer Carlino, Town of Easton and Easton volunteers	Responsible for implementation of invasive plant monitoring protocol, ensuring written procedures (including field sheet data entry) are followed by volunteers
Flow Monitoring Survey: James Houle, UNH Stormwater Center; Elizabeth Buschert, UNH Technician	Responsible for calibration and preparation of level loggers, deployment of level loggers, site survey work, data analysis, flow estimates and flow hydrographs, data management
Water quality survey crews: Jennifer Carlino, Town of Easton staff and Easton volunteers	Responsible for providing training to staff and volunteer monitors, collection of samples and lab analysis at assigned sites, using the sample collection techniques contained in SOPs, responsible for all data management and reporting, responsible for overseeing and coordinating volunteers

Figure 1. Project organization chart.



1.5 Purpose of Study, Background Information, and Problem Definition

The Canoe River Aquifer Resilience Pilot Project is located in sub-watersheds within the Taunton River Watershed major basin. The Taunton watershed (second largest in the state) is located in southeastern Massachusetts, extending 562 square miles and encompassing all or part of 40 cities and towns. The watershed is characterized by natural beauty and open waters (ponds, rivers and wetlands) that transition from low hills and flat areas to tidal rivers and estuaries in the lower basin. Dense development is concentrated in the northern portion of the watershed and along the southern end of the Taunton River. In the center of the watershed there is a significant amount of undeveloped land use that is undergoing a rapid change (Mass Audubon, Losing Ground, 2020 Report). This trend is consistent with the history of evolving uses of land, water, and sea that has impacted the ecological systems and has manifested in vulnerabilities to the surrounding communities. At the top of the list of stressors is climate change that threatens the very attributes that make the Taunton Watershed so unique.

To address these threats, the towns of Easton, Norton, Sharon, and Mansfield have agreed to participate in a regional facilitated planning process hosted by the Southeastern New England Program (SNEP) Network and its partners. This pilot project is designed to engage these communities, along with other communities that lie within the Canoe River Watershed, in a collaborative community-driven planning process to address localized flooding, aquifer protection, improved groundwater quantity/quality, and ecosystem restoration using Nature Based Solutions (NBS). The Canoe River Aquifer Resilience Pilot Project provides an opportunity to expand upon

the five communities planning activities that have been completed or are currently underway to address local hazards through:

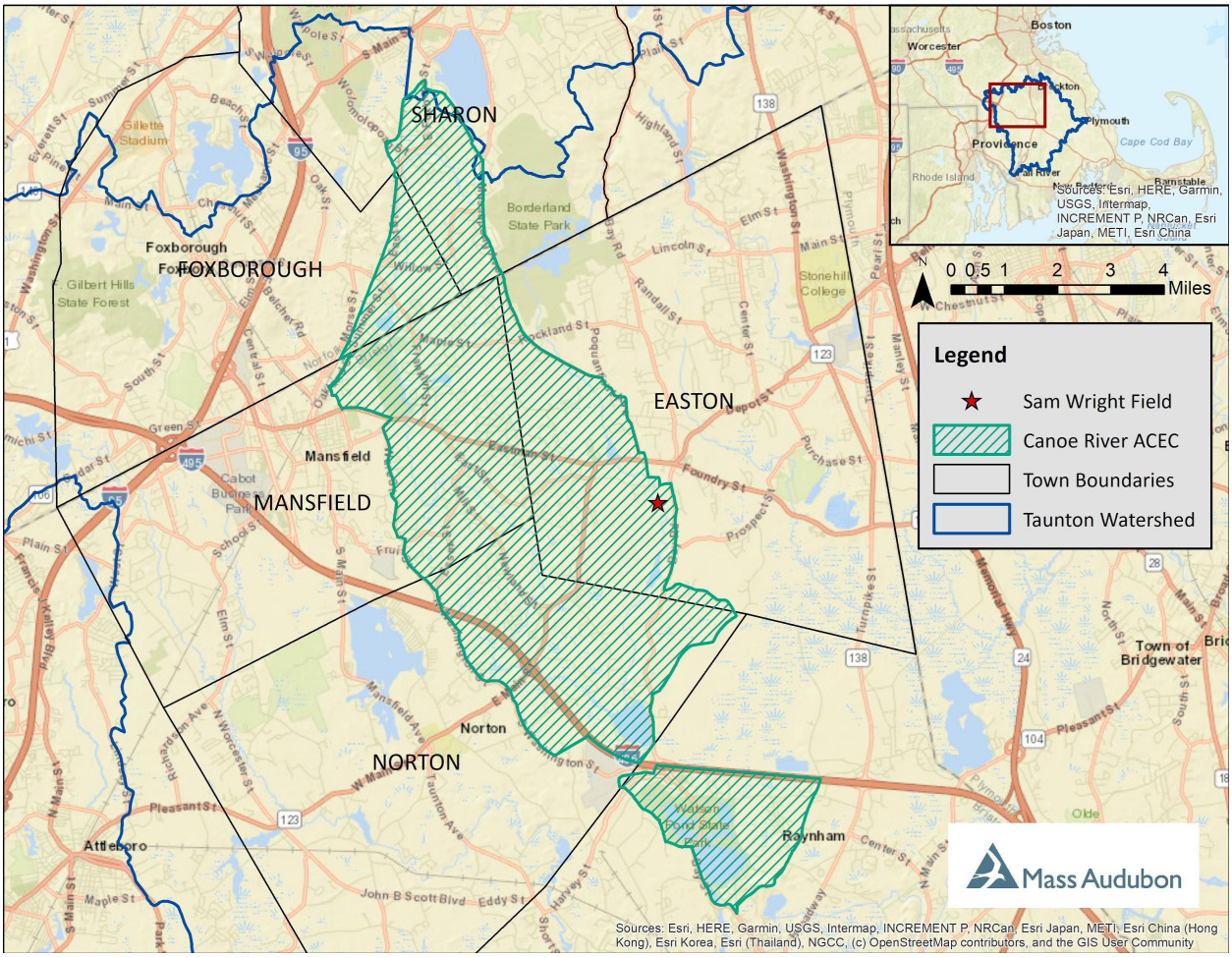
- Facilitated regional planning with a newly formed steering committee,
- Leveraging a tool to site NBS for climate resilience outcomes, recently developed by The Nature Conservancy (TNC) in collaboration with Massachusetts Vulnerability Preparedness (MVP) program, and
- Monitoring the outcomes of the project both at a program level and site-specific scale (e.g., Sam Wright Field Wetland Restoration, 445 Bay Road, Easton).

Easton is currently in the process of implementing a Wetland Restoration Project at Sam Wright Field which is part of the larger Wheaton Farm complex. The project is being implemented through a grant received by the Town of Easton from the Massachusetts Municipal Vulnerability Preparedness (MVP) action grant program, in partnership with The Nature Conservancy (TNC). The Town of Easton has agreed to conduct monitoring as part of the provisions of the MVP grant award. The SNEP Network has offered to provide technical assistance, through its partners as well as its pre-approved consultant pool, to develop a baseline monitoring program for the site. It is anticipated that this site will serve as a regional model for implementing nature-based solutions (NBS) and understanding the benefits of these practices.

One of the goals of the EPA SNEP program 2021-2025 Strategic Plan (https://www.epa.gov/sites/production/files/2020-11/documents/snep-2021-2025-strategic-plan.pdf) is to measure the benefits of environmental restoration projects to assess the overall program impact. Monitoring of the Sam Wright Field Wetland should be practical, with measures that can realistically be maintained with the use of volunteers. The SNEP Network will mobilize partners in winter of 2020-21 to begin baseline data collection. It is anticipated that the Network will design the program and support the effort until the fall of 2023, at which point the town of Easton and/or project partners will carry the established monitoring program forward with volunteers. Data collected in the field will support the environmental measures guidance provided by EPA.

The project site is located at Sam Wright Field that is part of a 1000-acre conservation area (Wheaton Farm) in Easton. The area of wetland restoration at Sam Wright Field is about 5 acres and is subject to flooding (e.g., FEMA flood zone A). Mulberry Meadow Brook flows through the site and is regionally significant from both a flood control and aquifer recharge perspective. Figure 2 shows the location of the project in relation to the Canoe River Area of Critical Concern (ACEC) and the Canoe River Aquifer.

Figure 2. Sam Wright Field, Easton, MA locus map.



Specific wetland restoration activities include:

- Expand flood storage capacity within a FEMA zone A,
- Remove concrete structures,
- Establish no-mow zones,
- Reestablish wetland soils and elevation grade,
- Seeding and planting, and
- Remove and manage invasive plant species.

The project was designed to restore a portion of the existing uplands at the site to a Bordering Vegetated Wetland (BVW). The BVW can be seen in the aerial photo and follows the Mulberry Meadow Brook. Large areas of the site are regularly mowed by Easton. By creating no mow zones along Mulberry Meadow Brook (e.g., several intermittent streams, and the BVW associated with the waterbodies) the buffers are expected to transition from meadow to a more forested condition. Buffers with complex layers (i.e., leaf litter layer, shrub layer, tall shrub layer, tree layer) are generally more effective at protecting wetland functions and values than buffers of a single layer (i.e., herbaceous cover typically seen in a meadow).

Non-native invasive species will be treated and removed from the site immediately after the wetland restoration portion of the project is complete, and then on an ongoing basis. The most common problem species onsite include Purple Loosestrife, Common Reed, Oriental Bittersweet, Common Wormwood, Autumn Olive, Multiflora

Rose, and Glossy Buckthorn. Non-native species were noted along the wetland edge near the stream as well as through the concrete pads, and in other un-mowed areas.

The EPA Region 1 SNEP program will supplement the pilot project with funding/resources to collect pre- and post-implementation data. The collection of baseline information will inform the local project but also yield information that may be useful to surrounding communities that wish to move forward with the implementation of NBS through the broader Canoe River Aquifer Resilience Pilot.

The purpose of the overall project is to assist the Town of Easton with developing a set of baseline measures to evaluate the impact of the wetland restoration project at Sam Wright Field in Easton both locally and regionally. The project will use both primary and secondary data to meet the project goals:

1. Collect data before and after wetland restoration activities to measure the benefit of the restoration project in:
    - restoring of natural hydrology,
    - expanding wetland extent,
    - increasing flood storage,
    - improving habitat, and
    - reducing invasive species.
2. Use existing data to assist in analyzing the benefits in the areas mentioned above.

Given that this project will use primary data collected through this project (both direct measures and indirect measures) and secondary (existing data), this QAPP covers the quality objectives and criteria for collecting, using, and managing both types of data. The project's Sampling and Analysis Plan (SAP) (Appendix A) and the Laboratory Standard Operating Procedures for (Appendix B) outline in more detail the sampling plan for the tasks.

Results will be used by the Town of Easton, the EPA Region 1 SNEP program, state agencies, and local municipalities or other key stakeholder groups to understand the impacts and benefits of the Sam Wright Field wetland restoration project in Easton and more broadly, future restoration projects.

This QAPP was developed in accordance with the following guidance documents: EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5) (EPA, 2002), *EPA New England Environmental Data Review Program Guidance* (EPA, 2018), and *EPA New England QAPP Guidance for Projects Using Secondary Data* (EPA, 2009). Some of the language used in this QAPP was drawn directly from existing EPA-approved QAPP or relevant documents, including the *Taunton River Watershed Alliance Sample Collection and Analysis QAPP (Environmental Strategies and Management, Inc., 2022).*

1.6 Overview of Project Tasks

The following project tasks outline the steps to complete this project.

Task 1: Wetland Aerial Extent Survey (direct measure)

The BVW will be restored and the extent of the BVW and wetland meadow will be expanded to a 30-foot no mow area, which is expected to increase the wetland meadow habitat. The extent will be visually inspected and relative changes will be mapped in GIS. This task will help answer If the wetland restoration improves wetland habitat. This task will be managed by Save the Bay in coordination with the Town of Easton Monitoring Coordinator.

Task 2: Wetland Storage Capacity (direct measure)

Flow will be measured upstream and downstream of the wetland area. The level loggers have already been deployed and measured pre-restoration flow. Post wetland restoration, the loggers will measure the flow and

changes in flow before and after will be measured downstream of the wetland. This task will help answer if the wetland restoration enhanced wetland storage capacity.

This task will be managed by UNH in coordination with the Town of Easton Monitoring Coordinator.

Task 3: Invasive Plant Species Survey (indirect)

Invasive species will be removed during the restoration activities. Areas will be monitored visually by volunteers for the presence or absence of invasive plant species in the BVW wetland meadow. This task will provide a qualitative answer to whether the wetland restoration and control measures reduced invasive plant species in the BVW adjacent to the wetland pool. The data will be used to help guide further application of herbicides and will not be quantitatively analyzed as part of the measures report.

This task will be managed by the Town of Easton Monitoring Coordinator.

Task 4: Water Quality Monitoring (indirect)

Water quality will be monitored upstream and downstream of the overall project site and at the same locations as the flow measurement locations, as well as in the immediate vicinity of the wetland restoration area (e.g., in both upstream and downstream). It is anticipated that more stations may be added by the Town of Easton in the future as part of their MS4 monitoring program. This task will inform water quality management decisions moving forward and will not directly inform the impact of the wetland restoration, since no water quality data is currently available for the site.

This task will be managed by the Town of Easton Monitoring Coordinator.

1.7 Quality Objectives and Criteria

Data quality objectives and criteria for the project will ensure that data collected and used are scientifically valid and defensible, with a high level of transparency and data-sharing capabilities. The end users of the final products of the project are the Town of Easton, the SNEP Network and the Region 1 SNEP program who will use the results to inform future restoration projects and understand the environmental benefits of restoration investments. The data quality objectives and criteria for primary data will be done by evaluating both the measurement performance criteria (quantitative) and by the PARCCS (precision, accuracy, representativeness, comparability, completeness, and sensitivity) parameters (qualitative) (Section 1.7.1). The data quality objectives and criteria for secondary data used in this project will be addressed by evaluating the criteria according to the acceptance criteria (Section 1.7.2).

1.7.1 Measurement Performance Criteria

Primary data collected under this project will be evaluated based on measurement performance criteria. Table 3 provides the analytical sensitivity information and project criteria for the water quality monitoring parameters. The project will compare the analytical results to Massachusetts Water Quality Standards (for Enterococci), EPA Ecoregion recommendations, and EPA NPDES Permit Fact Sheet basis limits for municipal wastewater plants for total phosphorus and total nitrogen (nitrates). Note the targets in Table 3 are guidelines. Mulberry Meadow Brook is a wetland dominated system and values in excess of the targets do not necessarily imply water quality impairment.

Table 3. Water Quality Monitoring Sample Analytical Precision, Accuracy and Project Criteria.

Parameter	Analytical Method	Massachusetts Water Quality Standards (Class B)**	Target Guidance**	Precision (%RPD)	Accuracy (%)

Enterococci Bacteria	EPA 1600	33 colonies/100 mL		<30	29-122%
Total Phosphorus	EPA 365.1		0.100 mg/L	20	90-110%
Nitrate	SM 4500 NO3-F		0.4 mg/L	20	90-110%
** this is a wetland dominated system and may have naturally elevated levels of nutrients and bacteria					

In addition to the measurement performance criteria shown above, the primary data will be reviewed for data usability according to the following PARCCS (precision, accuracy, representativeness, comparability, completeness, and sensitivity) parameters:

Precision, Accuracy, and Bias: The data for all spike data and laboratory duplicate results, if available, from the project will be reviewed. All appropriate Relative Standard Deviations (RSD) and % recovery results and averages will be reviewed. The precision and accuracy of data will be assessed against the criteria presented in Table 3. The data usability assessment will be documented in the final report. Any bias in the data will be noted. In addition, any observations, conclusions, and/or limitations on the use of the data based on the precision, accuracy and bias will be reported. In addition, the precision and accuracy of the laboratory are evaluated by reviewing the Laboratory Control Sample (LCS) to confirm that results are within the QC limits of the methodology used.

Representativeness: Data will be evaluated to ensure the spatial and temporal resolution are appropriate for the project goals so that data can be aggregated and analyzed together. For example, representativeness for the water quality data will be assessed by qualitatively comparing the field monitoring data from each of the surface water sampling locations in the same stream segment and establishing if there is any uniformity across the site. Also, representativeness will be established by the locations of data collection points.

Comparability: Comparability refers to obtaining consistent sampling and analysis between locations and sampling events. Comparability will be assessed qualitatively by checking field note logs for location information when collecting data. Comparability will be assessed quantitatively by comparing the analytical results of field duplicates collected from specific monitoring locations using the same sampling procedures in consecutive sampling events. Site conditions and other site-specific factors will be considered in this assessment.

Completeness: A completeness criteria of 90% for analytical data will be specified. The results of the completeness assessment will be documented in the final report. If the QA QC results for any critical samples (as determined through the development of the conceptual site model) do not meet the data usability evaluation, whether or not the 90% completeness goal has been achieved, these samples will be collected and analyzed again. Completeness is measured by the percentage of sites monitored each month. If completeness is not met for the project, then a discussion will be provided in the final report on the effects that the lack of completeness has on the usability of the remaining data for that month.

1.7.2 Acceptance Criteria

Secondary data will be evaluated according to the acceptance criteria defined for this project. The acceptance criteria are used to assess data adequacy and to evaluate any uncertainty that would arise from using the secondary data. Secondary data that meet the acceptance criteria below (Table 4) will be determined sufficient to meet the goals of the project.

Table 4. Secondary Data Acceptance Criteria.

Acceptance Criterion	Description
Reliability	The extent to which the collection methods, assumptions, quality assurance, review and analyses used to generate the data are documented and follow standard procedures. Sources of data will be considered reliable if they meet at least one of the following: - Data are from a peer-reviewed, government, industry-specific source. - The data are published through a credible source. - Data/information was presented at a technical conference where it is subject to review by other industry experts. - The information or data are from a watershed or association group, deemed credible by the SNEP Network. - The author/source is in a relevant field such that competent knowledge is expected.
Completeness	The extent to which the data has limited or no gaps in space and time. Data gaps may be filled by finding other acceptable data. Methods used to fill any data gaps will be discussed in project documentation.
Reasonableness	The extent to which the data have anomalous values that may represent data entry or analytical errors. Any errors will not be used without clarification from the source of data and will be documented in project documentation.
Relevance	The extent to which data used is specific to the project location, goals, and tasks. Data specific to the project's site will be used. Regional data may be used if it represents the project site and only as needed.

1.8 Special Training and Certification

To ensure that data is collected with sound scientific rigor, personnel collecting data must be trained in accordance with the procedures outlined in this QAPP. Personnel reviewing and analyzing the primary or secondary data must hold advanced degrees in a related environmental field.

Plant species data will be collected by volunteers who will be trained by experienced field biologists. Volunteers will be given a plant identification guide developed by the project team that will show pictures and describe defining characteristics of the target species of non-native invasive species. All volunteers must complete an in-person training, and demonstrate their ability to identify the target species. Furthermore, volunteers will be asked to take photos of suspected invasive plants during their surveys and upload them to the iNaturalist field identification app for immediate confirmation with the app's species ID feature as well as certification by other field naturalists who use the app. All Town staff and volunteers will be trained in appropriate sample collection and recording procedures.

1.9 Documentation and Records

All data and information collected and generated for the project will be stored to a backed-up network. A copy of all project files will be shared with and/or kept by the Town of Easton and EPA Region 1 SNEP Program. Project files will be kept by the originator for a minimum of five years. Folder structures will be clearly labeled. Metadata associated with model and other files will be explicitly documented in accompanying text files or within the document itself (e.g., Excel spreadsheet).

2.0 PRIMARY DATA GENERATION AND ACQUISITION

The information provided in this section pertains to the primary data that will be collected for the Sam Wright Field wetland restoration project. Some of the information presented below is from the approved *Taunton River*

Watershed Alliance Sample Collection and Analysis QAPP (Environmental Strategies and Management, Inc., 2019).

2.1 Sampling Process Design

2.1.1 Wetland Aerial Extent Field Survey

The existing wetland edge has been previously surveyed by Alpha survey group. The current aerial extent of the BVW is estimated to be expanded by 99,750 sq ft providing 6,291 cubic yards of flood storage capacity. A 30-foot wide no mow area will be added to the edge of the BVW, creating a buffer of vegetation that over time will transition to woody species, providing better water quality functions and values to the onsite wetlands as compared to the current condition. The wetland edge will be visually inspected after wetland plants are reestablished and annually for 1 to 2 years to visually monitor the changes in wetland extent. Relative changes will be delineated on spring aerial imagery and compared to the 2020 baseline. GIS analysis will be used to estimate acres managed to treat invasives, impervious surface removed, and agricultural acres using nutrient management. Over time, a project goal is to increase the no mow area to increase the width of the buffer. A 30-foot wide buffer is generally the minimum required for the most basic water quality protection. Bigger is better.

2.1.2 Wetland Storage Capacity

Flow monitoring will be conducted upstream and downstream of the wetland restoration area in culverts. It is more practical to log water levels and convert to flow than to measure flow directly because pressure-based water level sensors are lower power and more reliable than flow sensors. The level loggers will remain deployed until after the wetland vegetation has reestablished during a similar index period. Changes in flow before and after will be estimated downstream of the wetland. Quality controls for level loggers are included in Appendix B of the Sampling and Analysis Plan. Measures will include numbers of acres of floodplain restoration and estimates of changes in flood storage capacity.

Onset Hobo water level loggers will be used to track water levels. Continuous level logger units will be deployed at 3 locations as shown in Table 5. Two loggers will be deployed in culverts in the stream, the other will be deployed in a sheltered open-air location to log local barometric pressure. The devices will be calibrated in accordance with UNH-PSIC SOP's and data will be downloaded and managed by UNH. The units were deployed on December 15th, 2020.

Table 5. Sampling Stations for Level Loggers.

Logger NO.	Station ID	Description
1	Flow 1 (instream)	This station is located at the junction of the Highland Street culvert and Mulberry Meadow Brook, Easton. The site is immediately upstream of the wetland restoration site with good, vegetated buffer.
2	Flow 2 (instream)	This site is located on Mulberry Meadow Brook, the culvert immediately downstream from the wetland pool. The device is deployed in the middle culvert (south side).
3	Barometric pressure	This site is located under the eaves of the map kiosk at the Bay Road parking area near the community gardens.

As soon as the weather permits surveys will be conducted to measure the culverts within the stream channel. Manning's equation will be used to convert water pressure reading into volumetric flow. The amount of increased flood volume will be calculated based on grade changes before and after restoration. Field

measurements using level gages will be used to estimate changes in flow before and after wetland restoration to evaluate changes in flood storage.

2.1.3 Invasive Plant Species Survey

The presence and absence of invasive plant species in the BVW wetland meadow will be monitored after the concrete structures are removed and vegetation is reestablished through seeding of the property and no mow zones are implemented. During the restoration activities, invasive plants will be removed through the proposed excavation of the existing concrete pads. Additional physical and chemical treatments will be conducted by the Town of Easton and their consultant throughout sections of the site following construction and on an ongoing, as needed, basis in the years following restoration.

Invasive plant species surveys will be conducted at plots throughout the restored BVW at least annually (areas 1-4 in Figure 3). The baseline for the future monitoring of plots is zero plants, because each area is anticipated to be devoid of plants after restoration activities are completed. The perimeter and interior of each plot will be visually observed for specific invasive plants identified as of particular concern for the site (presence or absence, and estimated prevalence). Information collected by volunteers will be used to guide the herbicide application contractor. The presence/absence data will be verified by the herbicide contractor and used qualitatively to inform the Town's invasive species management.

Figure 3. Wetland restoration (areas 1-4) and proposed no mow zone (areas 5-7).



2.1.4 Water Quality Monitoring

Sampling locations have been selected (Table 6 and Figure 4) to obtain a baseline indication of surface water conditions in the vicinity of the wetland restoration effort. Field reconnaissance will be performed to confirm appropriate access points and ensure that sample collection is conducted at locations that are representative of water quality. It is anticipated that more stations may be added by the Town of Easton in the future as part of their MS4 monitoring program.

Table 6. Water quality monitoring sampling sites.

Sampling Location	GPS Location	Description	ID
South Street Culvert	42.020617, -71.127543	This station is located at the junction of the South Street culvert and Mulberry Meadow Brook, Easton. The site is upstream of the Highland Street culvert.	WQ MMB 001
Highland Street Culvert	42.018933, -71.125767	This station is located at the junction of the Highland Street culvert and Mulberry Meadow Brook, Easton. The site is immediately upstream of the wetland restoration site with good, vegetated buffer.	WQ MMB 002

Sampling Location	GPS Location	Description	ID
Upstream Wetland Pool	42.016296, -71.125847	Located at footbridge immediately upstream of the wetland pool adjacent to the wetland restoration.	WQ MMB 003
Downstream Wetland Pool Culvert	42.015509, -71.125085	This site is located on Mulberry Meadow Brook, the culvert immediately downstream from the wetland pool.	WQ MMB 004
Upstream Ward Pond	42,012207, -71.122586	Located on Mulberry Meadow Brook at the upstream side of Ward Pond downstream of the wetland restoration site.	WQ MMB 005

Figure 4. Water quality sampling locations.



2.2 Sampling Methods

2.2.1 Wetland Aerial Extent Field Survey

Sampling methods are described in the project's Sampling and Analysis Plan (SAP) in Appendix A.

2.2.2 Wetland Storage Capacity

Sampling methods are described in the SAP in Appendix A.

2.2.3 Invasive Plant Species Survey

Sampling methods are described in the SAP in Appendix A.

2.2.4 Water Quality Monitoring

Sampling methods are described in the Standard Operating Procedures for the Volunteer Monitoring Program in the SAP Appendix D. Grab samples are collected by lowering a clean sample bucket (or sample bottle using a pole sampler) into the midpoint of the river/stream to fill with water. The filled bucket is pulled up and gently dumped out to provide a rinse with river water. The bucket is then lowered again to collect the sample for laboratory analysis. The time of sample collection is written on the bottles and chain of custody used for analysis. Sample bottles are filled in the following order: enterococci bacteria, nitrate, total phosphorus.

Duplicate and blank samples are taken at the last site the sampler visits that day. Duplicate samples are collected from the same bucket used for the original sample. Field blanks are collected for enterococci, nitrate, and total phosphorus only. The sample bucket is thoroughly rinsed out using distilled water and dumped out. Remaining distilled water is then poured into the bucket to collect blanks. Sampling buckets are thoroughly rinsed with river water in between sites. A detailed summary of the samples to be collected and analyses performed is included in the following table:

Table 7. Sample collection, preservation and holding methods.

Parameter	Matrix	Number of Samples (including required field QC)	Analytical Method	Sampling SOP	Containers	Preservation Requirements	Maximum Holding Time
Enterococci Bacteria	Surface water	24 samples (including 2 duplicates and 2 field blanks)	USEPA Method 1600[1]	Sam Wright Field Baseline SAP	Pre-sterilized containers with secure lids; min. 100mL	4°C +/- 0.5°C	Analyzed within 2 hours of collection but always within a max of 6 hours transport time follow by 2-hour lab process time
Total Phosphorus	Surface water	24 samples (including 2 duplicates and 2 field blanks)	USEPA Method 365.1[2]	Sam Wright Field Baseline SAP	100 mL HDPE	4°C H_2SO_4 (2 mL concentrated H_2SO_4 per L)	2 months
Nitrate	Surface water	24 samples (including 2 duplicates and 2 field blanks)	Standard Method 4500-N03-F[3]	Sam Wright Field Baseline SAP	50 mL plastic	4°C	48 hours

[1] USEPA, Method 1600: Enterococci in Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-B-D-Glucoside Abgar (mEI), December 2009: https://www.epa.gov/sites/production/files/2015-08/documents/method_1600_2009.pdf.
2 USEPA, Method 365.1, Revision 2.0: Determination of Phosphorus by Semi-Automated Colorimetry, August 1993: https://www.epa.gov/sites/production/files/2015-08/documents/method_365-1_1993.pdf.

3 National Environmental Methods Index, 4500-N03-F Automated Cadmium Reduction Method: https://www.standardmethods.org/.

2.3 Sample Handling and Custody

2.3.1 Wetland Aerial Extent Field Survey

No physical samples are collected requiring sampling and custody procedures.

2.3.2 Wetland Storage Capacity

No physical samples are collected requiring sampling and custody procedures.

2.3.3 Invasive Plant Species Survey

No physical samples are collected requiring sampling and custody procedures.

2.3.4 Water Quality Monitoring

All samples will be tracked from collection, to shipment, to laboratory receipt, and laboratory custody using a standard laboratory chain of custody. Labels which contain the following information will be filled out on dry labels with ball point pen before sample collection and affixed to each sample containers (Figure 5):

- Sample number
- Sample Location
- Name of Sampler
- Analyses to be performed
- Preservation

Microbac is the laboratory that will be used for this project. If the laboratory changes before or during project implementation, the QAPP will need to be updated. Laboratory SOPs are included in Appendix B.

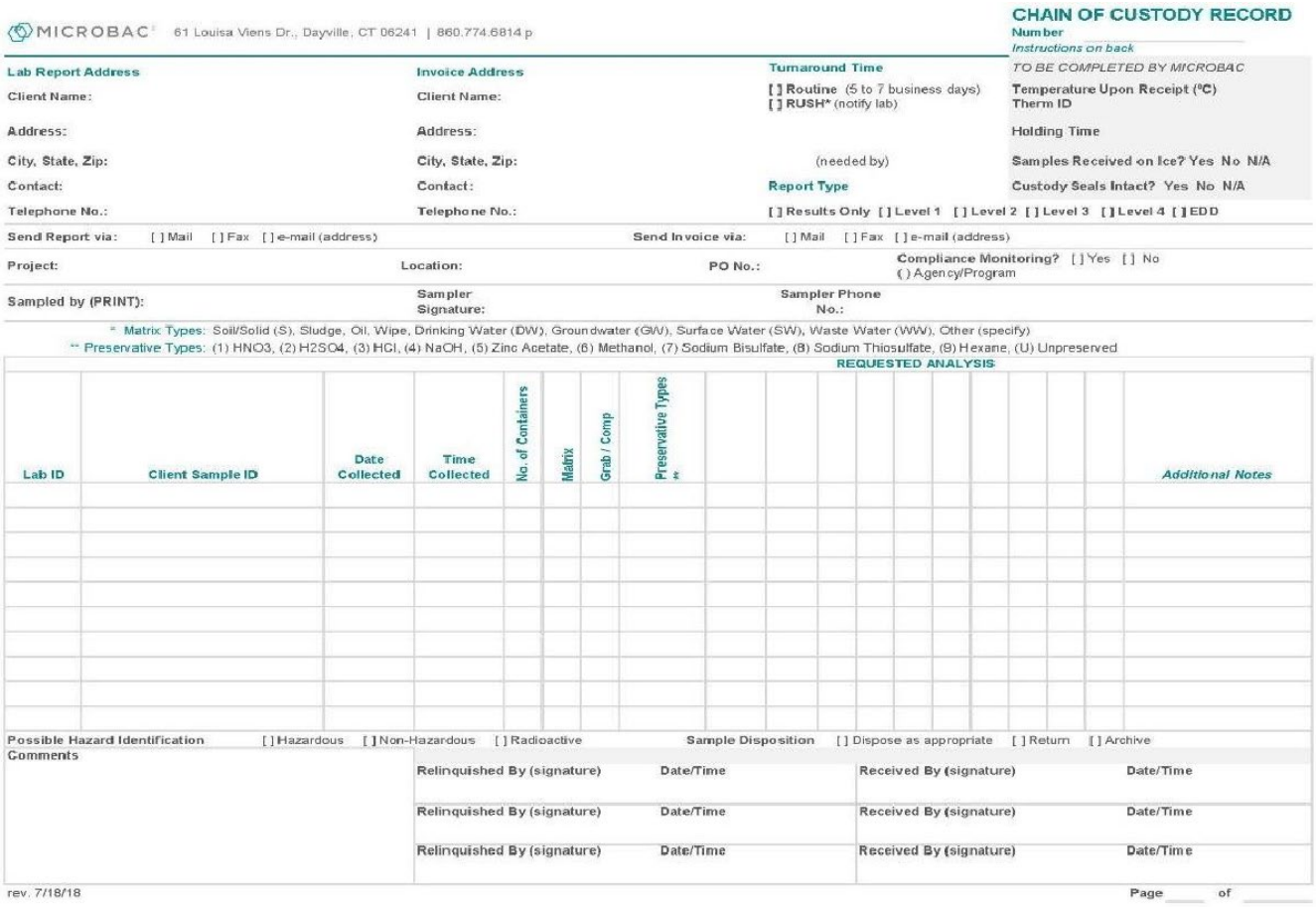
At time of sampling, date and time of collection will be filled out on dry labels immediately prior to sampling.

Figure 5. Example Sample Label.

PROJECT NAME	
SAMPLE ID	SAMPLE DATE
SAMPLED BY	SAMPLE TIME
PRESERVATIVE	_____GRAB _____COMPOSITE
ANALYSIS REQUESTED	

A Chain of Custody is maintained for all samples. The Chain of Custody form is signed by all individuals responsible for sampling, sample transport, and laboratory receipt (Figure 6). The original Chain of Custody form accompanies the samples until the project is complete. The original Chain of Custody is kept in the permanent project files.

Figure 6. Example Chain of Custody.



MICROBAC 61 Louisa Viens Dr., Dayville, CT 06241 | 860.774.6814 p

CHAIN OF CUSTODY RECORD
Number
Instructions on back

TO BE COMPLETED BY MICROBAC
Temperature Upon Receipt (°C)
Therm ID
Holding Time
Samples Received on Ice? Yes No N/A
Custody Seals Intact? Yes No N/A

Lab Report Address
Client Name:
Address:
City, State, Zip:
Contact:
Telephone No.:

Invoice Address
Client Name:
Address:
City, State, Zip:
Contact:
Telephone No.:

Turnaround Time
[ ] Routine (5 to 7 business days)
[ ] RUSH* (notify lab)
(needed by)

Report Type
[ ] Results Only [ ] Level 1 [ ] Level 2 [ ] Level 3 [ ] Level 4 [ ] EDD

Send Report via: [ ] Mail [ ] Fax [ ] e-mail (address)
Send Invoice via: [ ] Mail [ ] Fax [ ] e-mail (address)
Project:
Location:
PO No.:
Compliance Monitoring? [ ] Yes [ ] No
( ) Agency/Program
Sampled by (PRINT):
Sampler Signature:
Sampler Phone No.:

* Matrix Types: Soil/Solid (S), Sludge, Oil, Wipe, Drinking Water (DW), Groundwater (GW), Surface Water (SW), Waste Water (WW), Other (specify)
** Preservative Types: (1) HNO3, (2) H2SO4, (3) HCl, (4) NaOH, (5) Zinc Acetate, (6) Methanol, (7) Sodium Bisulfate, (8) Sodium Thiosulfate, (9) Hexane, (U) Unpreserved

REQUESTED ANALYSIS

Lab ID	Client Sample ID	Date Collected	Time Collected	No. of Containers	Matrix	Grab / Comp	Preservative Types **										Additional Notes

Possible Hazard Identification [ ] Hazardous [ ] Non-Hazardous [ ] Radioactive
Sample Disposition [ ] Dispose as appropriate [ ] Return [ ] Archive

Comments

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

rev. 7/18/18
Page ____ of ____

Custody seals are generally not used, as the lab, Microbac, employs couriers rather than regional hubs that utilize national shipping companies. When shipment via parcel services is required, laboratory supplied custody seals are used, which are signed and dated by volunteer personnel. Temperature of samples are measured upon receipt at the laboratory.

2.4 Analytical Methods

2.4.1 Wetland Aerial Extent

Delineating a wetland edge applies methods from both remote sensing and field verification. The wetland biologist will obtain satellite imagery that depicts the project site between the months of November and April (when deciduous trees and shrubs do not have canopy cover). Potential sources of the imagery are Google Earth Pro and/or OLIVER Mass GIS Online Mapping tool. The biologist uses indicators of wetland hydrology that appear in the imagery (colors and textural differences that indicate water, tree, shrub, or herbaceous cover) to delineate the wetland edge. The biologist will use features of the software mentioned above to delineate the extent of the wetland prior to and post wetland restoration. In Google Earth the biologist will use the “all Polygon” feature and draw the edge of the aerial wetland extent. This tool will calculate area, in square feet or acres. As part of the delineation, the biologist will also visit the site to look for indicators of wetland hydrology, wetland plants (Facultative (FAC), Facultative Wetland Plants (FACW), and Obligate Wetland Plants (OBL)), leaf staining, buttressed roots, and hydric soil indicators of wetlands, including scour, and/or shallow root systems.

2.4.2 Wetland Storage Capacity

Pressure data from the stream-deployed loggers will be corrected for local barometric pressure using the barometric pressure from the map kiosk logger and converted to water depth with Onset's HOBOware software. The water depth will then be converted to flow using Manning's equation and surveyed culvert dimensions and slope and observations of roughness of each monitoring site. The loggers will be checked for damage and internal battery health at each deployment, as well as periodically verified by immersing in water of a known depth and checking measurements.

2.4.3 Invasive Plant Species Survey

Volunteers will visually inspect each monitoring plot for the presence (scarce, moderate, or dominant prevalence) or absence of each invasive species of concern, as identified in SAP Appendix C. Volunteers will locate each plot by using their cell phone or a handheld GPS device to find the fixed pieces of rebar that mark each plot, and/or by locating the correctly numbered rebar centerpoint post, and plot areas will be measured using either a pre-measured length of string with markers at each foot (provided by the Town of Easton) or with a tape measure. If invasive species are present within a plot, the volunteer will indicate which species of concern are present on the field data sheet, and then estimate the prevalence of each within the plot as scarce, moderate or abundant. The Town will use the data collected to guide their herbicide contractor in the removal/treatment of invasive plants, and to qualitatively compare changes each year in the estimated areas of each species present within each plot. This information will be used informally by the Town to guide their invasive species plant management.

2.4.4 Water Quality Monitoring

The laboratory used for this project, Microbac, uses the following SOPs and analytical methods for analyzing the water quality samples:

SOP Reference	Document Title
MICROBAC SOP MB-10, rev 2, 10/12	Enterococci by Membrane Filter Method 1600
MICROBAC SOP WC-26, rev 3, 1/14	Phosphorous Automated (All Forms) Method 365.1
MICROBAC SOP WC-47, rev 4, 2/16	Determination of Nitrate and Nitrite SM4500 NO3-F

2.5 Quality Control

2.5.1 Wetland Aerial Extent

Interpretation of aerial imagery will be done by a qualified Professional Wetland Scientist with 18 years of experience. Additionally, delineation of the wetlands prior to the restoration work will be done on spring 2020 aerial imagery and compared to the wetland survey already completed by Alpha.

2.5.2 Wetland Storage Capacity

The level loggers will be purchased, installed and maintained by UNH project staff. These will be used according to SOP 03. Data from the loggers will be downloaded approximately twice a year.

Data from the loggers will be processed according to quality control procedures (Table 8). See SAP Appendix B.

Table 8. Measurement performance criteria.

Sampling Procedure	QC Sample and/or Activity Used to Assess Measurement Performance	Measurement Performance Criteria	Data Quality Indicators (DQIs)	Analytical Method/SOP
Water Level	Comparison with staff gauge	Difference between HOBO and staff gauge not greater than 0.03 ft	Accuracy	PSIC SOP 03 (SAP Appendix B)

2.5.3 Invasive Plant Species Survey

In order to ensure consistency with data collection between volunteers, standardized field forms, (e.g., Wetland Restoration Plot Survey) will be used to make a presence/absence assessment and provide an estimate of the prevalence measure where invasive species are present (scarce, moderate, dominante) for each target invasive species of concern (SAP Appendix C). Volunteers will be given a species ID guide with photos of the plant species they are looking for, and be trained in the field to identify the species. Volunteers will also be asked to upload photos of the plants they identify to the iNaturalist app for confirmation of species identification. Finally, the Town of Easton's contract herbicide applicator will confirm species identification prior to any treatments applied.

2.5.4 Water Quality Monitoring

Samples collected for water quality monitoring will be processed under field quality control requirements (Table 9). Standardized field forms, or field logs, will be used to ensure constituency with data collection between volunteers.

Table 9. Field quality control requirements for water quality monitoring.

Matrix and Parameter	QC Sample	Frequency	Acceptance Criteria	Corrective Action
Surface water, all parameters	Field Duplicate	10% of total number of samples collected	Meets data quality objectives	Results will be rejected or qualified
Surface water, all parameters	Field Blank	10% of total number of samples collected	Meets data quality objectives	Results will be rejected or qualified

In addition to the field quality control requirements, Microbac laboratory follows laboratory quality control procedures (Table 10). More information on the laboratory's quality control procedures is included in their SOPs in Appendix B.

Table 10. Laboratory quality control procedures for water quality monitoring.

Parameter	Matrix	QC Samples	Frequency	Acceptance Criteria	Corrective Action
Enterococci	Water	Blank	One per batch or 20 samples	All below detection limit	Positive results for any blank in a run invalidates all samples in the run
Enterococci	Water	Lab control sample	Two per month	All below 10 colonies per 100 mg/L	Identify source of problem; Re-prep/Re-analyze LCS prior to analysis of samples
Total Phosphorus	Water	Lab reagent blank	One per batch or per 20 samples	All compounds below detection limit	Assess contamination form lab equipment; Identify source of problem and take corrective action
Total Phosphorus	Water	Lab fortified blank	One per batch or per 20 samples	90-110% Refer to SOP	Rerun all the samples in a batch including LCS and blank to assess the analytical system
Nitrate	Water	Lab reagent blank	One per batch or per 20 samples	All compounds below detection limit	Assess contamination from lab equipment; Identify source of problem and take corrective action
Nitrate	Water	Lab fortified blank	One per batch or per 20 samples	90-110% Refer to SOP	Remake and rerun the LCS and blank to assess the analytical system

2.6 Instrument/Equipment Testing, Inspection and Maintenance

2.6.1 Wetland Aerial Extent Field Survey

No instruments or equipment will be used during data collection.

2.6.2 Wetland Storage Capacity

The data loggers will be tested, inspected and maintained by project staff in accordance with the manufacturer procedures (Table 11).

Table 11. Field equipment testing, inspection and maintenance.

Sampling Equipment/ Instrument	Maintenance Activity	Testing Activity	Inspection Activity	Responsible Person	Frequency	Acceptance Criteria	Corrective Action	SOP Reference
Onset Water Level Meter	Wipe any debris; download data	NA	Be sure to re-deploy in the software to log; be sure to deploy at the same stage	Person(s) downloading the data	At each download	Equipment is not damaged, line is securely attached	Call UNH if need assistance	PSIC SOP 03 (SAP Appendix B)

2.6.3 Invasive Plant Species Survey

Volunteers will use tape measures or pre-measured length of string to determine distances and plot areas. These do not need to be tested or inspected after being provided to the volunteers. No further instruments or equipment will be used during data collection.

2.6.4 Water Quality Monitoring

No instruments will be used to collect in-situ data.

2.7 Instrument/Equipment Calibration and Frequency

2.7.1 Wetland Aerial Extent Field Survey

No instruments or equipment will be used during data collection.

2.7.2 Wetland Storage Capacity

The data loggers will be calibrated according to the manufacturer procedures (Table 12).

Table 12. Field sampling equipment calibration.

Equipment	Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Onset Water Level Meter	Check raw pressure sensor data under multiple pressures and temperatures	Every 3 years	Less than 0.03 ft difference	Send back for factory calibration	Onset	PSIC SOP 02 (SAP Appendix B)

2.7.3 Invasive Plant Species Survey

No instruments or equipment will be used during data collection.

2.7.4 Water Quality Monitoring

Instrument/equipment calibration and corrective actions to be undertaken are outlined in the laboratory SOPs included in Appendix B.

2.8 Inspection/Acceptance of Supplies and Consumable

2.8.1 Wetland Aerial Extent Field Survey

There are no expected supplies and consumables for this data collection.

2.8.2 Wetland Storage Capacity

The level loggers have been obtained for this project.

2.8.3 Invasive Plant Species Survey

There are no expected supplies and consumables for this data collection.

2.8.4 Water Quality Monitoring

All laboratory supplies and consumables critical to the project will be inspected and accepted by the laboratory in accordance with their SOPs included in SAP Appendix D.

2.9 Data Management

2.9.1 Wetland Aerial Extent Field Survey

Data will be managed by Save the Bay. Save The Bay's Riverkeeper will create an image file (.jpg) with the pre and post restoration wetland extant. If requested, Save The Bay will provide the project partners with a Keyhole Markup Language (KML) file as well. The image will include a locus map, scale, title, and key. The original KML file as well as the image will be stored on Save The Bay's Google Drive, and will be shared via drive link and email to Easton and other interested project partners.

2.9.2 Wetland Storage Capacity

Data will be managed by UNH. Copies of raw download files from loggers will be retained by UNH. Survey measurements and notes from field visits will be taken and digitized. All digital data will be backed up using cloud computing services. Processed flow data will be provided to project partners.

2.9.3 Invasive Plant Species Survey

Data will be managed by the Town of Easton. SNEP Network partners will work with the Town to set up an electronic Google Form for volunteers to enter the data they collect. Volunteers may opt to collect data in the field on the provided paper data sheet (SAP Appendix C) and then submit their data via google form when they return from the field, or input their data collected directly to the Google Form in the field. Through this form, the data will automatically get uploaded to an excel database that the Town will manage. The Town will share these results directly with the contracted herbicide applicator to inform invasive plant management. Furthermore, photos that are uploaded to the iNaturalist app will automatically be added to a project for the site that will be set up by SNEP Network and the Town, and the photos will be stored by iNaturalist indefinitely and publicly accessible by app users.

2.9.4 Water Quality Monitoring

Data will be managed by the Town of Easton.

Field Documents and Records
A daily site visit form will be used to document the work activities conducted. Personnel on-site, site visitor names, arrival and departure times and date fields are included on the form. The parameters measured in-situ will also be recorded on the site visit form. The site visit form will be used as a cover sheet for the field package, which will document the sampling procedures. The site visit form is generated by the field crew and is turned into the Monitoring Program Coordinator. All field notes are scanned to create a digital version, and original versions are kept on-file at the Town of Easton.

The Monitoring Program Coordinator is responsible for performing a QA check to ensure that the notes are accurate and that all field work is well documented. If data appears to be missing or inaccurate, the field crew will be asked to provide an explanation prior to scanning and filing the field notes. The original notes themselves will be stored in the project file for review by the Monitoring Program Coordinator. Other data, such as surface water depth measurements, water quality parameters, etc., will be converted into tabular form and included within reports.

Laboratory Documents and Records
Laboratory reports will include project narratives that explain qualified data, analytical result sheets, and a QA/QC section. The QA/QC section will include results of any quality control samples requested by the Town of Easton and/or run by the laboratory. The analytical results will document the analytical method used, the preparation and analysis dates, the analytical results, the reporting limits, and other pertinent information.

Data is stored on Microsoft Excel files in the Town of Easton's office. Copies are also kept on the Monitoring Program Coordinator's computer, backed up to a hard drive.

Post Laboratory Data Manipulation
The laboratory will submit an electronic data deliverable (EDD), in the form of a Microsoft Excel file, along with the analytical report. This will minimize manual data entry. The EDD will be spot-checked to ensure accuracy, and transferred into the site's Microsoft Access database. Analytical result tables will be created using Access and will be tabulated within pertinent site reports. The tables will include the results of any field duplicates collected. Electronic versions of the original laboratory reports will be included as appendices.

3.0 SECONDARY DATA SELECTION AND MANAGEMENT

Some of the project data collection tasks will require the use of secondary data, also referred to as non-direct measurements. Secondary data are data that were collected under a different effort outside of the project. Secondary data to be used in the project will be collected from government publications and databases, scientific literature, industry published studies, lake associations/watershed groups, and other organizations.

3.1 Data Acquisition

A variety of secondary data may be used for the project, including spatial files, water quality data, weather data, and literature references. A list of possible secondary data for use in this project is provided in Table 13. Project reports will provide a more detailed list of data sources used.

Table 13. Sources of existing data.

Type of Data [File Name]	Description/Title	Format	Source (Date)	Intended Use	Possible Limitations	QA/QC	Analysis
Precipitation	Daily precipitation data	.csv	National Climatic Data Center (NCDC) or NOAA NCEI, nearest quality-controlled land-based station	Wetland storage capacity calculations	No weather stations nearby; data gaps	Check for major gaps and use next nearest station to fill in	Rain event data will be used to check the flow data for changes in hydrologic response post restoration.
Invasive species plant list	Identification information for invasive plant species	Word/Website	ECR Engineer observations, as listed in NOI Support Report to town Conservation Commission	Volunteers will review when identifying invasive plants in the field	Does not include sufficient photos	Check for major gaps and fill in from other reputable sources as needed	Plant photos and descriptions will be used by volunteers when identifying invasive species in the field.

3.2 Data Management

Consistent data management procedures will be used during pre-processing, calculations, and post-processing stages of the project. Original data sources will be documented to identify the website or contact person that provided the data, data query parameters, and data request correspondence. The final documentation will include a summary of all final data (including complete citations) used in the wetland storage capacity calculations. Metadata will be housed in the spreadsheet files.

3.3 Intended Use of Existing Data

The intended use of existing data for each data file is summarized in Table 13.

3.4 Limitation on the Use of Existing Data

The limitations on and quality control needed for the use of existing data are summarized in Table 13.

4.0 ASSESSMENTS AND OVERSIGHT

4.1 Project Oversight

The hierarchy of reporting within the project team, along with the project roles of key personnel, are identified in Section 1.4. The Project Manager has primary responsibility for monitoring the activities of this project, identifying or confirming any quality problems, and ensuring that the quality requirements specified in this generic QAPP are followed. Significant problems will be brought to the attention of the SNEP Network lead staff, who will initiate corrective actions, document the nature of the problem, and ensure that the recommended corrective action is carried out.

Data collection and assessment by project partners will be reviewed quarterly (or as needed) prior to analyses by the Project QA Officer. The QA Officer will make data evaluations to ensure that QC is occurring throughout the project. The QA Officer will consider the data's usability, quality, and consistency with other data sources and document any data limitations that do not meet data acceptance criteria. Data evaluations will also include reviewing field log entries, laboratory reports, and databases where raw data has been transferred into to ensure no transcription errors.

The Project Manager will make periodic site visits to oversee the field staff and ensure that work is being conducted in accordance with the QAPP. Periodic project management check-ins will be scheduled every 6 month, or as needed, with partners and the Town of Easton. SNEP Network partners will oversee Tasks 1 and 2. The Monitoring Program coordinator will oversee Tasks 3 and 4. Site visits will be scheduled approximately once per every seven field events. The field staff will receive verbal feedback from the Project Manager and the Monitoring Program Coordinator, and the Monitoring Program Coordinator will be responsible for dealing with follow up and corrective actions.

The Monitoring Program Coordinator will prepare work packages containing an instructional cover sheet and all pertinent blank forms to be filled out by the field crew. The field crew will fill out all forms contained within the field package, and will return the package in its entirety to the Monitoring Program Coordinator. The Monitoring Program Coordinator is responsible for reviewing the field packages to determine if there are any notable findings or trends which may impact the site model. Significant findings will be reported to the Project Manager and the entire project team.

All lab work is reviewed by the Project Lab Coordinator, who will complete a cover page to append to the laboratory report. Any inconsistencies will be addressed with the laboratory during the review process. The Lab Coordinator will maintain responsibility for laboratory data evaluation. The Project Lab Coordinator will keep

records regarding project-specific criteria, such as required method detection limits and field sampling requirements. When a laboratory package is received, it will be reviewed for completeness and for compliance with this project specific QAPP and the relevant site-specific addendum. The laboratory will be consulted if any data appears to be missing or if any questions arise. The Lab Coordinator will review the project narrative, which documents any problems related to preservation, handling, and analysis. The field and lab QC results will be approved, and a cover sheet describing findings will be prepared and appended to each laboratory report. A spreadsheet will be kept with all of the site's cover sheets and one main page cataloging all laboratory data collected.

4.2 Project Documentation

Data quality review procedures will be documented in the draft and final project products, which will be reviewed by the Project QA Officer and then reviewed by the Project Manager before sending to the SNEP Network lead staff for final review. Any feedback will be incorporated to the final project deliverables.

While data collection is in process, project documentation and files will be managed by the entity responsible for the task. Project files will be stored on the hard drives of individual personnel (including all files by the Project Manager) and will be backed up to an external hard drive daily. All final project files will be collected and stored by the Town of Easton. It is anticipated that data will be shared with the SNEP Network and EPA as well as other partners. The data will be evaluated and summarized by the end of 2023. Each contributing partner will be responsible for the work up of the data that will be shared with the Town of Easton.

4.3 Corrective Actions

If quality problems that require attention are identified, the Project Manager will determine whether attaining acceptable quality requires either short- or long-term corrective actions. Issues with field data collection will be discussed with the Monitoring Coordinator. Minor adjustments to the sampling design, such as moving a sampling location to avoid an obstruction, may proceed with notification to the Monitoring Coordinator and documentation in the field logbook. Major problems will require notification to the Project Manager prior to proceeding.

Any corrective actions which modify the approved QAPP will first be approved by EPA before work begins. Many of the technical problems that might occur can be solved on the spot by the staff members involved, for example, by modifying the technical approach or correcting errors or deficiencies in documentation. Immediate corrective actions form part of normal operating procedures and are noted in records for the project. Problems that cannot be resolved in this manner require more formalized, long-term corrective action.

Possible data problems that would require corrective actions include lack of appropriate or complete metadata, incomplete datasets, data that do not meet quality objectives and data that conflict with other quality-assured data sources. Corrective actions could include:

- Re-sampling.
- Contacting the data originator for more complete metadata or explanation.
- Researching alternative data sources or formats that could be added to the incomplete dataset.
- Filtering out or discarding highly conflicting data with justification based on the metadata.
- Retraining volunteers to more accurately collect data.

In some cases, acceptance criteria may need to be lessened or altered to accommodate problematic data that is necessary for the project but are the only data source available. Any data limitations will be documented in project products.

5.0 Data Validation and Usability

This section describes the checks performed on the primary and secondary data to see if it conforms to the project's quality criteria objectives, if the data is usable, and whether there are limitations of data. A complete and accurate data set is valuable to meet the project goals.

5.1 Data Verification and Validation

To determine whether the overall project data and analysis processes meet project criteria, the Project Manager and QA Officer will review the primary and secondary data. The primary and secondary data will be evaluated for completeness, correctness and conformance with the quality objectives outlined in Section 1.7. The primary data collected under Tasks 1-4 will be reviewed to verify how they have been recorded, transferred, analyzed, and reported. If the QA Officer determines certain corrective actions are necessary, these actions will be made promptly under the QA Officer's supervision. The QA Officer will document implementation and effectiveness of such corrective actions.

Metadata for secondary data used for this project will be maintained in project documentation and it will include a data description, source, publication date (if applicable), time period of data collection (or specific time and date), and spatial information. Other metadata that may be collected and recorded include sampling and analysis plan, laboratory methods, reporting limits, reporting units, field qualifiers or notes, and laboratory qualifiers.

For plant species data, plant identification will be reviewed by field biologists. These data will be used to determine when additional rounds of non-native plant control are required on the site in general, so rigorous identification of all species is not necessary. As a final ground-truthing method, the invasive species control consultant that will be hired by the town will only treat nonnative plants.

For water quality monitoring data, data results will be reviewed following a Tier I approach. EPA New England Environmental Data Review Program Guidance and applicable portions of the EPA New England Environmental Data Review Supplement for Regional Data Review Elements and Superfund Specific Guidance/Procedures 4/13, will be followed.

Analyte concentrations will be checked against contaminant levels in equipment/rinsate blanks and method/reagent blanks to identify possible sources of false positives. A review of all QC analyses will be performed to assess the data quality. Any encountered deviations not documented in the narrative will be rectified with the laboratory. The data package completeness check and assessment of each QC parameter provided with the data package deliverables will be provided in the final reports.

According to EPA Guidance on Data Verification and Data Validation (EPA QA/G8, November 2002), data validation is an analyte and sample specific process that extends the evaluation of data beyond method procedural or contractual compliance to determine the analytical quality of a specific data set. Data validation criteria are based upon the measurement quality objectives developed in this plan. Data validation will apply to both the laboratory analytical process and the field sample collection methods. A focused Tier I data validation will be conducted which will include review of the following:

- The laboratory analytical methods (Enterococci, TP, and Nitrates);
- Chain of custody;
- Case narrative;
- Field and sample identifications (IDs) cross-reference;
- Holding time;

- Preservation and cooler receipt;
- Laboratory blank data (method blanks, preparation blanks); • Spike data (including MS/MSD); and
- Laboratory control samples (LCS).

This is applicable to all parameters/matrices analyzed during the project conducted under this project specific QAPP. In addition to the Tier I data validation, the Project Manager will review and validate the results of any field blanks, field duplicates and organic matrix spikes/matrix spike duplicates.

5.2 Reconciliation with User Requirements

The data and information generated from this project will be evaluated to see if it meets the quality objectives and criteria and answers the project's task questions. Data will be tabulated and summarized as outlined in Appendix F of the SAP.

All wetland storage capacity data will be reviewed by the UNHSC Project Manager. The completeness, transcription errors, and compliance with procedures will be evaluated by comparison of tabulated results to what has been proposed in the original project proposal and this QAPP. The specific activities include the generation of data namely, flow measurements. When results appear to be abnormal, all appropriate project participants will review the available data and discuss the problem in periodic meetings to attempt to identify potential problems in sampling or analysis.

All data will be presented in Tables to show changes in conditions pre- and post-restoration. Since this project's goal is to collect baseline monitoring information, no statistical analyses will be performed. Limitations on use of data will be reported in the final report.

6.0 PROJECT REPORTING

The final project report will provide a complete and clear summary of data collection and analysis such that the data collection and analysis can be easily reproduced. The final report is anticipated to be submitted by the end of 2023. Draft and final project products will be generated in common or publicly available programs that are compatible with end user systems for ease of maintenance or updates in the future such as MS Office (e.g., Word for written reports, Excel for spreadsheets, CSVs for analysis) and ArcMap Desktop (e.g., geodatabase of spatial files and/or map packages of project maps). All MS Excel spreadsheets will include metadata on data sources, corrections, and exclusions (by whom and on what date). All MS Word reports (as applicable) will document QA/QC procedures either within the report or as an attachment. Any supporting files or documentation (e.g., laboratory analysis reports) will be submitted as raw data.

7.0 REFERENCES

EPA. (2002). Guidance for Quality Assurance Project Plans. EPA QA/G-5. U.S. Environmental Protection Agency. December 2002.

EPA. (2002). Guidance on Environmental Data Verification and Data Validation. U.S. Environmental Protection Agency. EPA/240/R-02/004. November 2002.

EPA. (2003). A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information. June 2003.

EPA. (2009). EPA New England Quality Assurance Project Plan Guidance for Environmental Projects Using Only Existing (Secondary) Data. U.S. Environmental Protection Agency New England. October 2009.

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APPENDIX A: Sam Wright Field Sampling and Analysis Plan

SAMPLING & ANALYSIS PLAN

2020-2022 SAM WRIGHT FIELD WETLAND RESTORATION BASELINE MONITORING



August 2021

Prepared by SNEP Network
in Partnership with
The Nature Conservancy, Mass Audubon, Save the Bay, University of New Hampshire Stormwater Center
and
Town of Easton, MA

NOTE: This sampling plan provides detail on sampling locations, data collection and frequencies as well as procedures used to collect data.

Table of Contents

1.0 PROJECT ORGANIZATION 4

2.0 BACKGROUND INFORMATION AND PROBLEM DEFINITION: SNEP NETWORK PILOT PROGRAM; CANOE RIVER AQUIFER RESTORATION 5

2.1 SAM WRIGHT FIELD WETLAND RESTORATION PROJECT DESCRIPTION 5
2.2 WETLAND MEADOW, GRASSLAND AND POLLINATOR HABITAT MAINTENANCE 7
2.3 SAM WRIGHT FIELD WETLAND RESTORATION PROJECT CONTEXT 8

3.0 BASELINE METRICS SAMPLING OBJECTIVES 8

4.0 OVERVIEW SAM WRIGHT FARM WETLAND RESTORATION – BASELINE MONITORING 10

4.1 DIRECT MEASURES 10
4.1.1 WETLAND AERIAL EXTENT FIELD SURVEY (PRE/POST WETLAND CONDITION) 10
4.2 INDIRECT MEASURES 11
4.3 EXTERNAL RESOURCES 15

5.0 REFERENCES 15

List of Appendices

APPENDIX A. WETLAND RESTORATION PLANS

APPENDIX B. WETLAND STORAGE CAPACITY - MEASURE PERFORMANCE CRITERIA AND STANDARD OPERATING PROCEDURES

APPENDIX C. WETLAND CONDITION MONITORING- WETLAND FIELD SURVEY PROTOCOLS AND DATA SHEETS

APPENDIX D. WATER QUALITY MONITORING VOLUNTEER MONITORING PROGRAM STANDARD OPERATING PROCEDURES

APPENDIX E. BASELINE MEASURES SAM WRIGHT FIELD WETLAND RESTORATION

List of Tables

Table 1. Project roles and responsibilities. 4
Table 2. Summary of Sampling Stations, Sam Wright Field Wetland Restoration. 14
Table 3. Summary of external data sources. 15

List of Figures

Figure 1. Location Sam Wright Field, Easton, MA 6
Figure 2. Wetland Area Depicting Wetland Restoration Activities: concrete structure removal (gray), regrading and wetland restoration (red), and proposed no mow zone expansion (green). 7
Figure 3. Recommended no mow sign to be placed at intervals of 50ft along the edge of the proposed no mow zone 7
Figure 4. Culverts in the vicinity of the project site in Easton. 8

Figure 5. Sam Wright Field Level Logger Locations....9
Figure 6. Wetland restoration (areas 1-4) monitoring plots. 12
Figure 7. Water Quality Monitoring Locations, Easton, MA....13

1.0 Project Organization

The SNEP Network is conducting two pilot projects (Maidford River, RI, and Canoe River, MA) to demonstrate project implementation. EPA has requested that baseline metrics be identified to measure before and after conditions to understand the impact of the pilot projects locally and regionally. Baseline metrics may include change in environmental conditions (e.g., water quality, flow, flooding occurrences), land use (e.g., land preservation, reduced impervious cover) and program capacity (e.g., increased public awareness, projects advanced, expanded partnerships). This document is intended to provide a roadmap for sampling at the Sam Wright Field, and is considered a living document that may need to be updated in the future based on changes in plans and the staff at various partner organizations.

Easton is currently in the process of implementing a Wetland Restoration Project at Sam Wright Field which is part of the larger Wheaton Farm complex. The project is being implemented through a grant received by the Town of Easton from the Massachusetts Municipal Vulnerability Preparedness (MVP) action grant program, in partnership with The Nature Conservancy (TNC). The Town of Easton has agreed to conduct monitoring as part of the provisions of the MVP grant award. The SNEP Network has offered to provide technical assistance, through its partners as well as its pre-approved consultant pool, to develop a baseline monitoring program for the site. It is anticipated that this site will serve as a regional model for implementing nature-based solutions and understanding the benefits of these practices. EPA Region 1 SNEP program will supplement the pilot project with funding/resources to collect pre- and post-implementation data. The collection of baseline information will inform the local project but also yield information that may be useful to surrounding communities that wish to move forward with the implementation of NBS through the broader *Canoe River Aquifer Resilience Pilot*.

Specific descriptions of project team roles and responsibilities for the 2020 baseline monitoring at the Sam Wright Field Wetland site are provided in Table 1.

Table 1. Project roles and responsibilities.

Project Personnel	**Responsibility**
Project Management: Partner and Technical Services Management Kimberly Groff, MA Liaison, SNEP Network	Ensure all project deliverables are completed and documented in a timely manner and that adequate resources are made available to the project.
Wetland Design Specification (Existing Wetland Aerial Extent and volume): Brad Holmes, Wetland Scientist, Environmental Consulting and Restoration (ECR)	Responsible for wetland restoration design, proposed wetland restoration and flood storage plan calculations, oversight of restoration.
Monitoring Coordinator: Jennifer Carlino, Town of Easton, Land Use/Environmental Planner; Sara Burns, The Nature Conservancy	Responsible for coordination and communications to project team as well as volunteers for water quality and wetland invasive species monitoring, responsible for maintaining data repository
Wetland Aerial Extent: Kate McPherson, Professional Wetland Scientist, Save the Bay	Responsible for monitoring the extent of bordering vegetated and meadow wetland (after vegetation is reestablished and annually thereafter)
Wetland Invasive Species (Presence/Absence)* Kate McPherson, Professional Wetland Scientist, Save the Bay; and Easton volunteers	Responsible for design of invasive plant monitoring protocol, field sheets and written procedures to be followed by volunteers
Flow Monitoring Survey: James Houle, Professor, UNH Stormwater Center; Elizabeth Buschert, Technician, UNH Technician	Responsible for calibration and preparation of level loggers, deployment of level loggers, site survey work, data analysis, flow estimates and flow hydrographs, data management

Project Personnel	Responsibility
*Protocols developed by Danica Belknap, (SRPEDD, formerly with MassAudubon)	

2.0 Background Information and Problem Definition: SNEP Network Pilot Program; Canoe River Aquifer Restoration

The *Canoe River Aquifer Resilience Pilot Project* is located in sub-watersheds within the Taunton River Watershed major basin. The Taunton watershed (second largest in the state) is located in southeastern Massachusetts, extending 562 square miles and encompassing all or part of 40 cities and towns. The watershed is characterized by natural beauty and open waters (ponds, rivers and wetlands) that transition from low hills and flat areas to tidal rivers and estuaries in the lower basin. Dense development is concentrated in the northern portion of the watershed and along the southern end of the Taunton River. In the center of the watershed there is a significant amount of undeveloped land use that is undergoing a rapid change (Mass Audubon, 2020). This trend is consistent with the history of evolving uses of land, water, and sea that has impacted the ecological systems and has manifested in vulnerabilities to the surrounding communities. At the top of the list of stressors is climate change that threatens the very attributes that make the Taunton Watershed so unique. The Southeastern New England Program (SNEP) 5-year Strategic Plan states the following "Scientists predict that our region will experience increased sea level rise, more frequent and intense storms, rising groundwater levels, and higher temperatures" (SNEP, 2020).

To address these threats, the towns of Easton, Mansfield, Norton, Sharon, and Mansfield have agreed to participate in a regional facilitated planning process hosted by the SNEP Network and its partners. This pilot project is designed to engage these communities, along with other communities that lie within the Canoe River Watershed, in a collaborative community-driven planning process to address localized flooding, aquifer protection, improved groundwater quantity/quality, and ecosystem restoration using Nature Based Solutions (NBS). *The Canoe River Aquifer Resilience Pilot Project* provides an opportunity to enhance and expand upon the three communities planning activities that have been completed or are currently underway to address local hazards through:

- Facilitated regional planning with a newly formed steering committee,
- Leveraging a tool to site NBS for climate resilience outcomes, recently developed by The Nature Conservancy (TNC) in collaboration with Massachusetts Vulnerability Preparedness (MVP) program,
- Providing the opportunity to engage representatives in the communities of Sharon and Foxborough in this process through peer-to-peer exchange, and
- Monitoring the benefits of the project both at a program level and site-specific scale (e.g., Sam Wright Field Wetland Restoration, 445 Bay Road, Easton).

The focus of this sampling and analysis plan will be to collect baseline measures for the Sam Wright Field Wetland restoration effort in Easton, Massachusetts. The overarching goal will be to collect data before and after wetland restoration activities to measure the benefit of the restoration project in:

- restoring of natural hydrology,
- expanding wetland extent,
- increasing flood storage,
- improving habitat, and
- reducing invasive species.

2.1 Sam Wright Field Wetland Restoration Project Description

The project site is located at Sam Wright Field that is part of a 1000-acre conservation area (Wheaton Farm) in Easton. The area of wetland restoration at Sam Wright Field is about 5 acres and is subject to flooding (e.g., FEMA flood zone A). Mulberry Meadow Brook flows through the site and is regionally significant from both a flood control and aquifer recharge perspective. Figure 1 shows the location of the project in relation to the Canoe River Area of Critical Concern (ACEC) and the Canoe River Aquifer.

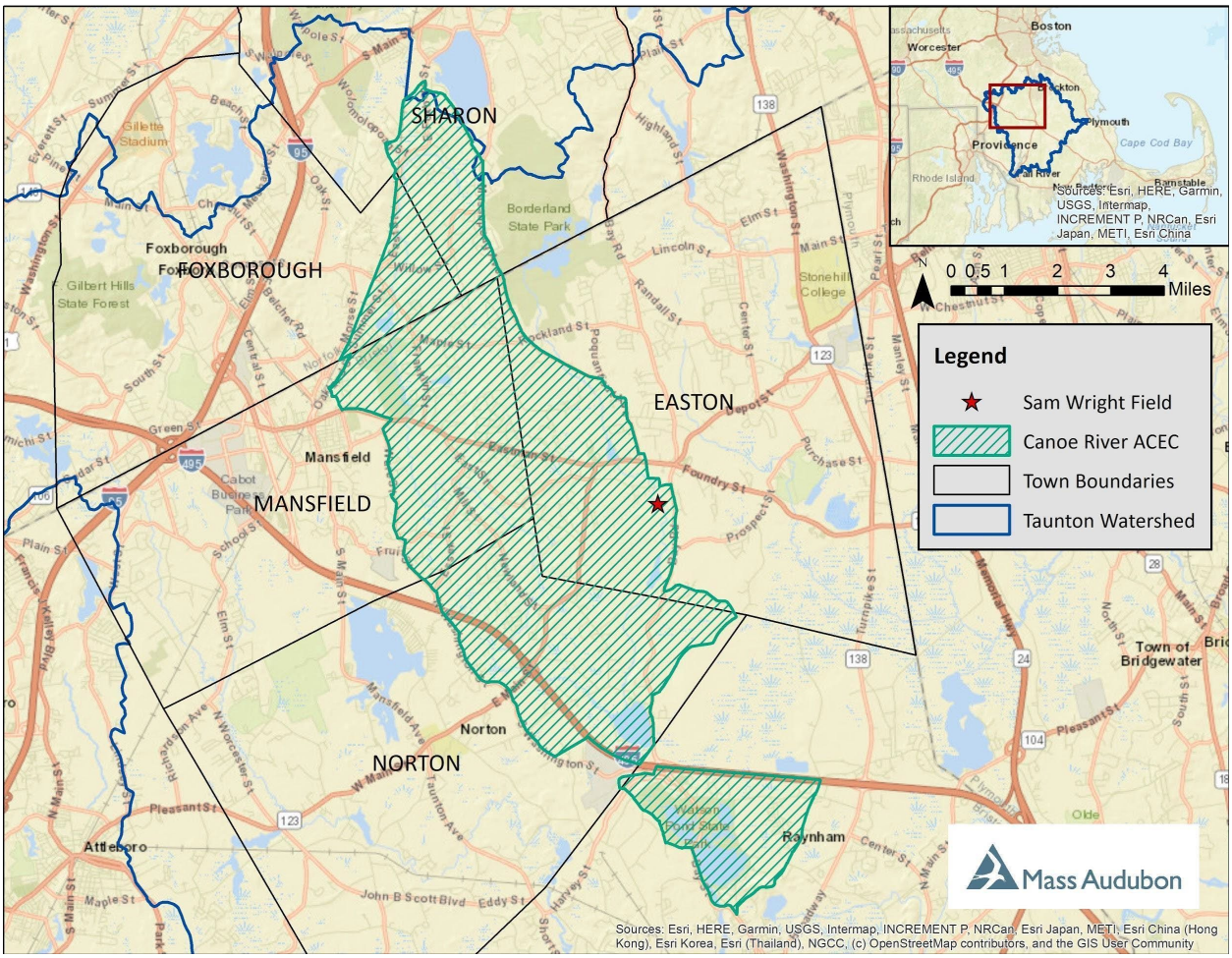


Figure 1. Location Sam Wright Field, Easton, MA

Specific wetland restoration activities include:

- Expand flood storage capacity within a FEMA zone A,
- Remove concrete structures,
- Establish no-mow zones,
- Reestablish wetland soils and elevation grade,
- Seeding and planting, and
- Remove and manage invasive plant species.

The project was designed to restore a portion of the existing uplands at the site to a Bordering Vegetated Wetland (BVW). The bordering vegetated wetland can be seen in the aerial photo and follows the Mulberry Meadow Brook (see dark green vegetated zones in Figure 2). There are currently large field areas that are mowed by Easton and it is envisioned that by applying no mow buffers the BVW along several intermittent streams and Mulberry Meadow Brook can be extended and permitted to transition to wetland meadow with distance from the intermittent streams and brooks at the site.

The restoration area is located to the east of Mulberry Meadow Brook and is hydraulically connected to the Brook's associated BVW. The area to the far east of the wetland pool will be excavated to 1 foot and will restore 25,650 sq ft of wetland and 876 cubic yards of storage capacity (see Appendix A, area shaded in green). The area immediately east surrounding the concrete farm structures will be excavated to create an additional 73,100 square feet of BVW and 5,415 cubic yards of additional flood storage (see Appendix A, area shaded in blue). The wetland restoration area has been designed to mimic the existing wetland system onsite and be established as a wet meadow environment (total wetland area 99,750 sq ft, total additional flood storage 6,291 cubic yard). The activities are anticipated to improve hydrology, address invasive species and improve aquatic and terrestrial habitat. Construction permits are in place (Wetland Order of Conditions recorded 10/22), construction activities began in January of 2021 and are projected to end by fall 2020 (Langhauser, 2020). The Easton Department of Public Works (DPW) will carry out the work with

contractor support, and it is anticipated that modifications to the construction plan may occur during construction. Brad Holms of ECR will provide technical oversight of the restoration activities.

An aerial view of the site where restoration activities will take place is shown in Figure 2. As shown in the figure the area of concrete removal is outlined in grey, regrading and wetland restoration are outlined in red, and the proposed no mow zone expansion is depicted by the green outline. It is anticipated that wetland plants will be established by seeding after construction is complete and that no mow areas will transition in a continuum with distance from the stream to wetland meadow habitat.

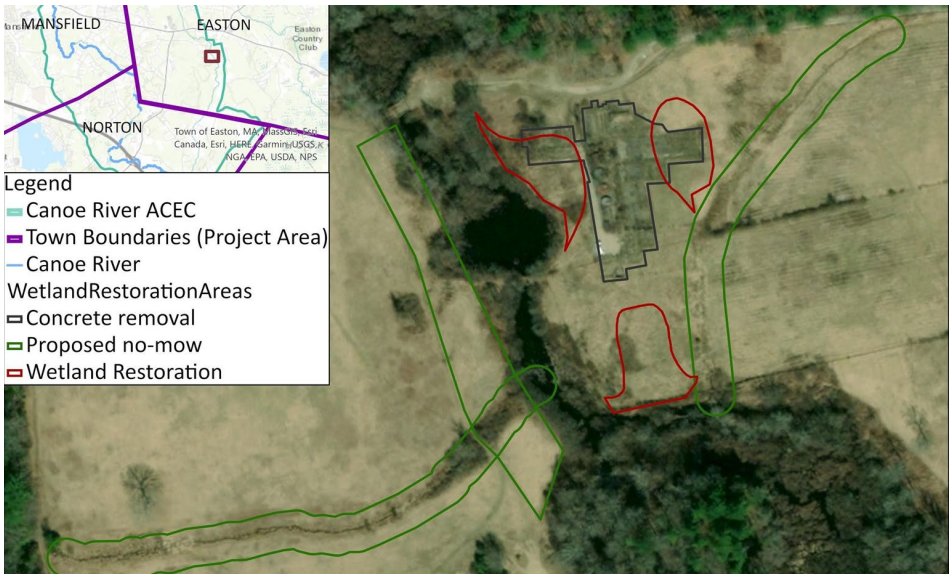


Figure 2. Wetland Area Depicting Wetland Restoration Activities: concrete structure removal (gray), regrading and wetland restoration (red), and proposed no mow zone expansion (green).

The wetland restoration has been designed to achieve appropriate hydrology to support proposed seeding and plantings. Non-native invasive species will be treated and removed from the site on an ongoing basis. The most common species noted before construction include Purple Loosestrife, Common Reed, Oriental Bittersweet, Common Wormwood, Autumn Olive, Multiflora Rose, and Glossy Buckthorn. Most of the non-native species are located along the wetland edge near the stream as well as through the concrete pads. The details of the invasive species treatment plan are described in the Notice of Intent (NOI) Support Report prepared by Environmental Consulting and Restoration LLC (Holmes, 2020).

2.2 Wetland Meadow, Grassland and Pollinator Habitat Maintenance

As wetland plants are reestablished there will be a need for ongoing maintenance of the area. Wetland meadow and grassland habitats are important ecosystems that are rapidly being lost across the region. Many grassland birds are listed as threatened or endangered, and promoting the expansion of these critical habitats is vital to many avian species. A variety of plant species provide habitat to pollinators, such as bees and butterflies, which are on the decline and integral to natural ecosystems and agriculture.



Figure 3. Recommended no mow sign to be placed at intervals of 50ft along the edge of the proposed no mow zone

The site currently contains an abundance of wetland meadow and grassland habitats that are very beneficial to the surrounding ecosystem. The existing wetland meadow

and grasslands at the site are proposed to be maintained and expanded. The overarching management goal will be to prevent spread of invasive species into restored wetland areas.

Maintenance of non-native invasive species will include a visual inspection of the wetland meadow and grasslands at the end of each growing season. It is anticipated that volunteers from the town of Easton will assist in identifying non-native plants that will be marked for later removal.

Maintenance shall also include the establishment of an annual mow schedule completed at the end of the growing season (initial buffer of 30 feet can be expanded to 160 ft). TNC has proposed no-mow areas in consultation with Save the Bay and advised that signs/pictograms (Spanish/English) be posted in perimeter areas (Fig. 3). Once approved by Easton, signage can be installed to ensure that the no-mow areas are maintained with limited effort. Changes in the no-mow areas have the potential to double or triple the area of meadow wetland habitat. By expanding the no-mow buffer, it is anticipated that sediment runoff will be reduced, water quality maintained/improved and habitat expanded.

2.3 Sam Wright Field Wetland Restoration Project Context

The Sam Wright Wetland Restoration is part of a larger plan in Easton to mitigate flooding impacts attributed to undersized culverts. Easton is in the process of upgrading culverts in the vicinity of the project as follows.

- South Street Culvert Replacement – completed,
- Highland Street Culvert Replacement – pending Grant funding,
- Wheaton Farm, Sam Wright Field wetland restoration – MVP Action Grant Award– in progress, and
- Sam Wright Field – removal of 2 culverts, To Be Determined.



New South Street Culvert



Aging Highland Street Culvert

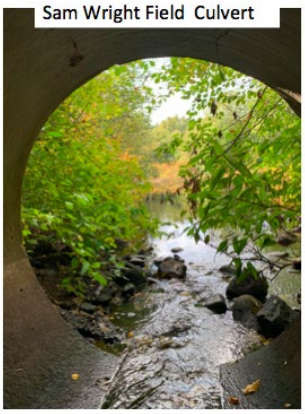


Figure 4. Culverts in the vicinity of the project site in Easton.

3.0 Baseline Metrics Sampling Objectives

A search of the MassDEP water quality and USGS flow gauge network shows that there is no baseline water quality or flow data collected in the vicinity of this project site. USGS does report stream stats for the Mulberry Meadow Brook. This presents challenges and opportunities to begin the process of characterizing the benefit of the wetland restoration and the long-term site management.

The baseline monitoring project is being viewed in the context of a broader watershed planning effort. It is anticipated that the culvert replacement projects and other watershed planning efforts will occur in the next 5-10 year timeframe or longer. The SNEP Network views its role as providing technical support and resources to establish what is likely to be a long-term program (e.g., extending beyond the Network's current funding).

In this context monitoring for flow and potentially other water quality parameters may make sense in the long term, if local partners and other resources are available to support the effort over time. It should also be noted that Stonehill College has expressed interest in partnering with Easton to create student projects to support this effort and the project team is still in the process of exploring this opportunity. A limited water quality monitoring program has been included in this sampling plan at the request of Easton and is modeled after the regional program administered by the Taunton River Watershed Alliance (TRWA).

Easton may be interested in developing an inventory of odonate, avian and terrestrial species information that is gathered by citizen scientists. Since these potential future program elements are in the process of being evaluated, only brief descriptions of the elements have been included as a placeholder for future development. It is recognized that if the monitoring program is expanded in

the future the sampling and analysis plan will need to be revised to include detailed procedures for the collection of this type of data.

The overarching goal of the monitoring effort will be to look at change in condition over time to assess relative changes using a weight-of-evidence approach. The measurement of year-to-year variation is beyond the scope of this effort. The baseline monitoring program should be practical, with measures that can realistically be maintained with the use of volunteers. The SNEP Network will mobilize partners in winter of 2020-21 to begin baseline data collection. It is anticipated that the Network will design the program and support the effort until the fall of 2022, at which point the town of Easton and/or project partners will carry the established monitoring program forward with volunteers. The objectives of this baseline monitoring project are described below.

Primary Measures (comparison to quantifiable baseline)

Objective 1: Degraded habitat and water quality: Did the wetland interventions improve wetland habitat?
The area of bordering vegetated wetland to be restored is shown in green and red in Figure 2 above. The existing wetland extent has been surveyed by Alpha survey group (Existing Conditions Survey) and is depicted in the restoration site plan (Appendix A). The current aerial extent of the BVW is estimated to be expanded by 99,750 sq ft, providing an additional 6,291 cubic yards of flood storage capacity (shown in green and blue in site plan Appendix A, FEMA flood zone A). The extent of the BVW and wetland meadow will be expanded to a 30 ft no mow area which is likely to double or triple the wetland meadow habitat as compared to the current condition. The extent will be visually inspected after wetland plants are reestablished and annually for 1-2 years. Relative changes will be mapped in GIS and compared to the 2020 baseline. Measures will include before and after GIS mapping of acres of wetland, acres managed to treat invasives, impervious surface removed, and agricultural acres using nutrient management.



Figure 5. Sam Wright Field Level Logger Locations.

Objective 2: Community sustainability, Floodplain function: Did the wetland restoration enhance wetland storage capacity?
Flow monitoring will be conducted upstream and downstream of the wetland restoration area. It is more practical to log water level and convert to flow than to measure flow directly because pressure-based water level sensors are lower power and more reliable than flow sensors. Many flow sensors also have the problem of having to be deployed in the middle of a stream, which means that they will catch a lot of debris. Water level data loggers are commonly used to determine stream flow over time and "peak

discharge." "Discharge" is another way of saying the flow volume through the stream, typically in CFS (cubic feet per second). Level loggers were deployed at the site in Mulberry Meadow Brook in December 2020 (prior to construction) and remain on site to capture pre-construction and post construction conditions (Fig. 5). Changes in flow before and after wetland restoration will be estimated downstream of the wetland. Quality controls and standard operating procedures adopted from the Providence Stormwater Innovation Center (PSIC) for level loggers are included in Appendix B. Measures will include numbers of acres of floodplain restoration and estimates of changes in wetland storage capacity.

Objective 3:(indirect Measure) For how long did control measures reduce invasive plant species in the BVW?
The presence and absence of invasive plant species in the BVW and wetland meadow will be monitored after the concrete structures are removed and vegetation is reestablished through seeding of the property and no mow zones are implemented. Non-native invasive species are recognized as one of the greatest threats to the integrity of natural communities. During the restoration activities, invasive plants will be removed through the proposed excavation of the existing concrete pads. Additional physical and chemical treatments will be conducted by the Town of Easton and their consultant throughout the entire site following construction and on an ongoing, as needed, basis in the years following restoration. Control areas will be established and monitored visually at least annually by the town of Easton and volunteers, and data will be captured in pictures and field sheets developed by Mass Audubon and Save the Bay, and shared directly with the town of Easton. Data will be uploaded to a Google sheet and shared with the invasive removal contractor to identify areas where intervention is required. Detailed protocols and field sheets for wetland condition monitoring are provided in Appendix C. Invasive plants will be flagged by volunteers for removal by the town of Easton. Volunteers who are trained in invasive plant removal may also remove the plants manually, but they will not be expected to do so. Measures will include before and after estimated presence/absence along with relative abundance (e.g., scarce, moderate, abundant) of invasive species over time in test plots using standardized field sheets. The numbers of volunteers participating in the project will be tracked to promote community awareness and stewardship.

Objective 4: (indirect Measure) What is the Condition of Mulberry Meadow Brook
No water quality monitoring has been conducted in the vicinity of the project site. As a result, water quality data has limited utility for the purposes of evaluating the effectiveness of the restoration measures. However, the town of Easton has expressed interest in establishing a water quality monitoring program. In addition, TNC has interest in collecting water quality data to inform the modeling effort that selected the Sam Wright Field site for restoration. Water quality data is considered a secondary indicator for the purposes of evaluating the effectiveness of the wetland restoration program. At this juncture the field program is limited and modeled after the approach taken by Taunton River Watershed Alliance (TRWA). Water chemistry grab samples will be collected once a month throughout the year as feasible. A summary of the locations and map are shown in Table 2 and Figure 7, respectively. Parameters to be measured at all stations include: Bacteria, Nitrite, and Phosphorus. All samples will be delivered to a Massachusetts certified lab for analysis. Quality assurance/quality control samples will be taken according to protocols established in an approved quality assurance project plan (QAPP). Detailed protocols for water quality monitoring are included in Appendix D.

An overview of the suite of baseline measures is provided in Appendix E. The baseline measures were developed in consultation with the project team. Appropriate measures identified by EPA in the Metrics V10 Dashboard have also been included to ensure consistency with the EPA Strategic Plan.

4.0 Overview Sam Wright Farm Wetland Restoration – Baseline Monitoring

The Sam Wright Field Wetland Restoration baseline monitoring program has been developed by the SNEP Network in coordination with it's partners and in consultation with the Town of Easton Environmental Planning Department. The program has been initiated through the SNEP Network partners and will be conducted in accordance with an EPA approved QAPP. Since restoration activities can take months to years to implement and many more years to see the measured benefits, it is anticipated that Easton will continue to coordinate and manage the program (data collection and data management) after the SNEP role ends in 2022. The following section provides a description of the data collection activities and locations and was created as a support document to the QAPP.

4.1 Direct Measures

4.1.1 Wetland Aerial Extent Field Survey (pre/post wetland condition)

Wetland extent will be visually inspected after wetland plants are reestablished and annually for 1-2 years to visually monitor the changes in extent. A wetland biologist will obtain satellite imagery that depicts the project site between the months of November and April (when deciduous trees and shrubs do not have canopy cover). Potential sources of the imagery are Google Earth Pro and/or OLIVER Mass GIS Online Mapping tool. The biologist uses indicators of wetland hydrology that appear in the imagery (colors and textural differences that indicate water, tree, shrub, or herbaceous cover) to delineate the wetland edge. The biologist will use features of the software, for example, in Google Earth, using the add polygon tool to draw a polygon around the wetland to delineate the extent of the wetland prior to and post wetland restoration. Those tools will calculate area, in square feet or acres. As part of the delineation, the biologist will visit the site to look for indicators of wetland hydrology, including wetland plants that are categorized as facultative wetland (FAC), facultative wetland (FACW), and obligate wetland (OBL), leaf staining, buttressed roots, soil indicators of wetland, scour, and/or shallow root systems, in areas that are challenging to delineate based on aerial review alone.

Relative changes as delineated on spring aerial imagery and field verified will be compared to the 2020 baseline. GIS analysis will be used to estimate acres of wetland, acres managed to treat invasives, impervious surface removed, and agricultural acres using nutrient management.

4.2.1 Wetland Storage Capacity (pre/post wetland condition)

Continuous level logger units will be deployed at 3 locations as shown in Table 2 and Figure 7. The devices will be calibrated in accordance with SOP's and data will be downloaded and managed by UNH. The units were deployed on December 15th, 2021.

As soon as the weather permits, surveys will be conducted to measure the culverts within the stream channel. Manning's equation will be used to convert water pressure reading into volumetric flow. Engineering estimates will be used to calculate the amount of increased flood volume. Field measurements using level gages will be used to estimate changes in flow before and after wetland restoration to evaluate changes in flood storage in a weight-of-evidence approach.

4.2 Indirect Measures

4.2.1 Invasive Plant Species

Invasive plant species surveys will be conducted at plots throughout the restored BVW at least annually during the growing season. The baseline for the plots is assumed to be zero plants, since all plants will be removed during the concrete removal and regrading process in the restoration areas. Monitoring locations will be established throughout the site by placing rebar at locations predetermined in ArcGIS at regular intervals of 60 ft throughout monitoring areas 1-4 (Fig. 6). Each piece of rebar will be assigned a unique number and mapped in GIS. The monitoring plots will include a 15 ft radius surrounding each piece of rebar. No mow zones (areas 5-7) will not be monitored for invasive species at this time.

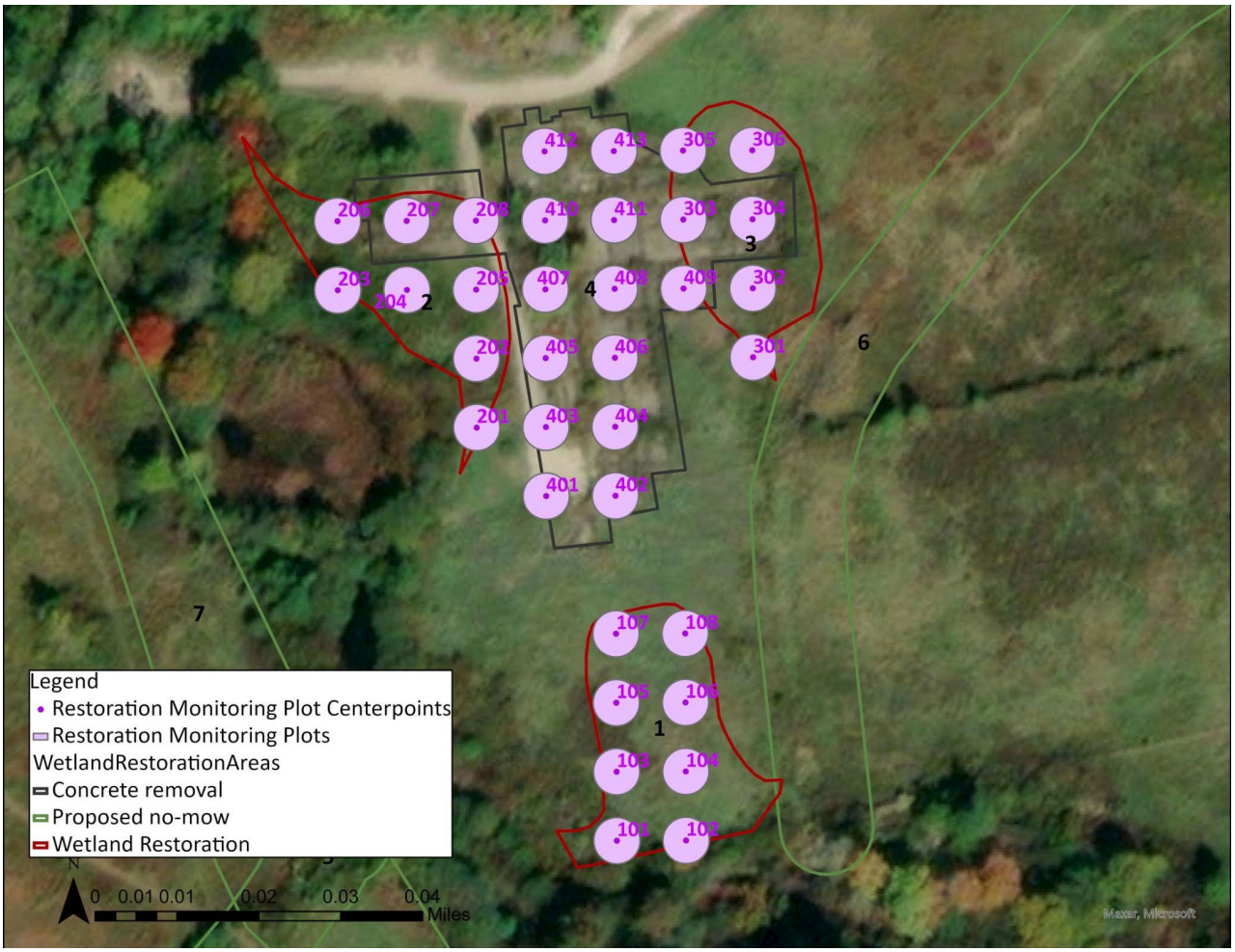


Figure 6. Wetland restoration (areas 1-4) monitoring plots.

Volunteers will navigate to their assigned restoration monitoring plots by using their cell phone or a handheld GPS device to find the pieces of rebar that mark each plot, and/or by locating the correctly numbered rebar centerpoint post. The perimeter and interior of each plot will be visually observed for specific invasive plants identified as of particular concern for the site (presence or absence). Volunteers will indicate which species of concern are present and estimate the prevalence of each within each plot on the standardized field sheets (as described in Appendix C).

Volunteers will be asked to take photos of invasive plants observed and upload them to the iNaturalist phone application for confirmation of species ID. An iNaturalist project will be established to compile all observations (plant and animal) recorded at the Sam Wright Field site. Volunteers will also flag observed invasive plants with orange tape for easy spotting by the Town's contracted invasive species consultant to confirm species and treat as necessary.

Volunteers will be asked to enter the data from their field sheets into a Google form, which will upload the data directly to a database that will be managed by the Town, and shared with the invasives consultant to help with locating invasive plants for treatment. Volunteers may also choose to directly enter their data into the Google form in the field, and forgo the paper field sheet. Information collected by volunteers will be used to inform invasive species maintenance on the site, and may be used to measure the changes in invasive species observed over time and the effectiveness of the invasive treatments; however, the latter type of long-term monitoring is not part of the scope of this project at this time.

4.2.2 Water Quality

Water chemistry grab samples will be collected once a month throughout the year as feasible at locations shown in Figure 7. and Table 2. Parameters to be measured at all stations include: Bacteria, Nitrate, and Total Phosphorus. All samples will be delivered to a MassDEP certified lab for analysis and collected in accordance with established protocols.



Figure 7. Water Quality Monitoring Locations, Easton, MA

4.2.3 Wildlife and Wetland Indicator Species Monitoring (Placeholder)

It is anticipated that a volunteer program will be set up to capture the public's encounters with terrestrial and avian species on the site. Species monitored and data collected will be dependent on volunteer availability and capacity. Local individuals with expertise in odonate and bird survey methods have been identified and are willing to conduct surveys on a weekly to monthly basis during the first growing season following construction, from May to September, to establish a species inventory for the site. Survey data may be collected in subsequent years as volunteer capacity allows, to monitor changes in the species composition present on site over time. Odonate species, in particular, can be used as an indicator for wetland condition, and may serve as an indirect measure of the success of the wetland restoration.

In the absence of volunteers with capacity to collect wildlife species data in future years, the Town may leverage crowdsourced data from public platforms, such as iNaturalist and eBird, whereby the public can capture and record observations using a cell phone. Photo observations are georeferenced, recorded and stored in a publicly accessible online database. Data collected can be periodically revisited to look for relative trends over time. The town can include directions for downloading and using these free mobile applications on informational signage installed at the site, or through other public outreach methods, to encourage the public to report observations from the site that contribute to this longer-term monitoring effort.

Table 2. Summary of Sampling Stations, Sam Wright Field Wetland Restoration.

Station ID	Description	Type - Level Logger (flow)	Type – Water Quality (Nitrate, Phosphorus, Bacteria)	Reason
Flow 1 (instream)	This station is located at the junction of the Highland Street culvert and Mulberry Meadow Brook, Easton. The site is immediately upstream of the wetland restoration site with good vegetated buffer.	X		This site will act as an upstream wetland restoration reference station.
Flow 2 (instream)	This site is located on Mulberry Meadow Brook, the culvert immediately downstream from the wetland pool. The device is deployed in the middle culvert (south side).	X		This site will provide the condition downstream of the restoration site.
Flow 3 (barometric pressure - land)	This site is located on land at the community garden directory downstream of the site.	X		This site will provide an atmospheric pressure reading.
WQ MMB 001	This station is located at the junction of the South Street culvert and Mulberry Meadow Brook, Easton. The site is upstream of the Highland Street culvert.		X	Baseline Water Quality
WQ MMB 002	This station is located at the junction of the Highland Street culvert and Mulberry Meadow Brook, Easton. The site is immediately upstream of the wetland restoration site with good vegetated buffer.		X	Baseline Water Quality
WQ MMB 003	Located at footbridge immediately upstream of the wetland pool adjacent to the wetland restoration.		X	Baseline Water Quality
WQ MMB 004	This site is located on Mulberry Meadow Brook, the culvert immediately downstream from the wetland pool.		X	Baseline Water Quality
WQ MMB 005	Located on Mulberry Meadow Brook at upstream side of Ward Pond downstream of the wetland restoration site.		X	Baseline Water Quality

4.3 External resources

Table 3 provides a brief list of relevant external data sources that may be used in coordinating monitoring efforts, the interpretation of monitoring data and flow estimation. Flow information relevant to this project is collected by USGS. USGS maintains an active stream gage at on the Wading River near Norton (01109000). In addition, USGS provides stream stats for 4 locations in the vicinity of the project site (Poquanticut Brook, North Easton [01108340], Mulberry Meadow Brook Near Norton,[01108360], and Mill River near Taunton [01108400]. The USGS reports on a variety of flow information including daily, monthly, seasonal, annual and peak stream flow. This information will provide useful information on the temporal hydrology during the survey period (spates). National Climatic Data Center (NCDC) weather data could be used to determine if a sampling event is during wet or dry weather.

Table 3. Summary of external data sources.

Organization	Data
National Climatic Data Center (NCDC) http://www.ncdc.noaa.gov/oa/ncdc.html	Daily precipitation and temperature data weather stations within the central basin group.

5.0 References

EPA (2020), Southeastern New England Program: Five Year Strategic Plan. https://www.epa.gov/snep/snep-strategic-plan.

Holmes, B and C. Larson, 2020. Notice of Intent (NOI) Support Report, Environmental Consulting and Restoration, LLC, September 11, 2020.

Langhauser, A., 2020. Memo to Conservation Commission dated September 25th, 2020. Subject: Notice of Intent , 445 Bay Road, Sam Wright Field Wetland Restoration, Easton #E1.

Mass Audubon 2020. MassAudubon Losing Ground 2020 Report.

Appendix A. Wetland Restoration Plans

PROPOSED WETLAND RESTORATION & FLOOD STORAGE PLAN

Prepared by: Environmental Consulting & Restoration, LLC

Date: Sept. 11, 2020 Sheet: 1 of 3

WETLAND RESTORATION NOTES:
1.) THE PROPOSED WETLAND RESTORATION (HIGHLIGHTED IN GREEN) HAS BEEN DESIGNED TO RESTORE A PORTION OF HISTORIC WETLANDS ON THE SITE. A TOTAL OF 73,100 SQUARE FEET OF EXISTING UPLAND IS PROPOSED TO BE RESTORED TO WETLANDS.
3.) PRIOR TO WORK, EROSION CONTROLS WILL BE INSTALLED ALONG the DOWNGRADIENT EDGE OF THE WETLAND RESTORATION AREA.
4.) THE RESTORATION AREA WILL BE EXCAVATED TO EXPOSED HYDRIC SOILS. IT IS ESTIMATED THAT THE FINAL ELEVATION WILL BE APPROXIMATELY 85-87 FEET, BUT FIELD VERIFICATION SHALL BE COMPLETED BY THE OVERVIEWING WETLAND SCIENTIST.
EXCAVATION SHALL BE COMPLETED SEVERAL INCHES BELOW THE FINAL GRADE AND TOPPED WITH A LAYER OF HIGH ORGANIC COMMERCIALLY AVAILABLE COMPOST.
EXCAVATION INCLUDES THE REMOVAL AND DISPOSAL OF THE EXISTING CONCRETE PAD(S) AND AGRICULTURAL MATERIAL.
6.) ONCE EXCAVATION IS COMPLETE, EROSION CONTROLS WILL BE INSTALLED ALONG THE UPGRADIENT EDGE OF THE RESTORATION AREA.
7.) THE RESTORATION AREA SHALL THEN BE SCRATCHED AND SEEDED WITH A NATIVE FACW MEADOW MIX (SEE BELOW). NATIVE SHRUBS AND SAPLINGS COULD BE HAND PLANTED THROUGHOUT THE RESTORATION AREA TO BENEFIT BIODIVERSITY AND THE WILDLIFE. SIDE SLOPES WILL BE SEEDED WITH A NATIVE UPLAND WILDLIFE AND FORAGE MIX.
8.) IT IS ESTIMATED THAT EXCAVATING THE APPROXIMATELY 73,100 SQUARE FOOT RESTORATION AREA DOWN AN AVERAGE OF TWO FEET WILL RESULT IN APPROXIMATELY 5,415 CUBIC YARDS OF ADDITIONAL FLOOD STORAGE CAPACITY ON THE SITE.

FLOOD STORAGE NOTES:
1.) THE PROPOSED ADDITIONAL FLOOD STORAGE (HIGHLIGHTED IN BLUE) HAS BEEN DESIGNED AS PART OF THE CONCRETE PAD(S) REMOVAL AT THE SITE.
2.) PRIOR TO REMOVAL OF THE EXISTING CONCRETE AND THE ESTABLISHMENT OF ADDITIONAL FLOOD STORAGE, EROSION CONTROLS SHALL BE INSTALLED TO PROTECT NEARBY WETLAND RESOURCE AREAS.
3.) EXISTING CONCRETE PAD(S) AND AGRICULTURAL MATERIAL SHALL BE REMOVED FROM THE SITE AND DISPOSED OF AT AN APPROPRIATE FACILITY. THE REMOVAL INCLUDES THE EXCAVATION OF THE CONCRETE PAD TO EXPOSE NATIVE SOILS BELOW. IT IS ESTIMATED THAT 12 INCHES OF EXISTING FILL SHALL BE REMOVED. PLEASE NOTE: THE INTENT IS TO MAINTAIN AN UPLAND AREA AT A LOWER ELEVATION TO INCREASE FLOOD STORAGE. HYDRIC SOILS SHALL NOT BE EXPOSED WITHIN THE PROPOSED FLOOD STORAGE AREA.
4.) THE EXCAVATED AREA SHALL BE ROUGH GRADED TO BLEND SIDE SLOPES INTO THE ADJACENT UPLAND AND WETLAND RESTORATION AREA. NO ADDITIONAL FILL SHALL BE PLACED WITHIN THE PROPOSED FLOOD STORAGE AREA WITH THE EXCEPTION OF ORGANIC LOAM TO SUPPLEMENT AS NECESSARY FOR SEEDING.
5.) ONCE THE AREA HAS BEEN GRADED, THE AREA SHALL BE HAND SEEDED WITH A NATIVE UPLAND WILDLIFE FORAGE MIX (SEE BELOW).
6.) IT IS ESTIMATED THAT EXCAVATING THE APPROXIMATELY 23,650 SQUARE FOOT AREA DOWN ONE FOOT WILL RESULT IN APPROXIMATELY 876 CUBIC YARDS OF ADDITIONAL FLOOD STORAGE CAPACITY ON THE SITE.

FACW Meadow Mix

Mix Composition

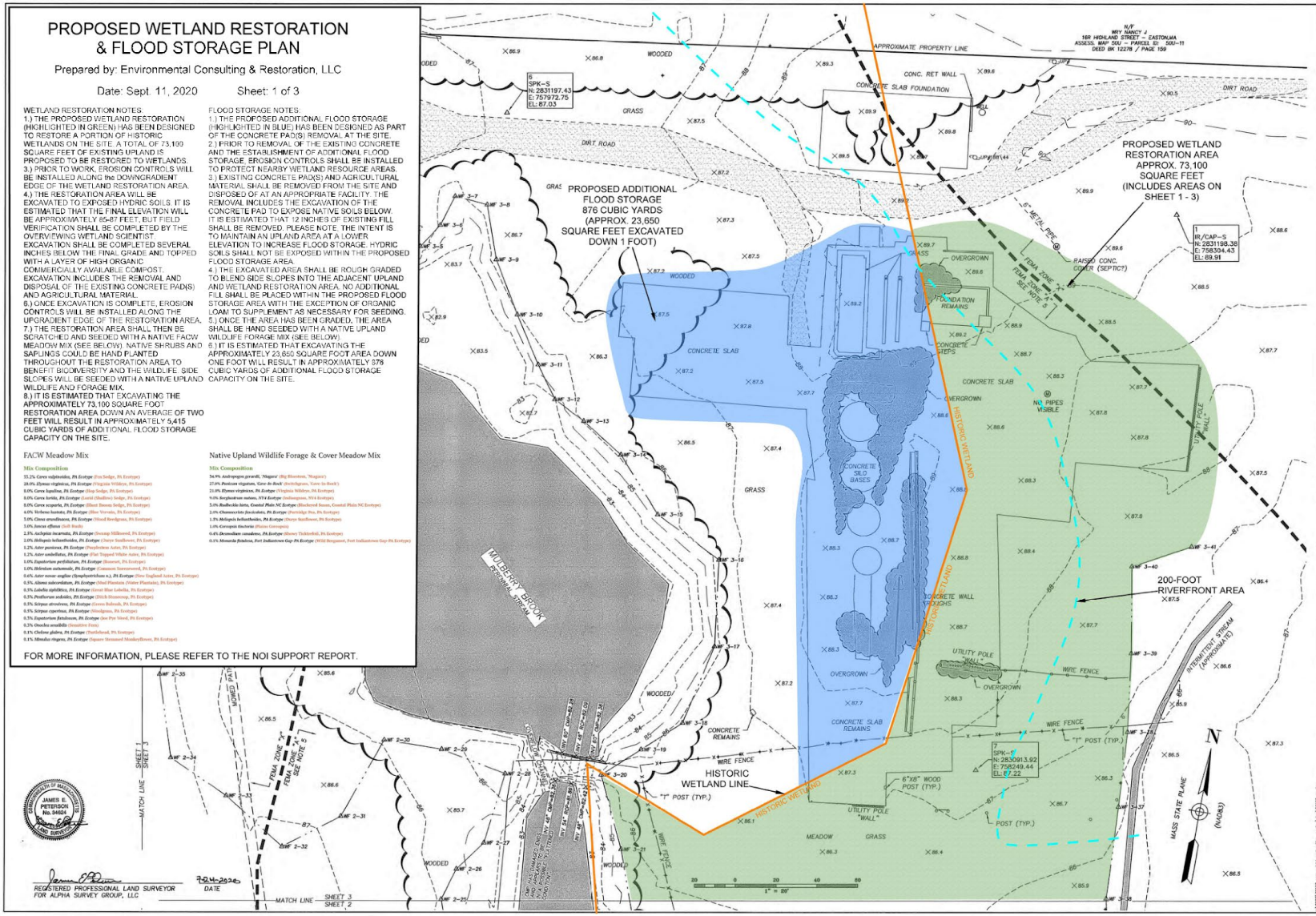
15.2% *Carex vulpinoidea*, PA Ecotype (Fox Sedge, PA Ecotype)
20.0% *Elymus virginicus*, PA Ecotype (Virginia Wildrye, PA Ecotype)
5.0% *Carex lupulina*, PA Ecotype (Hop Sedge, PA Ecotype)
5.0% *Carex lurida*, PA Ecotype (Lurid (Shallow) Sedge, PA Ecotype)
5.0% *Carex scoparia*, PA Ecotype (Blunt Broom Sedge, PA Ecotype)
4.0% *Verbena hastata*, PA Ecotype (Blue Vervain, PA Ecotype)
5.0% *Cinna arundinacea*, PA Ecotype (Wood Reedgrass, PA Ecotype)
5.0% *Juncus effusus* (Soft Rush)
2.8% *Asclepias incarnata*, PA Ecotype (Swamp Milkweed, PA Ecotype)
2.0% *Helenpis helianthoides*, PA Ecotype (Ox-eye Sunflower, PA Ecotype)
1.2% *Aster puniceus*, PA Ecotype (Purplestem Aster, PA Ecotype)
1.2% *Aster umbellatus*, PA Ecotype (Flat Topped White Aster, PA Ecotype)
1.0% *Eupatorium perfoliatum*, PA Ecotype (Boneset, PA Ecotype)
1.0% *Helenium autumnale*, PA Ecotype (Common Sneezeweed, PA Ecotype)
0.6% *Aster novae-angliae (Symphyotrichum n.)*, PA Ecotype (New England Aster, PA Ecotype)
0.3% *Alisma subcordatum*, PA Ecotype (Mud Plantain (Water Plantain), PA Ecotype)
0.3% *Lobelia siphilitica*, PA Ecotype (Great Blue Lobelia, PA Ecotype)
0.3% *Penthorum sedoides*, PA Ecotype (Ditch Stonecrop, PA Ecotype)
0.3% *Scirpus atrovirens*, PA Ecotype (Green Bulrush, PA Ecotype)
0.3% *Scirpus cyperinus*, PA Ecotype (Woolgrass, PA Ecotype)
0.3% *Eupatorium fistulosum*, PA Ecotype (Joe Pye Weed, PA Ecotype)
0.3% *Onoclea sensibilis* (Sensitive Fern)
0.1% *Chelone glabra*, PA Ecotype (Turtlehead, PA Ecotype)
0.1% *Mimulus ringens*, PA Ecotype (Square Stemmed Monkeyflower, PA Ecotype)

Native Upland Wildlife Forage & Cover Meadow Mix

Mix Composition

34.9% *Andropogon gerardii, 'Niagara'* (Big Bluestem, 'Niagara')
27.0% *Panicum virgatum, 'Cave-In-Rock'* (Switchgrass, 'Cave-In-Rock')
21.0% *Elymus virginicus, PA Ecotype* (Virginia Wildrye, PA Ecotype)
9.0% *Sorghastrum nutans, NY4 Ecotype* (Indiangrass, NY4 Ecotype)
5.0% *Rudbeckia hirta, Coastal Plain NC Ecotype* (Blackeyed Susan, Coastal Plain NC Ecotype)
2.0% *Chamaecrista fasciculata, PA Ecotype* (Partridge Pea, PA Ecotype)
1.5% *Helianthus helianthoides, PA Ecotype* (Ox-eye Sunflower, PA Ecotype)
1.0% *Coreopsis tinctoria* (Plains Coreopsis)
0.4% *Desmodium canadense, PA Ecotype* (Showy Ticktrefoil, PA Ecotype)
0.1% *Monarda fistulosa, Fort Indiantown Gap-PA Ecotype* (Wild Bergamot, Fort Indiantown Gap-PA Ecotype)

FOR MORE INFORMATION, PLEASE REFER TO THE NOI SUPPORT REPORT.



JAMES E. PETERSON No. 34624 REGISTERED PROFESSIONAL LAND SURVEYOR

7-24-2020

REGISTERED PROFESSIONAL LAND SURVEYOR FOR ALPHA SURVEY GROUP, LLC

DATE

DATE	DESCRIPTION
7/24/20	ADDITIONAL TOPOGRAPHIC AND ADDED LABELS

PREPARED FOR
TOWN OF EASTON
136 ELM ST.
NORTH EASTON, MA 02356

EXISTING CONDITIONS SURVEY
SAM WRIGHT RESTORATION
STREAM AND WETLAND ENHANCEMENT AND REPLICATION FOR FLOOD ABATEMENT AND WATER QUALITY SERVICES
445 BAY ROAD - EASTON, MA

SCALE	1"=20'
DRAWN	CDV,DM
FILE	
CHECKED	JEP

PREPARED BY
ALPHA SURVEY GROUP, LLC
695 WARESHAM STREET
MIDDLEBORO, MASS. 02346
T: (508) 295-1655
F: (508) 295-5935
WWW.ALPHA1.COM

ALPHA SURVEY GROUP
Accuracy | Experience | Quality

DATE	09/28/2020
JOB NO.	20123
SHEET NO.	3 of 3
DWG. NO.	20123-EC

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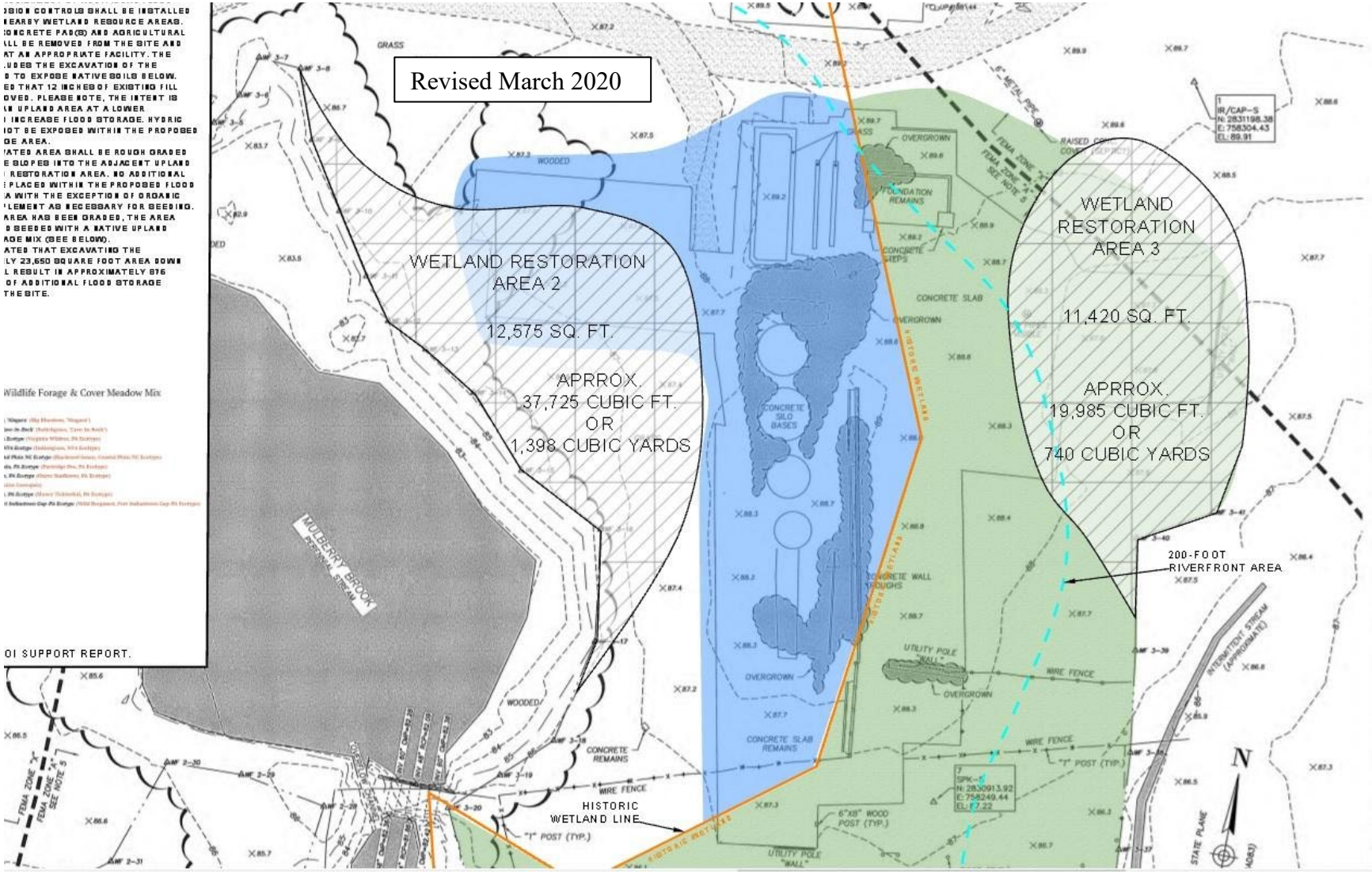
Revised March 2020
WETLAND RESTORATION AREA 2
12,575 SQ. FT.
APRROX. 37,725 CUBIC FT. OR 1,398 CUBIC YARDS
WETLAND RESTORATION AREA 3
11,420 SQ. FT.
APRROX. 19,985 CUBIC FT. OR 740 CUBIC YARDS
200-FOOT RIVERFRONT AREA
HISTORIC WETLAND LINE
MULBERRY BROOK
INTERMITTENT STREAM (APPROXIMATE)
FOUNDATION REMAINS
CONCRETE SLAB
CONCRETE SLAB REMAINS
CONCRETE SILO BASES
CONCRETE WALL TROUGHS
WIRE FENCE
"I" POST (TYP.)
6"X8" WOOD POST (TYP.)
UTILITY POLE
OVERGROWN
WOODED
GRASS
FEMA ZONE "X"
SEE NOTE 5
Wildlife Forage & Cover Meadow Mix
OI SUPPORT REPORT.

TORATION
PLAN

estoration, LLC

2 OF 3

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REA HAS BEEN GRADED, THE AREA
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GE MIX (SEE BELOW).
TED THAT EXCAVATING THE
23,650 SQUARE FOOT AREA DOWN
RESULT IN APPROXIMATELY 876
F ADDITIONAL FLOOD STORAGE
HE SITE.

ildlife Forage & Cover Meadow Mix

Revised March 2020

WETLAND
RESTORATION
AREA 1

14,050 SQ. FT.

APPROX.
24,590 CUBIC FEET
OR
910 CUBIC YARDS

"T" POST (TYP.)

HISTORIC WETLAND

BORDERING VEGETATED WETLAND

MULBERRY BROOK
PERENNIAL STREAM

WIRE FENCE

WOODED

N/F
EASTON TOWN OF
445 BAY ROAD – NORTH EASTON,MA
ASSESS. MAP 50U – PARCEL ID: 50U-50
DEED BK 7152 / PAGE 281

APPROXIMATE
HISTORIC
WETLAND LINE

APPROXIMATE PROPERTY LINE

N

MASS STATE PLANE
(NAD83)

INV 24" RCP=83.85

INV 24" RCP=83.10

INV 18" CPP=83.98

18" CPP

Appendix B. Wetland Storage Capacity - Measure Performance Criteria and Standard Operating Procedures

It is anticipated that water Hobo water level loggers to track surface water levels. These will be purchased, installed and maintained within the UNH by project staff. These will be used according to PSIC SOP 03. These levels will be set at 5-minute recording intervals to adequately record level changes in this highly urbanized watershed. Data will be downloaded when samples are collected from adjacent monitoring sites, approximately weekly.

Measurement Performance Criteria Table				
Sampling Procedure	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**	**Data Quality Indicators (DQIs)**	**Analytical Method/SOP**
Precipitation	Single-tip and Intensity Checks	Difference between observed and standard not greater than 5% (single-tip) and 10% (intensity)	Accuracy	PSIC SOP 02
Water Level	Comparison with staff gauge	Difference between HOBO and staff gauge not greater than 0.03 ft	Accuracy	PSIC SOP 03
Stream Flow	Discharge comparison measurements	Difference between measurements not greater than 10%	Accuracy	PSIC SOP 03

Measurement Performance Criteria Table – Reference EPA NE QAPP Worksheet 11b (10/99)– Field Procedures

Note: All QC Measurement Performance Criteria in this table are for assessment of analytical error only,

Field Sampling Equipment Calibration Table

Field Sampling Equipment Calibration Table						
Equipment	**Procedure**	**Frequency of Calibration**	**Acceptance Criteria**	**Corrective Action (CA)**	**Person Responsible for CA**	**SOP Reference**
Onset Water Level Meter	Check raw pressure sensor data under multiple pressures and temperatures	Every 3 years	Less than 0.03 ft difference	Send back for factory calibration	Onset	PSIC 02
Pygmy flow meter	Spin test	Before each measurement	45 seconds	Replace pivot	UNH Staff	PSIC 03

Measurement Performance Criteria Table – Reference EPA NE QAPP Worksheet #14 (10/99)– Field Procedures

Note: All QC Measurement Performance Criteria in this table are for assessment of analytical error only,

Field Equipment Maintenance, Testing and Inspection Table

EPA-NE QAPP Worksheet #15 - Rev. 10/99

Field Equipment Maintenance, Testing and Inspection Table

Sampling Equipment/ Instrument	Maintenance Activity	Testing Activity	Inspection Activity	Responsible Person	Frequency	Acceptance Criteria	Corrective Action	SOP Reference
Onset Water Level Meter	Wipe any debris; download data	NA	Be sure to re-deploy in the software to log; be sure to deploy at the same stage	Person(s) downloading the data	At each download	Equipment is not damaged, line is securely attached	Call James Houle, UNH	PSIC SOP 03

Measurement Performance Criteria Table – Reference EPA NE QAPP Worksheet #15 (10/99)– Field Procedures

Note: All QC Measurement Performance Criteria in this table are for assessment of analytical error only,

UNH adopted Providence Stormwater Innovation Center SOPs

PSIC 02 - Precipitation Monitoring

PSIC 03 - Flow measurements and rating curve development

(SOP 02)

Precipitation Monitoring

Revision: 1
Date: 1/2020
Revision Author: Ryan Kopp and Elizabeth Herron

1 PURPOSE

The purpose of this Standard Operation Procedure is to establish a uniform process for collection, calibration, and processing of a tipping bucket rain gauge and associated precipitation data. Precipitation data will be used for water balance and hydrologic modelling within the project area.

2 SUMMARY OF PROCEDURE

A tipping bucket rain gauge will be calibrated using two different methods. A single tip calibration and an intensity calibration. Both methods are used to ensure that the recorded volume of precipitation is within accuracy limits of the actual volume precipitation falling into the rain gauge. A known volume of water is poured into the tipping bucket mechanism and verified versus factory calibrated volumes.

3 DEFINITIONS

Observed value – field volumes of water
Standard value – theoretical volume of water based on factory calibration Percent error – ((Observed-Standard)/Standard) *100.
Volume of rainfall (cubic inches) = $\pi * r^2 * h$
Height = h = 0.01 inch of rainfall
Onset Rain Gauge Diameter is 6.06 inches
Radius = r = 3.03 inches
Single tip = 0.01 inches
1 cubic inch = 16.39 ml
0.01 inch of rainfall = 4.73 ml of rainfall

4 HEALTH AND SAFETY WARNINGS

HAZARDS

The rain gauge maybe mounted on a rooftop likely with steep and slippery surfaces and accessed by ladder. Caution should be used and field visits not be scheduled directly after rain events when slippery surfaces would be worse. Wear proper footwear for climbing ladders and walking on steep slippery slopes. At least two people should perform this activity so someone can hold and steady the ladder during use. In addition, the black powder-coated aluminum knife-edged ring is extremely sharp and can cause injury if not handled properly. Do not press edge against any body parts as severe cuts and bleeding may occur.

TECHNICIAN TRAINING/QUALIFICATION

General training in how to access and operate the tipping bucket rain gauge must be completed prior to completing calibrations and data recovery. Technician training will be provided by Ryan Kopp, project manager.

5 EQUIPMENT AND SUPPLIES

Required Material	Notes	Re-order information
Onset Rain Gauge RG3		Part #RG3

Onset Hoboware Software	Cable required to connect to computer	https://www.onsetcomp.com/hoboware free-download
Onset Shuttle		Part #U-DTW-1-
Laptop	With USB port	
USB cable		
Novalynx Tipping Bucket Rain Gauge Calibrator Kit		Part #260-2595
Pipette (1 ml subdivisions)		Fisher #50-154-2882 (or similar)
Precision Scale		Fisher #02-112-10 (or similar)
Plastic container with ~ 2 liters of water	Tap water	
Ladder	Stored in RWP maintenance facility	Ladder type/height dependent on location??
Allen Wrench		5/64 inch
Battery	1 year typical use	CR-2032 3V lithium battery

6 PROCEDURE

SCHEDULING CONSIDERATIONS
Field visits will be made every six weeks to clean, perform single tip calibration checks, and level rain gauge. Intensity calibration checks will be done at the beginning of the field season and at shutdown.

SEASONAL STARTUP
Accessing the data logger and other procedures should be completed according to the manual (https://www.onsetcomp.com/files/manual_pdfs/10241-M%20MAN-RG3%20and%20RG3- M.pdf).
Seasonal start-up steps:
1- Install new battery prior to start of field season.
2- Label each tipping bucket A and B.
3- Set internal time and date of rain gauge.
4- Set recording interval to 5 minutes.
5- Visually inspect that there is 45-degree clearance from trees, branches, leaves, and buildings above the instrument.

ROUTINE VISIT - SINGLE TIP CALIBRATION TEST – BEFORE CLEANING
1- Open electronic Excel field note (see documentation section), fill in date and time cells (important as calibration tips will need to be deleted from the dataset after download) 2- Note if bucket, screen, and funnel conditions are clean or dirty, but DO NOT clean at this point
3- Check the built-in bubble level to see if rain gauge is level, note under the Condition column, but DO NOT re-level at this point
4- Perform before-cleaning/before-leveling single tip test procedure:

a. Tip any remaining water out of high bucket so both buckets are empty. b. Position bucket A in the high position. Slowly pipette water into high bucket until mechanism tips.
c. Record milliliters required to tip as" Observed A" in "before-cleaning calibration" section.
d. Repeat for single tip test for bucket B.
e. Record milliliters required to tip as "Observed B".

ROUTINE VISIT - SINGLE TIP CALIBRATION TEST – AFTER CLEANING

1- Clean buckets, screen and funnel and make note of date and time.
2- Verify that rain gauge is level, if not, re-level and make note of maintenance operation. 3- Perform after cleaning/after leveling single tip test procedure:
a. Tip any remaining water out of high bucket so both buckets are empty. b. Position bucket A in the high position. Slowly pipette water into high bucket until mechanism tips.
c. Record milliliters required to tip as "Observed A" in "after-cleaning calibration" section.
d. Repeat for single tip test for bucket B.
e. Record milliliters required to tip as Observed B.
4- If bucket A or bucket B single tip percent error are greater than 5%, adjust set screws until single tips for both buckets are within 5% of standard 4.73 ml

RAIN INTENSITY CALIBRATION TEST – AFTER CLEANING

1- Reset internal logging counter to 0.00.
2- Tare bottle weight prior to water addition, weigh 473 g (ml) of water into Novalynx plastic bottle.
3- Using the 1/32" Novalynx intensity nozzle (3.11 inches/hr for 6" diameter rain gauge), turn bottle upside down into the rain gauge funnel.
4- Tips should be audible and should be counted.
5- Once bottle is empty remove housing from rain gauge.
6- There will likely be a small amount of water in the high cup. Pipette water into the cup until one last tip occurs.
7- Document number of tips (including last tip with pipetted water) and volume (reported as observed intensity) used (473 ml + pipetted ml) in the electronic field note in the intensity check calibration section.
8- Verify that audible tips match logged tips.
9- If calibration intensity percent error is greater than 10%, rain gauge should be re-leveled and/or the calibration set screws adjusted based on the manufacturers manual (https://www.onsetcomp.com/files/manual_pdfs/10241-D-MAN-RG3.pdf). Repeat the intensity check until the percent error is less than 10%.
10- Reset internal logger to read 0.00 after successful completion of intensity calibration.

7 DATA PROCESSING/CALCULATIONS

If the average percent error is greater than 15%, data generated between field visits (or if an obvious fouling point is noticed in the data) should be deleted.
Use comparison precipitation sites in analysis of data to look for erroneous data.
https://waterdata.usgs.gov/ri/nwis/current/?type=precip
https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USW00014765/detail
If a suspected snow day occurs during data collection, tips logged during melting will be moved back to the suspected day the snow fell. Temperature data from the following link can be used to help with analysis.
https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USW00014765/detail
Unit precipitation values in 0.01 inches will be calculated internally in the logger, a cumulative sum will also be calculated internally within the logger. Daily and monthly sums will be calculated externally in Excel file.

Date: 1/2020

Flow measurements and rating curve development

Revision: 1

Author: Kelly Addy and Elizabeth Herron

(SOP 03)

1 PURPOSE

Understanding stormwater inputs and impacts requires information on the volume and timing of flows. Two methods different methods are used to estimate and compute continuous discharge (streamflow):
1. At the inflow, a standard rectangular weir equation will be used to estimate a continuous discharge record. Weirs are structures (dams) installed across a stream channel. The water level rises behind the weir and that rise (or 'head') is measured and used to calculate discharge. Each weir geometry has a specific equation associated with it that is used to calculate the discharge. The rectangular weir is the most commonly used weir shape and what will be installed at the inflow site in RWP ponds.
2. At the outflow, a stage-discharge rating curve will be developed to compute a continuous discharge record. An open-channel streamflow gauging station is established by developing a relationship between stage (water level) and discharge (flow) at a selected cross section site. The relationship is developed by taking flow measurements over the expected range of discharge and stage. Each flow measurement and corresponding water level is plotted and a smooth curve is drawn. The stage-discharge rating curve can be used with a continuous water level record to produce a time series of discharge for the period during which water level has been recorded.

A stage-discharge graph allows for discharge computation with any stage value. Stage data and discharge rating curves allow for the computation of streamflow. Streamflow data provides information needed in the evaluation of changes in hydrologic and constituent load response to various land use changes and management practice regimes.

Once a continuous discharge record is established, using the weir equation or rating curve development, the streamflow in and out can be assessed to complete a water balance. We plan to also measure nutrients at these sites and can develop nutrient flux estimates with the flow values.
These methods are based on well-established practices in the hydrology. The sites are accessible, and well suited for use of flow meters and for setting up staff gauges. Some structural modifications may be required to facilitate development of rating curves.

2 SUMMARY OF PROCEDURE

Flow measurements and rating curve development can be summarized by the following:
1. Flow measurements will be made: 2. Continuous water level recorders will be installed inside a stilling well and a staff gauge will be installed on the concrete structure along the stream.
3. From approximately April to November of 2020 weekly monitoring, regardless of the weather, will include:
1. Record stage – water level recorder and value on staff gauge
2. Measure stream flow - measuring flow depth and flow velocity at selected points across the gauging cross section

In addition, five storm events between April and November 2020 will be monitored. During those events, the following will be monitored three times during each storm:
1. Record stage
2. Measure stream flow
Head or depth measurements and use of weir equations to estimate discharge can be summarized by the following:
1. Stage measurements from a staff gauge (installed on the concrete structure along the stream) at the inflow of the system.
2. Continuous water level recorders will be installed inside a stilling well.
3. From approximately April to November of 2020 weekly monitoring, regardless of the weather, at these locations

will include:
a. Record depth or head in weir, water level recorder and value on staff gauge.

3 DEFINITIONS

Streamflow, **discharge** or **flow** is the volume of water passing through a given cross section of the watercourse during a specific period of time. Typical units are cubic feet per second (cfs).
A **current meter** is an instrument used to measure water velocity at a point. This procedure recommends that vertical-axis bucket-wheel current meters be used; for example, the Price Type AA current meter and the Pygmy type current meter.

Water level recorder or **data logger** is a submersible pressure transducer designed to record water level or pressure data. This procedure is based on a Hobo water level data logger.
A **staff gauge** is a long ruler placed in a water body used to measure water surface elevation or just to determine the level of the water surface over time and act as a reference or comparison gauge for the water level recorder. The ruler is mounted to a stable surface such a bridge support, culvert or a post deeply set into the water body bottom so that it can withstand strong currents or wind.

4 HEALTH AND SAFETY WARNINGS

HAZARDS
The water level data logger will be mounted in the water, and streamflow requires that technicians be in the water, often when water levels are high. Caution should be used, and field visits should be completed with two or more technicians. Proper protective gear (waders, gloves, person floatation device, etc.) should be worn when working in or around stormwater. Effective lighting should be used to ensure safety if monitoring after dark, as may be required during storm event monitoring.

TECHNICIAN TRAINING/QUALIFICATION
UNH staff is responsible for training staff to install staff gauges, calibrate and maintain equipment, collect and manage data, and to calculate and maintain the stage/discharge rating curves.

5 EQUIPMENT AND SUPPLIES

Required Material	**Notes**
Staff gauge (2)	Recommend - USGS Style A Staff Gauges (or similar)
Posts, pipe or other material for mounting the staff gauge	May need auger or other equipment to “dig in” posts
Glue, bolts or other supplies to mount staff gauge to posts/bridge	The staff gauge may be able to be secured to a wooden post in advance
Hardware, tools and miscellaneous materials	As needed for installation of staff gauge and water level logger
Onset Hobo Water level data logger	Connects with a coupler, base station and USB cable. Hobo equipment on loan from URI Watershed Hydrology Lab and UNH
Laptop	With USB port
USB cable	
Survey tape or marked “tag” line	Materials to secure the tape/line

Required Material (continued)	Notes
Pygmy current meter and counter, with wading rod	Equipment on loan from URI
Field log book / data sheet	
Digital camera	To record conditions at the time of measurement

Preventative Maintenance: Pygmy Current Meter
A spin test is performed before and after all measurements. The buckets of the pygmy meter must spin for at least 60 seconds in order to pass. Spin tests results are recorded on the discharge measurement notes. After each use, the field staff dries the meter and oils the pivot bearing, top of the vertical shaft, steady bearing, worm gear and gear bearing. Before each measurement, personnel should inspect the bucket wheel for dents and misalignment and check the pivot for excessive wear. When traveling and after use, field staff should remove the measurement pivot and install the brass travel pivot.

6 PROCEDURE
To determine flow at the inflow location, we will use the rectangle weir equations from Kindsvater and Carter (1957). Stage and velocity data collection by the current meter method and rating curve development at the outlet will follow the accepted USGS methodologies as outlined by Smoot and Novak (1977), Buchanon and Somers (1982), Rantz et al. (1982a), Rantz et al. (1982b), Carter and Davidian (1989), Kennedy (1989). The height of each gage relative to a local benchmark will be surveyed at the installation.

SCHEDULING CONSIDERATIONS
Field visits will be made weekly to record depth (head), stage, measure stream flow as needed.
Additional storm event monitoring will take place during five storm events of greater than 0.5 inches of rainfall over a 24-hour period. During those rain events, stage will be recorded, stream flow measured and water samples collected three (3) times during each storm. We will try to collect measurements and samples on the rising limb of the storm, peak of the storm (if it is safe) and near the end of the storm, using weather.com for estimates. This site can be used to time events or just watch general weather radar.
https://water.weather.gov/ahps/region_forecast.php?state=ri. The goal is to collect more data at higher than average flows.

SETTING UP STAFF GAUGES AND WATER LEVEL LOGGERS
Staff gauges and water loggers will be installed at the inflow and outflow. Installation of the staff gauges will follow the details outlined by the US Army Corps of Engineers (see https://www.spa.usace.army.mil/Portals/16/docs/emergencymgmt/2012-Staff_Gage_Setup Instructions.pdf). The Hobo water level datalogger will be installed using guidance from the Onset Company.
Features at either site may need to be slightly modified to ensure that the weir/dam areas are stable and not subject to scour or debris accumulation. Cross sectional areas need to be as uniform as possible and free of vegetative growth, large rocks or other protruding obstructions. A suitable and convenient location for secure installation of the water-level data logger and of a staff gauge that will allow for routine visual checks on water level needs to be identified or created as needed. A suitable local benchmark will be surveyed at each installation.

WATER LEVEL LOGGERS
A Hobo water level datalogger set to collect level data at 10-minute intervals will be installed at both the inflow and outflow sites. Data will be downloaded from the datalogger bi-weekly and store on a PC as a CSV in addition to a Hobo file.

MEASURING STREAM DISCHARGE

Staff will measure discharge weekly and during high-intensity events to ensure that a range of values necessary for proper rating curve calculations is obtained. Stage/discharge rating curves for these locations will be established by PSIC staff in accordance with USGS standard operating procedures.
Briefly, the general approach will be to take point velocity readings at varied points so that subsection discharge is ideally less than 5% - 10% of total discharge, and at the same time record the water depth at each station. Flow rate can then be computed using the method described below. Paired water level/discharge values can then be used to develop the station's rating curve.
The following procedures will be used to carry out stage-discharge measurements at selected cross sections:
1. The cross section is first divided into several vertical subsections or "panels" of appropriate width. As a general rule, there should be at least 10 panels to properly account for velocity variations across the cross section. Discretion may have to be used to estimate number of panels needed for small channels.
2. Using an onshore reference object, the distance to the mid-point of each panel should be measured using a surveyor's tape or other suitably accurate method. Distances should be expressed as distance from the onshore reference point.
3. A survey tape or line should then be strung across the cross section. The line should have markers indicating the locations were depth and flow velocity are to be measured (i.e., the midpoints of each of the panels).
4. For each occasion when a stage-discharge measurement is made, first make notes on conditions at the gauging site, including information on any scour, deposition, and aquatic vegetation growth or debris accumulation. Make note of any apparent changes, since the previous measurement visit. Take photos of the site conditions if necessary.
5. Record the start time and current water level from the staff gauge and begin the panel-by-panel depth and velocity measurements.
6. Flow depth at the midpoint of each panel is measured using the wading rod. The rod is lowered vertically into the water until it reaches the bed or bottom. Take care that the rod is not pushed into the bottom sediment, record the depth.
7. Flow velocity is also measured at the midpoint of each panel. Velocity measurements will be taken with a reliable and calibrated Pygmy current meter, equipped with an AquaCount or AquaCalc device.

• If water depth is greater than 18 inches, measure velocity at 20% and 80% of water depth. These measurements are to be made along a vertical line at the mid-point of the panel.
• If water depth is less than 18 inches, measure velocity at 60% of water depth.
• When measuring velocity, hold the current meter steady, with the “buckets” pointed into the flow for at least 40 seconds to allow a stable reading.
• Ensure that all velocity readings are within the measurement range of the Pygmy meter. The meter is rated to measure streamflow velocities from 0.1 to 25 feet per second (0.03 to 7.6 meters per second).

8. Record water depth and velocity readings as they are taken. These can be relayed to onshore personnel for recording. Use the Stream Discharge Form (Section 7).
9. Once all readings have been taken, record the stop time and the water level. Then compute the discharge using the method described below. If any of the individual depth or velocity measurements or the computed discharge appears questionable, take additional readings to confirm the results.

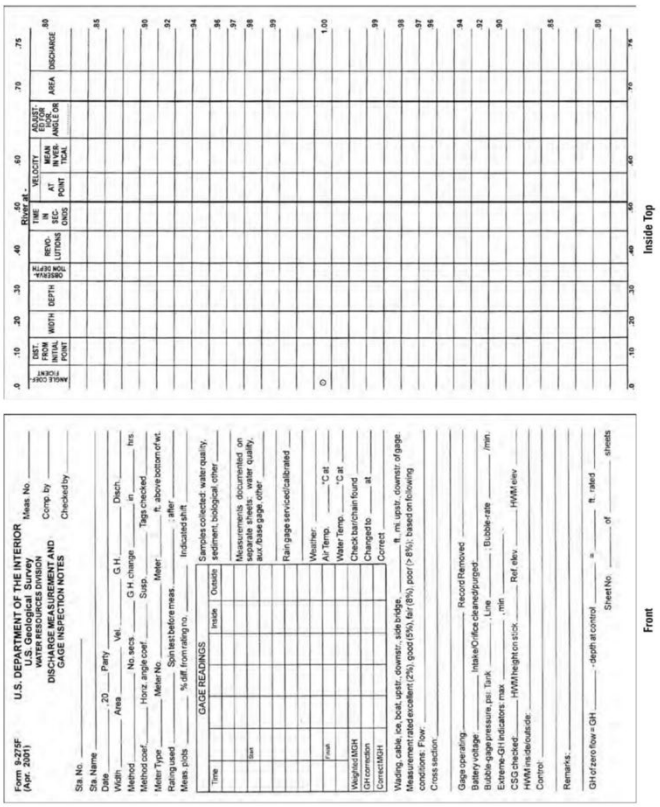
7 DATA PROCESSING/CALCULATIONS

Calculating discharge from depth-velocity data
The method used to compute discharge makes the following assumptions:
• The measured depth at the mid-point of each panel is considered to be the mean depth for the panel
• The mean velocity at an observation vertical is assumed to be the mean velocity for the respective panel
For each panel, the discharge is the mean depth multiplied by the mean velocity. The panel discharges

are then summed to obtain the total discharge through the gauging cross section.
For panels where velocity was measured at 20% and 80% of depth, the mean velocity is computed as the arithmetic average of the two readings: Vmean = (V0.2+V0.8) /2 . Where velocity was measured at only 60% of depth, that velocity would be considered the mean velocity.

DEVELOPING A STAGE-DISCHARGE RATING CURVE
A stage-discharge rating curve allows for discharge computation with any stage value. Stage data and discharge rating curves allow for the computation of streamflow. A rating curve is developed for the gauging station by plotting the stage-discharge measurements on graph paper or an appropriate computer program, and then fitting a smooth curve to the data.

DOCUMENTATION



Appendix B6. Form 9-275-F, Discharge Measurement Notes.

8 QA/QC
ASSESSMENT TECHNIQUES

UNH will be responsible for QA/QC activities related to water quality measurements, staff gauge readings, and instantaneous discharge measurements. Any data posted will be labeled as provisional until it has been reviewed for compliance with quality objectives, and, in the case of streamflow readings, until their respective rating curves have been verified. Data from the instantaneous flow measurements taken to verify the stage discharge rating curves.

PRECISION
Stage measurements: Staff gage readings (stage measurements) will be made to the nearest 0.01 ft (+/-0.02 ft).

Stage-discharge rating curves: A stage-discharge rating curve will be considered acceptable if all measured points used to establish the curve fall within 10% of the curve or within the estimated error bars for “poor” quality low flow discharge estimates.
Instantaneous discharge measurements: Discharge measurements will be reported to 0.01 cfs.
Precision of the discharge measurements will be assessed by making a duplicate discharge measurement immediately following one original measurement for every 10 field measurements. Field precision will be considered acceptable if the measurements fall within 10% of each other.

ACCURACY/BIAS
Stage-discharge rating curves: Accuracy of established rating curves will be checked at least once a year by UNH Staff. Additional discharge measurements will be taken to check the rating curve if changes to the staff gage position, channel morphology near the gage, or the gage control are observed.
Acceptable measurements are used only to confirm the rating curve and are not added to an existing rating curve. If more than two consecutive discharge measurements or three non-consecutive measurements fall outside the acceptable range (within 10% of the curve or within the estimated error bars for streamflow less than 0.01cfs), the rating curve and gauge site will be reviewed by UNH and, if necessary, the rating curve will be re-done or the staff gauge moved and a new rating curve established (as described above). During the discharge measurement, stream width and depth will be measured to the nearest 0.01 ft (+/- 0.02 ft) unless otherwise noted.

9 REFERENCES

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Appendix C. Wetland Condition Monitoring- Wetland Field Survey Protocols and Data Sheets

C-1 Invasive Plant Species Monitoring Protocol



Fig. 1: Map of Sam Wright Field with restoration monitoring areas (1-7) labeled.

Restoration areas 1 - 4 (outlined in red in Fig. 1) are areas where regrading and seeding has taken place, and plots have been established for monitoring growth of invasive plant species. Plots have been designated and named in ArcGIS as portrayed in figure 2, and will be marked on site with the installation of rebar with caps labeled with the plot # (as labeled in figure 2). Restoration areas 5-7 (outlined in green in Fig. 1) are proposed no mow zones for riparian buffer restoration; however these areas will not be monitored for invasive species at this time.

Volunteers will be assigned monitoring plots (Fig. 2), and will return to those same plots each year, at least once per growing season. Volunteers can navigate to their plot with a handheld GPS device using the plot centerpoint's coordinates (table 1), and/or find the rebar with the correct plot number labeled on the cap. From the plot centerpoint (the rebar), volunteers will survey the vegetation within a 15ft radius (measured with a tape measure or pre-measured length of string) for the presence of the following invasive plant species: Oriental Bittersweet (*Celastrus orbiculatus*), Wormwood (*Artemisia spp.*), Autumn Olive (*Elaeagnus umbellata*),

Multiflora Rose (*Rosa multiflora*), Glossy Buckthorn (*Frangula alnus*), Common Reed (*Phragmites australis*), and Purple Loosestrife (*Lythrum salicaria*).

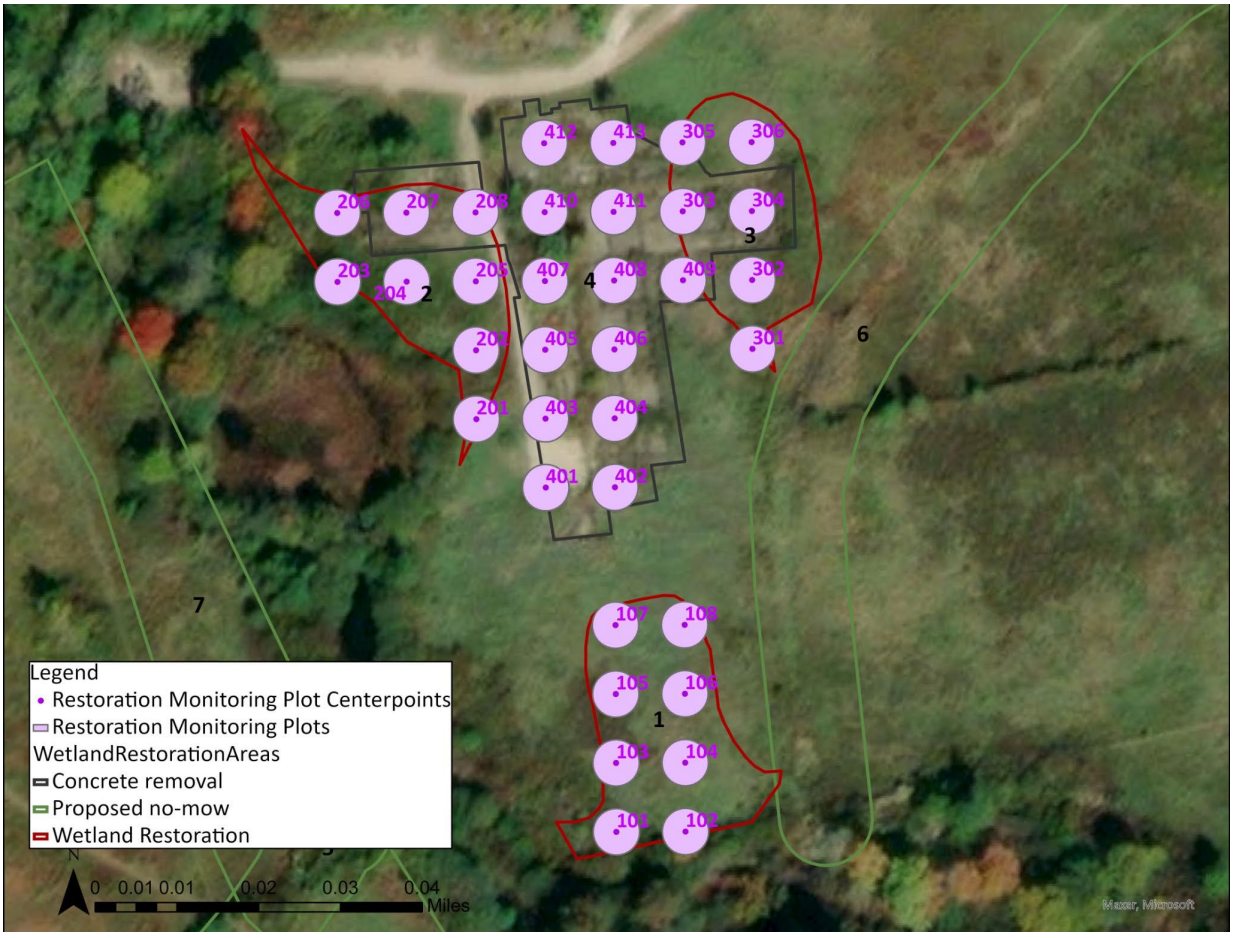


Fig. 2: Wetland restoration monitoring plots in areas 1-4.

Volunteers will fill out one of the attached Wetland Restoration Plot Survey data sheets for each plot that they survey, noting whether each species is present and, if so, the estimated prevalence of each within the plot (selecting from scarce, moderate, or abundant presence). In the additional comments section, volunteers may note any other relevant observations about the site or plot, and whether they flagged the invasive species for later removal by the Town.

Volunteers are advised to take photos of invasive plants observed and upload them to the iNaturalist phone application for immediate confirmation of species ID in the field. Volunteers should join the “Sam Wright Field Wetland Monitoring” project on iNaturalist, and all observations uploaded at the site will get automatically compiled on that project page. Volunteers will also flag observed invasive plants with orange tape for easy spotting by the Town’s contracted invasive species consultant to confirm species and treat as necessary.

Volunteers must enter the data from their field sheets into the project Google form, which will upload the data directly to a database that will be managed by the Town, and shared with the

invasives consultant to help with locating invasive plants for treatment. Volunteers may also choose to directly enter their data into the Google form in the field, and forgo the paper field sheet. Each plot surveyed will require a separate Google Form entry. Information collected by volunteers will be used to inform invasive species maintenance on the site, and may be used to measure the changes in invasive species observed over time and the effectiveness of the invasive treatments; however, the latter type of long-term monitoring is not part of the scope of this project at this time.

Plot #	Lat	Long
101	42.01495976	-71.12448356
102	42.01495976	-71.12431927
103	42.01508182	-71.12448356
104	42.01508182	-71.12431927
105	42.01520387	-71.12448356
106	42.01520387	-71.12431927
107	42.01532593	-71.12448356
108	42.01532593	-71.12431927
401	42.01557005	-71.12464784
402	42.01557005	-71.12448356
201	42.0156921	-71.12481212
403	42.0156921	-71.12464784
404	42.0156921	-71.12448356
202	42.01581416	-71.12481212

405	42.01581416	-71.12464784
406	42.01581416	-71.12448356
301	42.01581416	-71.12415499
203	42.01593622	-71.12514069
204	42.01593622	-71.12497641
205	42.01593622	-71.12481212
407	42.01593622	-71.12464784
408	42.01593622	-71.12448356
409	42.01593622	-71.12431927
302	42.01593622	-71.12415499
206	42.01605827	-71.12514069
207	42.01605827	-71.12497641
208	42.01605827	-71.12481212
410	42.01605827	-71.12464784
411	42.01605827	-71.12448356
303	42.01605827	-71.12431927
304	42.01605827	-71.12415499
412	42.01618033	-71.12464784

413	42.01618033	-71.12448356
305	42.01618033	-71.12431927
306	42.01618033	-71.12415499

Table 1: Wetland restoration monitoring plot locations (GPS coordinates).

Sam Wright Field Invasive Plant Survey Sheet
Wetland Restoration Plot Surveys (areas 1, 2, 3, 4)

Surveyor Name: _____ Date of site visit: _____

Plot #:

Species	Present?	If present, estimated prevalence (circle one):		
Oriental Bittersweet (*Celastrus orbiculatus*)	Y / N	Scarce	Moderate	Abundant
Wormwood (*Artemisia spp.*)	Y / N	Scarce	Moderate	Abundant
Autumn Olive (*Elaeagnus umbellata*)	Y / N	Scarce	Moderate	Abundant
Multiflora Rose (*Rosa multiflora*)	Y / N	Scarce	Moderate	Abundant
Glossy Buckthorn (*Frangula alnus*)	Y / N	Scarce	Moderate	Abundant
Common Reed (*Phragmites australis*)	Y / N	Scarce	Moderate	Abundant
Purple Loosestrife (*Lythrum salicaria*)	Y / N	Scarce	Moderate	Abundant

Additional notes (include whether invasive plants were removed or marked):

*****Please remember to upload this data to the project Google Form**

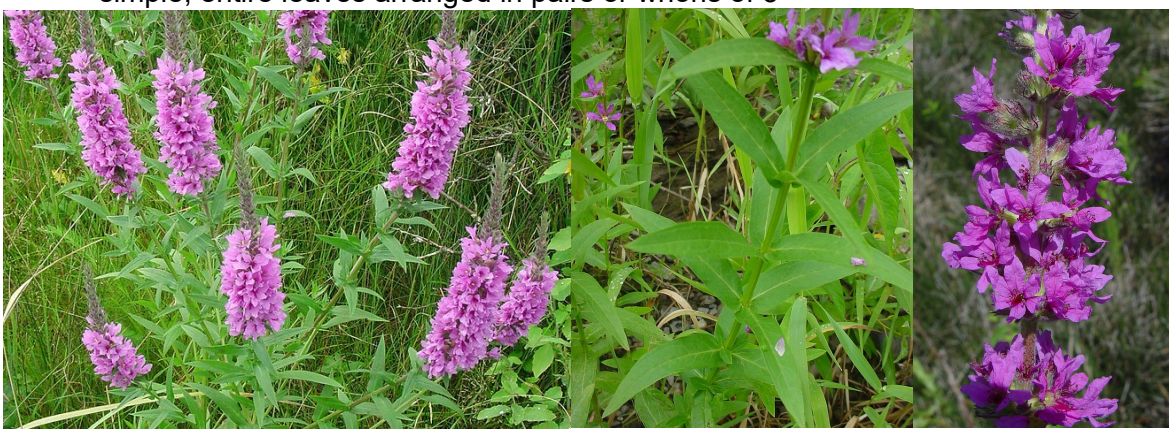
C-2 Invasive Plant Species Identification and Removal Guide

The following species list includes non-native, invasive plant species that are expected to be encountered at Sam Wright Field (located at 445 Bay Rd in Easton, MA) and are of particular concern for the success of the completed wetland restoration. The presence of these problem species is being monitored following restoration activities, and in accordance with the Sam Wright Field Wetland Restoration Baseline Monitoring Sampling and Analysis Plan. Volunteer monitors will be asked to flag the invasive plants they observe for later removal by the Town's contracted invasive plant removal consultant.

All images are sourced from the Native Plant Trust (www.gobotany.nativeplanttrust.org). Volunteers are encouraged to upload plant photos to iNaturalist to confirm identification.

Purple Loosestrife, *Lythrum salicaria*

- Bright purple flowers with 5 or 6 petals blooming in the summer
- simple, entire leaves arranged in pairs or whorls of 3



Common Reed, *Phragmites australis*

- Tall reed with long, broad leaves arranged all along the stem
- Flowers arranged in a head on branches protruding from the top of the stem



Oriental Bittersweet, *Celastrus orbiculatus*

- Woody, climbing vine with toothed leaves arranged alternately
- Small, green flowers arranged in clusters in the leaf axils
- Orange fruit splits open to reveal red seeds in fall



Wormwood, *Artemisia spp.*

- Aromatic and deeply lobed or divided leaves, white or silvery underneath
- Green flowers in spikes



Autumn Olive, *Elaeagnus umbellata*

- Woody shrub with alternate, entire oval leaves that are silvery underneath
- Fragrant, clustered, white flowers tubular with four petals, bloom April to June



Multiflora Rose, *Rosa multiflora*

- Woody shrub with curved thorns and toothed compound leaves with 3-9 leaflets
- White flowers with 5 petals bloom in summer



Glossy Buckthorn, *Frangula alnus*

- Wood shrub with alternate, entire, glossy green leaves
- Small, white, star-shaped flowers with 5 petals, arranged in cluster in leaf axils
- Berries emerge green then red in summer, and turn black when ripe in fall



Appendix D. Water Quality Monitoring Volunteer Monitoring Program Standard Operating Procedures

STANDARD OPERATING PROCEDURES for the Sam Wright Field, Wetland Restoration Town of Easton, Easton, MA

VOLUNTEER MONITORING PROGRAM

Prepared for:
Town of Easton

Prepared by:

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SNEP Network
July 2021

Date: August 2021

Table of Contents

1.0 PROJECT DESCRIPTION 1

1.1. Scope of this Document 4
1.2. Purpose for Sampling 4
1.3. Intended Use of Data 4

2.0 TECHNICAL DESIGN 4

2.1. Sampling Strategy 4
2.2. Sampling Locations 4
2.3. Sampling Design 5
2.4. Monitoring Parameters 5
2.5. Quality Control 6

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY 7

4.0 FIELD SAMPLING TABLE 8

5.0 SAMPLE PROCEDURES AND CHAIN OF CUSTODY 9

5.1. Safety 9
5.2. List of Sampling Equipment 9
5.3. Sampling Preparation 10
5.4. Sample Collection 11
5.5. Documentation 11
5.6. Sample Transport 12
5.7. Transfer of Custody 12

6.0 ANALYTICAL PROCEDURES 12

7.0 COLLECTION OF SUPPLIES 13

8.0 SAMPLE ANALYSIS 13

9.0 DUPLICATE AND BLANK 2020 SAMPLE COLLECTION LOCATIONS BY MONTH 13

APPENDIX A – WATER QUALITY MONITORING FORMS AND TOOLS ON THE EASTON WEBSITE

1.0 PROJECT DESCRIPTION

The Water Quality Monitoring Project: Purpose of Study, Background Information, and Problem Definition

The Canoe River Aquifer Resilience Pilot Project is located in sub-watersheds within the Taunton River Watershed major basin. The Taunton watershed (second largest in the state) is located in southeastern Massachusetts, extending 562 square miles and encompassing all or part of 40 cities and towns. The watershed is characterized by natural beauty and open waters (ponds, rivers and wetlands) that transition from low hills and flat areas to tidal rivers and estuaries in the lower basin. Dense development is concentrated in the northern portion of the watershed and along the southern end of the Taunton River. In the center of the watershed there is a significant amount of undeveloped land use that is undergoing a rapid change (Mass Audubon, Losing Ground). This trend is consistent with the history of evolving uses of land, water, and sea that has impacted the ecological systems and has manifested in vulnerabilities to the surrounding communities. At the top of the list of stressors is climate change that threatens the very attributes that make the Taunton Watershed so unique.

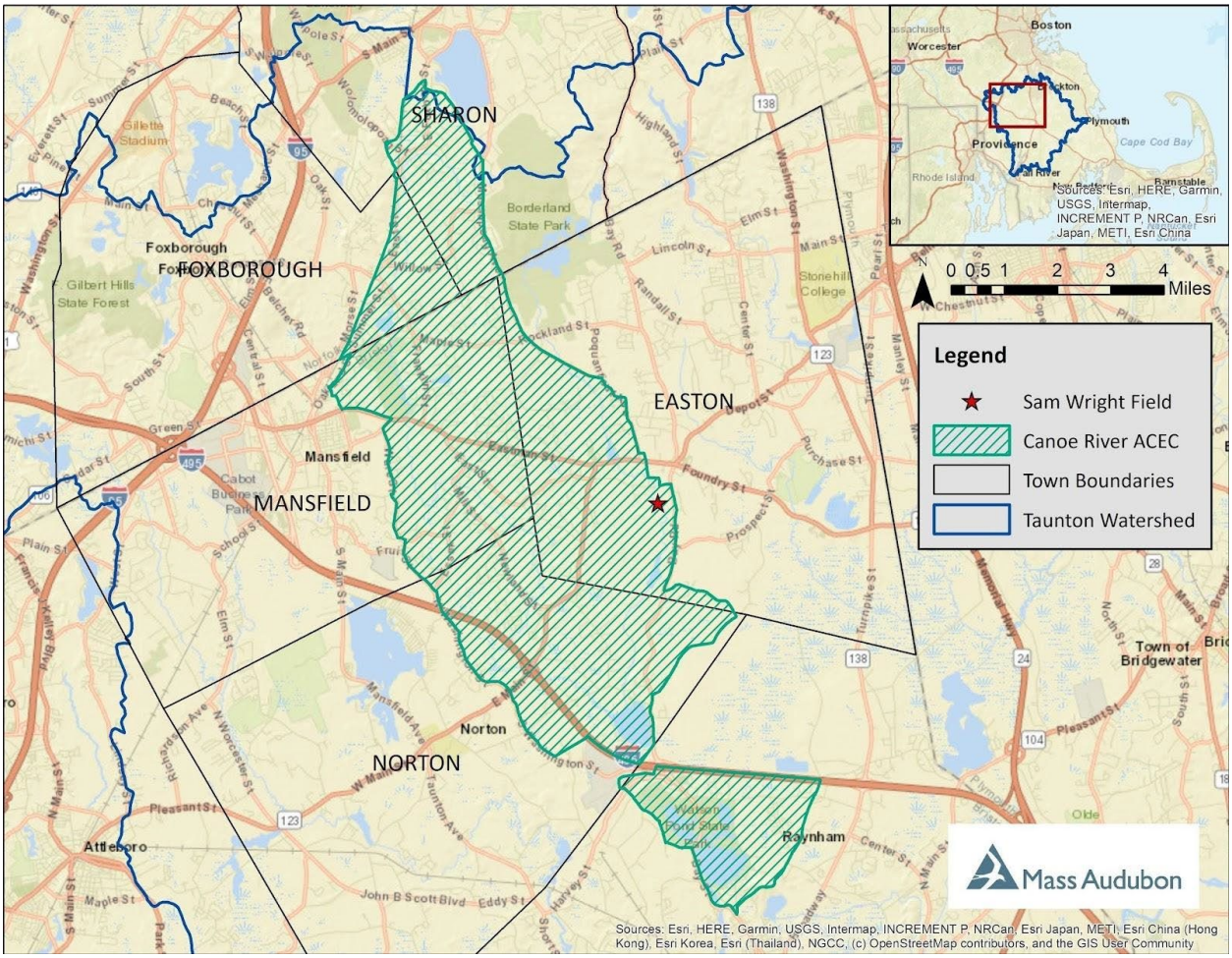
To address these threats, the towns of Easton, Norton, Sharon, and Mansfield have agreed to participate in a regional facilitated planning process hosted by the Southeastern New England Program (SNEP) Network and its partners. This pilot project is designed to engage these communities, along with other communities that lie within the Canoe River Watershed, in a collaborative community-driven planning process to address localized flooding, aquifer protection, improved groundwater quantity/quality, and ecosystem restoration using Nature Based Solutions (NBS). The Canoe River Aquifer Resilience Pilot Project provides an opportunity to expand upon the five communities planning activities that have been completed or are currently underway to address local hazards through:

- Facilitated regional planning with a newly formed steering committee,
- Leveraging a tool to site NBS for climate resilience outcomes, recently developed by The Nature Conservancy (TNC) in collaboration with Massachusetts Vulnerability Preparedness (MVP) program,
- Providing the opportunity to engage community members of Sharon and Foxborough in this process through peer-to-peer exchange, and
- Monitoring the outcomes of the project both at a program level and site-specific scale (e.g., Sam Wright Field Wetland Restoration, 445 Bay Road, Easton).

Easton is currently in the process of implementing a Wetland Restoration Project at Sam Wright Field which is part of the larger Wheaton Farm complex. The project is being implemented through a grant received by the Town of Easton from the Massachusetts Municipal Vulnerability Preparedness (MVP) action grant program, in partnership with The Nature Conservancy (TNC). The Town of Easton has agreed to conduct monitoring as part of the provisions of the MVP grant award. The SNEP Network has offered to provide technical assistance, through its partners as well as its pre-approved consultant pool, to develop a baseline monitoring program for the site. It is anticipated that this site will serve as a regional model for implementing nature-based solutions (NBS) and understanding the benefits of these practices.

One of the goals of the EPA SNEP program 2021-2025 Strategic Plan (https://www.epa.gov/sites/production/files/2020-11/documents/snep-2021-2025-strategic-plan.pdf) is to measure the benefits of environmental restoration projects to assess the overall program impact. Monitoring of the Sam Wright Field Wetland should be practical, with measures that can realistically be maintained with the use of volunteers. The SNEP Network will mobilize partners in winter of 2020-21 to begin baseline data collection. It is anticipated that the Network will design the program and support the effort until the fall of 2023, at which point the town of Easton and/or project partners will carry the established monitoring program forward with volunteers. Data collected in the field will support the environmental measures guidance provided by EPA.

The project site is located at Sam Wright Field that is part of a 1000-acre conservation area (Wheaton Farm) in Easton. The area of wetland restoration at Sam Wright Field is about 5 acres and is subject to flooding (e.g., FEMA flood zone A). Mulberry Meadow Brook flows through the site and is regionally significant from both a flood control and aquifer recharge perspective. Figure 2 shows the location of the project in relation to the Canoe River Area of Critical Concern (ACEC) and the Canoe River Aquifer.



Specific wetland restoration activities include:

- Expand flood storage capacity within a FEMA zone A,
- Remove concrete structures,
- Establish no-mow zones,
- Reestablish wetland soils and elevation grade,
- Seeding and planting, and
- Remove and manage invasive plant species.

The project was designed to restore a portion of the existing uplands at the site to a Bordering Vegetated Wetland (BVW). The bordering vegetated wetland can be seen in the aerial photo and follows the Mulberry Meadow Brook. Large areas of the site are regularly mowed by Easton. By creating no mow zones along Mulberry Meadow Brook, several intermittent streams, and the BVW associated with the waterbodies, the buffers are expected to transition from meadow to a more forested condition. Buffers with complex layers (i.e., leaf litter layer, shrub layer, tall

shrub layer, tree layer) are generally more effective at protecting wetland functions and values than buffers of a single layer (i.e., herbaceous cover typically seen in a meadow).

Non-native invasive species will be treated and removed from the site immediately after the wetland restoration portion of the project is complete, and then on an ongoing basis. The most common problem species onsite include Purple Loosestrife, Common Reed, Oriental Bittersweet, Common Wormwood, Autumn Olive, Multiflora Rose, and Glossy Buckthorn. Non-native species were noted along the wetland edge near the stream as well as through the concrete pads, and in other unknown areas.

The EPA Region 1 SNEP program will supplement the pilot project with funding/resources to collect pre- and post-implementation data. The collection of baseline information will inform the local project but also yield information that may be useful to surrounding communities that wish to move forward with the implementation of NBS through the broader Canoe River Aquifer Resilience Pilot.

The purpose of the overall project is to assist the Town of Easton with developing a set of baseline measures to evaluate the impact of the wetland restoration project at Sam Wright Field in Easton both locally and regionally. The project will use both primary and secondary data to meet the project goals:

1. Collect data before and after wetland restoration activities to measure the benefit of the restoration project in:

    - restoring of natural hydrology,
    - expanding wetland extent,
    - increasing flood storage,
    - improving habitat, and
    - reducing invasive species.

2. Use existing data to assist in analyzing the benefits in the areas mentioned above.

A project QAPP was developed in accordance with the following guidance documents: EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5) (EPA, 2002), *EPA New England Environmental Data Review Program Guidance* (EPA, 2018), *EPA New England QAPP Guidance for Projects Using Secondary Data* (EPA, 2009). Some of the language used in this generic QAPP was drawn directly from existing EPA-approved QAPP or relevant documents, including the *Taunton River Watershed Alliance Sample Collection and Analysis QAPP (Environmental Strategies and Management, Inc., 2022).* Given that this project will use primary data collected through this project and secondary (existing data), the QAPP covers the quality objectives and criteria for collecting, using, and managing both types of data. The QAPP includes all relevant Standard Operating Procedures (SOPs). Results will be used by the Town of Easton, the EPA Region 1 SNEP program, state agencies, and local municipalities or other key stakeholder groups to understand the impacts and benefits of the Sam Wright Field wetland restoration project in Easton and more broadly, future restoration projects. Details related to monitoring at the project site are described in the Sam Wright Field Sampling and Analysis Plan (SAP).

Since there is no baseline water quality data, this data set is of secondary importance to the Sam Wright Field Wetland Restoration SNEP Network baseline measures initiative. However, the Town of Easton has expressed interest in developing a volunteer program to help inform stormwater management programs in the town. This document is intended to help guide Easton's volunteer water quality monitoring at the project site and beyond and is modeled after the Taunton River Watershed Alliance (TRWA) monitoring program to expand the understanding of watershed water quality. Data collection was outlined to be consistent with the TRWA program. Taunton River Watershed Alliance is a non-profit alliance of concerned individuals, businesses, and organizations who are dedicated to protecting and restoring the Taunton River watershed – its tributaries, wetlands, floodplains, river corridors and wildlife. The Watershed Alliance conducts water quality monitoring at sites along the Taunton River

and its tributaries. Volunteers play a critical role in water quality sampling. Easton's network of volunteers gives concerned residents an effective vehicle for “doing something real” to protect our rivers.

1.1. Scope of this Document

This SOP describes procedures employed by Easton's volunteer water quality monitoring program. The background information, general safety, and water sampling information are described. Supplementary information, instruction sheets, and blank forms are provided as attachments to the Sampling and Analysis Plan and are posted on Easton’s website and listed in the Appendix of this SOP. In 221 EASTON received MassDEP and EPA approval of its Quality Assurance Project Plan (QAPP) for its most environmentally significant sampling parameters: nitrate, total phosphorus, and enterococci bacteria.

1.2. Purpose for Sampling

Mulberry Meadow Brook is located in Easton. The Brook crosses several roadways that have experienced flooding. Work is underway in the Town of Easton to replace culverts in the vicinity of Highland Ave and South Street. Many communities in the Taunton River basin are experiencing rapid growth and hazards related to climate. The Sam Wright Field Wetland Restoration will serve as a model to surrounding communities.

This sampling program monitors the water quality of a tributary to the Taunton River to help inform water quality management decisions and understand the impact of residential, agricultural, and industrial sprawl on water quality which affects the species indigenous to this basin.

1.3. Intended Use of Data

The monitoring data will be forwarded from the contract lab when available to Easton. Easton will store the data and use the scientific data gathered to establish a baseline of knowledge from which changes to the watershed can be measured. Monitoring data is also forwarded to TRWA to help expand their understanding of water quality in the region. Also, areas of concern will be flagged for local communities, MassDEP and EPA to help determine the cause or water quality impairment and help determine what remedial actions are possible.

2.0 TECHNICAL DESIGN

2.1. Sampling Strategy

Sampling is performed monthly, on the second Tuesday, between the hours of 8:30 a.m. and 11:00 a.m. Samples must be dropped off or transported to the appropriate lab via currier in a manner that maintains appropriate sample holding times. Monthly sampling was picked because it is frequent enough to include wet-weather events, dry spells, and temperature variations. The second Tuesday of the month was chosen because there are few national holidays celebrated on this day. The samples are collected in the morning because during photosynthesis, which occurs in the daytime, plants release more oxygen than is used by respiration and decomposition, raising oxygen levels. However, at night, with no photosynthesis oxygen levels are depleted. By sampling in the early morning, water quality can be assessed during a time when the river would be under the greatest oxygen stress. Early sampling also provides time for drop off and pick up of contract analysis samples and for the lab to perform those analysis.

2.2. Sampling Locations

A total of five sites and a duplicate are sampled at this time. Samples are taken close/from bridges, normally at public access, due to safety considerations and accessibility for parking. These sites were chosen to bracket the area where wetland restoration activities are underway. The number of samples and locations may be expanded at any time based on Easton’s needs.

STREET/BRIDGE LOCATION	RIVER	GPS Location	ID
South Street Culvert	Mulberry Meadow Brook, Easton	42.020617, -71.127543	WQ MMB 001
Highland Street Culvert	Mulberry Meadow Brook, Easton	42.018933, -71.125767	WQ MMB 002
Upstream Wetland Pool	Mulberry Meadow Brook, Easton	42.016296, -71.125847	WQ MMB 003
Downstream Wetland Pool Culvert	Mulberry Meadow Brook, Easton	42.015509, -71.125085	WQ MMB 004
Upstream Ward Pond	Mulberry Meadow Brook, Easton	42,012207, -71.122586	WQ MMB 005

2.3. Sampling Design

Volunteers make careful visual observations about the basic conditions of the river (i.e., color, odor, etc.). Volunteers collect and store for transportation (place in an insulated cooler with a cold pack) samples for enterococci bacteria, nitrate nitrogen, and total phosphorus. Samples of enterococci, nitrate and phosphorus samples are sent following chain of custody protocols to a state certified contract laboratory for analysis). If a smartphone or camera is available volunteers take pictures of water quality conditions.

Samples and field data sheets are either delivered directly to the lab or to a currier by volunteers to the laboratory. At the drop off site, chain-of-custody forms are completed, and custody of the samples is transferred to the laboratory technician. At time of pick-up the contract lab currier signs for the enterococci, nitrate, and total phosphorus samples. **ALL CHAIN OF CUSTODY FORMS MUST BE COMPLETED AND SIGNED BY THE VOLUNTEER SAMPLE COLLECTOR**. The Analytical labs and Easton will maintain copies of chain of custody forms and contract lab analysis reports.

2.4. Monitoring Parameters

The Easton volunteer water quality monitoring program focuses on physical, biological, and chemical water quality indicators. The parameters tested are as follows:

Nitrate Nitrogen (**NO3-N)** – Nitrogen found in water or soil as organic nitrogen, ammonia (NH3), nitrite (NO2) and

nitrate (NO3). Like phosphorus, nitrogen is a necessary part of the life cycle. Most plants, animals, and microorganisms require some amount of nitrogen for growth and reproduction. Like phosphorus, nitrogen is a limiting nutrient particularly in estuaries where freshwaters and saltwaters mix (Taunton River below route 24 and Mount Hope Bay are tidal and classified as SB waters by the Commonwealth of Massachusetts). Excess nitrates will result in excessive growth of algae and aquatic plants. The decomposition of these aquatic plants depletes oxygen from the water (the process of decomposition requires oxygen). This may result in "choking" the river or estuary due to low DO levels or habitat destruction by macro-algae and weed proliferation. Nitrates above low levels are toxic to beneficial sea grasses. Excessive amounts of nitrates can come from sewage treatment plants, animal manure, runoff from fertilized lawns, agricultural farming, industrial discharges and stormwater runoff which carries low concentration but high volume (hence significant mass loads) of nitrogen and phosphorus to the watershed. Nitrates from land sources end up in rivers more quickly than nutrients like phosphorus. This is because they dissolve in water more readily than phosphorus, which has an attraction for soil particles. Nitrates because they dissolve in water flow with groundwater to rivers and streams when applied as fertilizers at rates higher than lawns and crops require for growth. Nitrates serve as an indicator of sewage pollution during dry weather. Past EASTON monitoring consistently measures nitrate levels above state water quality criteria (TN – 0.45 mg/l; NO3>0.4 mg/l) as interpreted by EPA and MassDEP in Taunton watershed NPDES permit Fact Sheets.

Total Phosphorus (Total P) – Phosphorus occurs in water in several forms called phosphates. The total phosphorus test measures all of the forms of phosphates. Phosphates are necessary for biological growth, yet it is the nutrient that is in the shortest supply in most fresh waters. For this reason, it is referred to as a "limiting" nutrient (meaning it limits the amount of biological growth). A small increase in the level of phosphorus may result in an undesirable chain of events including excessive

growth of aquatic plants, low dissolved oxygen and death of certain aquatic animals. Phosphates enter the water both naturally and from humans. It naturally occurs in soil and rocks. It is introduced from human activities such as wastewater treatment plant discharges, runoff from fertilized lawns and crop land, failing septic systems, impervious surface deposition stormwater wash-off), road salt (which incorporates phosphorus compounds as anti-caking agents), and commercial cleaning operations. Past EASTON monitoring periodically measures total phosphorus (TP) levels above state water quality criteria (TP – 0.100 mg/l) as interpreted by EPA and MassDEP in Taunton watershed NPDES permit Fact Sheets. Levels of TP often exceed the EPA Gold Book criterion (TP – 0.05 mg/l) recommended for lakes and impoundments and EPA's Ecoregion VIII recommendation for rivers and streams (TP – 0.01 mg/l).

Enterococci Bacteria – Enterococci bacteria are indicators of the presence of fecal contamination from warm blooded animals (human or animal). National studies conducted under the Beach Act found the best correlation between bacteria levels and swimmer illness for enterococci, and E. coli bacteria. Subsequently MassDEP revised its water quality standards to change its class B bacteria criteria from fecal coliform to enterococci for Class SB and B waters; or alternately, E. coli for B waters. The water quality criterion for enterococci is 61 colonies per 100 ml as a single sample maximum (SSM); and 33 colonies/100ml as a geometric mean of all samples taken in the last six months. For SB waters the criteria are: SSM – 104 colonies/100 ml and Geo Mean for the last six months of samples – 35 colonies/100ml. EASTON samples in both SB (TNT-01 and TNT-02) and B (remainder of watershed) waters. Past EASTON monitoring periodically measured violations of the former fecal coliform criterion. In 2019 we changed our program to monitor using one of the currently approved bacteria indicator enterococci and found many violations of the state standards. We will be looking for trends and sources using the future sampling data.

2.5. Quality Control

In 2021, Easton received MassDEP and EPA approval of its Quality Assurance Project Plan (QAPP) for its most ecologically important samples which are: nitrate, total phosphorus, and enterococci bacteria.

For these samples we collect duplicate and blank samples for every ten samples collected. Since Easton samples 5 sites per month, we do 1 set of duplicates and blank samples at two rotating locations per month (see blank

monthly results summary form for NO3, TP, and Enterococci on the Easton website.

Following the sampling event and analytical analysis, the results from the MassDEP approved contract lab used for nitrate, total phosphorus, and enterococci analysis including their QA results are forwarded to Easton. After review by Easton the results are put in our monthly results tracking table and posted on the Easton website typically within a month of sample collection.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Katherine Wall
Microbac Lab Manager
Microbac Laboratories, Inc.
61 Viens Drive
Dayville, CT 06241

Easton Monitoring Program Coordinator:
Jen Carlino
Environmental Planner
Town of Easton
136 Elm Street
North Easton, MA 02356
508-230-0630
jcarlino@easton.ma.us

TRWA
Stephen Silva
124 Titicut Rd
Raynham, MA 02676
508-824-7345; Cell: 508-280-3991
steve124@gmail.com

Easton Quality Assurance Officer: TBD
Kimberly Groff (Acting)
SNEP Network
27 Pearl Street
Marblehead, Ma)1945
508-932-5528
kimberlygroffma@gmail.com

The field sampling program coordinators check each sample site directly for safety and accessibility and assist with training sessions for community volunteer samplers the last Saturday of the month before each year's sampling program is scheduled to begin and as needed throughout the year.

The laboratory coordinating sampling team sample drop-off, contract lab sample pick-up, and performing the analyses for nitrate, total phosphorus, and enterococci and reporting results reporting is:

Microbac Laboratories, Inc.
61 Louisa Viens Drive
Dayville, CT 06241
Quality Assurance Officer: Melisa A. Montgomery

4.0 FIELD SAMPLING TABLE

Sample Matrix: River water for all samples.

Discrete Samples

Analyte/ Parameter	Sample Matrix	Sample Container (P) Plastic or Glass (G)	Total # of samples collected at each site	Volume needed (ml)	Method of preservation	Maximum Hold Time
Enterococci	River water P (100 ml)		1	100 ml	Cool to 4°C	6 hours
Nitrate Nitrogen	River water	P (120 ml)	1	120	Cool to 4°C	48 hours
Total Phosphorus	River water	P (250 ml)	1	250	H2SO4 by lab	48 hours

Quality Control/Quality Assurance Samples, Duplicate and Blank Samples for Every Ten Samples - Two of Each per Month* at Rotating Locations Based on Easton's 5 Sample per Month Sampling Program

Analyte/ Parameter	Sample Matrix	Sample Container (P) Plastic or Glass (G)	Total # of samples collected at each site*	Volume needed (ml)	Method of preservation	Maximum Hold Time
Enterococci	River water P (100 ml)		1 (Dup + Bl)	100 ml	Cool to 4°C	6 hours
Nitrate Nitrogen	River water	P (120 ml)	1 (Dup + Bl)	120	Cool to 4°C	48 hours
Total Phosphorus	River water	P (250 ml)	1 (Dup + Bl)	250	H2SO4 by lab	48 hours

As described in Section 2 (E), duplicate samples are collected by each sampling team on a rotating basis. If it is your turn to collect a duplicate sample, field duplicates are to be taken from the same container of river water sample (e.g., sample bucket of river water collected) at the same time as the original regular sample. Duplicate samples and blank samples are collected at the last site you visit for the day as shown on the blank monthly analysis reporting table on the website and on each month's sample reporting page.

If you are also scheduled to collect blank samples for enterococci, nitrate, and total phosphorus analysis after your regular samples and duplicates are collected:

• rinse your sample collection container thoroughly two times using about half of your deionized (blank) water on all sides and dump out (a clean sampling bucket or container is important),

• pour the remaining half of your blank water into your sampling container, and

• fill the blank enterococci, nitrate, and total phosphorus blank analysis bottles from your blank water rinsed sampling container. [Note we don't do blanks for DO, pH/TSS].

Sample bottles for Nitrate Nitrogen, Total Phosphorus and Enterococci Bacteria are provided by the contract laboratory, Microbac Laboratories Inc. of Dayville, CT. The labels on the bottles are to be filled out by the sample collectors as follows:

- Client – Easton
- Date Collected
- Time Collected
- Sample ID
- Analysis Required

An example of how to fill out sample bottle labels is on the Water Quality Monitoring page of the Easton website.

5.0 SAMPLE PROCEDURES AND CHAIN OF CUSTODY

5.1. Safety

There are many safety precautions that must be followed both in the field and in the lab. Potentially hazardous situations exist in any field sampling situation. Volunteer samplers are encouraged to always sample in pairs. Since most of the sampling locations are off bridges (plastic bucket tied to a rope) or near bridge embankments, and the sampling times are in the early morning hours, it is advisable to wear high-visibility clothing. Be aware that embankments may be slippery and/or icy. Proper footwear is recommended. Sampling is done in all weather conditions except snow, but if there is lightning in the area, sampling must be avoided. Standard lab safety procedures are followed during all laboratory analyses.

In the event of a cancellation due to inclement weather or lab schedule issue, Easton will notify each volunteer. If you, the volunteer, are unable to collect your samples, for whatever reason, please notify Easton by phone/cell or e-mail at least 2 hours prior to the sampling event.

5.2. List of Sampling Equipment

<u>Easton Provided</u>

Sample grabber or Plastic Bucket with rope
Thermometer
Gloves
Field paperwork (Field Sheet / Chain-of-Custody Form)
Clipboard
Pens
Cooler(s)
Cold pack(s)
One clear plastic cylindrical screw top container from Microbac for each sampling site for enterococci Two plastic

bottles from Microbac for each sampling site for nitrate and total phosphorus samples

Assigned duplicate and blank bottles and of deionized water for field blanks as described above

Volunteer Provided

Flashlight
Emergency Telephone Numbers
First Aid Kit
Cell Phone

All sampling equipment is provided by Easton. Each volunteer monitor will be given one set of sample containers for each sample location, a clipboard with pen, field data and chain of custody sheets, a cooler with a blue ice pack, a sample grabber if needed, plastic bucket with a rope, and a pair of latex or nitrile gloves. Sample collectors are requested to provide their own flashlight, first aid kit and cell phone.

Monthly, when the samples are collected and delivered to the laboratory, the sample bottles for next month (including extra bottles for duplicate samples and blanks as needed along with deionized (blank) water) will be given to the collector to replace the relinquished samples. Any paperwork is replenished by Easton as needed.

After analyses are complete, all used sample bottles are cleaned in the laboratory dishwasher using Sparkleen Laboratory Detergent, a non-phosphate detergent manufactured to clean laboratory glassware or replaced by the contract lab.

Volunteers are requested to not use the buckets or coolers for any other purpose. Buckets should be rinsed with tap water and river water only and air dried. Sampling buckets should be rinsed with river water at each sampling site at time of sample collection before sample collection.

5.3. Sampling Preparation

Sampling preparation is the most important part of a successful sampling event. Careful attention must be given to both equipment and handling in order to collect a valid sample. Sampling site(s) and type(s) of samples will determine the equipment needed and the method of collection. A standard sampling checklist is specified above. Sampling preparation procedures are as follows:

1. Two days prior to the event contact your sampling partners to confirm the sample date and meeting time and place. Contact back-up team members or back teams if needed.

2. The night before the event, place the ice packs into the freezer.

3. Either the night before or the morning of the event, notify someone other than your partner of your intended sampling locations and approximate departure and return time.

4. Go over the sample checklist and the field sheet to determine what will be used for each site.

5. The morning of the sampling event, place the ice packs into the cooler along with empty sample bottles.

6. Check your vehicle to make sure it is properly stocked with all necessary equipment and paperwork.

IMPORTANT: In the event that you are unable to collect a sample please notify your sampling team back-ups or

Easton at 508-230-0630.

5.4. Sample Collection

Each of the sample containers provided by the Lab Assurance Officer is labeled with an identification number. Each sampling location has been assigned a three letter - two number I.D. or unique name. This I.D. correlates with the name of the river and location. All river samples are grab samples from running water.

1. Park your vehicle in a safe, secure location. Prepare the equipment necessary for the site being sampled. Set aside the appropriately labeled sample containers. Have the field sheet on the clipboard, and a pen on hand. Leave the cooler in your car. Set all test equipment in a bucket to carry to the sample site.

2. Assess your situation to ensure safety and ease of sample collection. You should have adequate space for yourself and all of the sampling equipment.

3. Observe the color of the water and notice if any odors are present. Make note of any plant or algal growth. Log this information onto the field sheet. Take photos of unusual conditions: low flow, high flow, debris etc.

4. Use the sample grabber or bucket to retrieve each of the following samples. Insert the container into the grabber and immerse in the river or more commonly use a rope and plastic bucket.

a. Set the sample container into the grabber and immerse into the river or more commonly immerse the bucket into the river using a rope from a bridge to collect river water. Rinse with river water and dump. Take a sample of river water. Break the paper label seal on the top and fill the Lab supplied small cylindrical clear plastic container with the screw on cover. These will be used for enterococci bacteria (EN) analysis.

b. Fill the Lab supplied plastic bottle, non-preserved the smaller of the two small rectangular bottles from: the sample bucket of water, the river directly, or pour from the larger bottle used to collect samples with the grabber. This sample will be used for nitrate nitrogen (NO3) analysis.

c. Fill the Lab supplied plastic bottle, preserved with sulfuric acid the larger of the two small rectangular bottles from: the sample bucket of water, the river directly, or pour from the larger bottle used to collect samples with the grabber. This sample will be used for total phosphorus (TP) analysis.

5. Place these sample bottles into the bucket to carry to the cooler with the ice packs.

6. Be sure to complete the field data sheet and chain of custody form for that sample site.

7. Continue on to your next sample site, repeating Steps 1 – 7 at each sample location.

** If you are collecting any duplicate samples collect the duplicate when collecting the original sample at the last location you visit for the day as described above. If collecting blanks, at this same location, after samples and duplicates are collected; rinse your sample collection container (e.g., bucket) thoroughly two times on all sides using about half of your deionized (blank) water, pour the remaining deionized (blank) water into the rinsed container or bucket and collect the blank water samples for enterococci, nitrate, and total phosphorus analysis from the container or bucket.

5.5. Documentation

Documentation is an integral part of any sampling program. The validity of samples collected, and data obtained

both in the field and the laboratory is ensured through documentation and record keeping. All information must be complete and accurate. Documentation includes the field sheet and the chain-of custody record. The overall success of a monitoring program depends on its capability to produce valid data through the use of accepted sampling procedures and protocol, and its ability to substantiate such data through documentation. This begins with properly trained personnel and continues with sampling preparation, the sampling event, transfer of sample custody, laboratory analyses, equipment cleaning and data management.

1) WATER QUALITY MONITORING FIELD TEST SHEET

The Field Sheet is a permanent record of the information gathered during the sampling round. It is also the Chain of Custody. A blank field sheet is included on the Easton website. The chain of custody (COC) must always be completed. The COC is the legal document that follows the sample from collection through to final analysis. The data on the field sheet includes:

- Unique site identification number (e.g., WQ-MMB-xxx) or Duplicate Sample (DUP 1 or DUP 2) or Blank Sample (Bank 1 or Blank 2) designation
- Name of Sampling Personnel
- Date and Time of Sample Collection
- Water Clarity or other notes on water appearance, color, odor or tide level (see comments below)
- Requested Analysis
- Comments or any observations, such as algae or excessive weed growth presence, weather, water odor, watercolor, oil slicks. Unusually large groups of wildlife.
- Relinquished by: Name of person who relinquishes sample to laboratory personnel
- Date/Time: Date and Time that lab person receives the sample
- Received by: Lab person receiving sample accepts transfer by signing.

5.6. Sample Transport

Every sample collected, regardless of type, should be handled in the same manner. Once the sample is collected, place it upright into the cooler. When all samples are collected at the site, carry the bucket to your vehicle and place it securely in the cooler containing a blue cold pack. Once all of your sample sites are collected, drive directly to the laboratory conducting the tests and deliver the samples to the laboratory manager or technician.

5.7. Transfer of Custody

All of the samples that are collected are analyzed by the laboratory specified in this document. When delivering the samples to the laboratory, place the cooler on the lab counter and unload the sample containers. Group the sample bottles by site and line up the bottles so that the ID is visible. The chain-of-custody form and sample label should be checked for completion and accuracy. The laboratory technician signs off on the chain of custody and receives all samples. These samples are the nitrate-nitrogen, total phosphorus, and enterococci bacteria samples. All samples are placed into the laboratory refrigerator until analysis.

FOR SAFETY AND HEALTH REASONS, NO CHILDREN UNDER THE AGE OF 14 ARE ALLOWED IN THE WASTEWATER TREATMENT PLANT LABORATORY.

6.0 ANALYTICAL PROCEDURES

This monitoring program uses the procedures specified below:

Sample collection, preservation and holding methods.

Parameter	Matrix	Number of Samples (including required field QC)	Analytical Method	Sampling SOP	Containers	Preservation Requirements	Maximum Holding Time
Enterococci Bacteria	Surface water	5 samples (including 2 duplicates and 2 field blanks)	USEPA Method 1600[1]	Sam Wright Field Baseline SAP	Pre-sterilized containers with secure lids; min. 100mL	4°C +/- 0.5°C	Analyzed within 2 hours of collection but always within a max of 6 hours transport time follow by 2-hour lab process time
Total Phosphorus	Surface water	5 samples (including 2 duplicates and 2 field blanks)	USEPA Method 365.1[2]	Sam Wright Field Baseline SAP	100 mL HDPE	4°C H_2SO_4 (2 mL concentrated H_2SO_4 per L)	2 months
Nitrate	Surface water	5 samples (including 2 duplicates and 2 field blanks)	Standard Method 4500-N03-F[3]	Sam Wright Field Baseline SAP	50 mL plastic	4°C	48 hours

7.0 Collection of Supplies

Collect necessary sampling supplies for the following month at the sample drop-off, at Easton.

8.0 Sample Analysis

Samples are analyzed for nitrate, total phosphorus and total coliform by either:

Microbac, Dayville, CT a MassDEP certified laboratory using EPA approved methods and as described in Easton's MassDEP approved Quality Assurance Project Plan (QAPP). https://www.microbac.com/locations/connecticut-dayville

9.0 Duplicate and Blank 2020 Sample Collection Locations by Month

Event	Site No.	Duplicate and Blank Locations by Event	DUP #	BL #
Date	WQ MMB 001	South Street Culvert	DUP 1	BL 1
	WQ MMB 002	Highland Street Culvert	DUP 2	BL 2
Date	WQ MMB 003	Upstream Wetland Pool	DUP 1	BL 1

Event	Site No.	Duplicate and Blank Locations by Event	DUP #	BL #
	WQ MMB 004	Downstream Wetland Pool Culvert	DUP 2	BL 2
Date	WQ MMB 005	Upstream Ward Pond	DUP 1	BL 1
	WQ MMB 001	South Street Culvert	DUP 2	BL 2
Date	WQ MMB 002	Highland Street Culvert	DUP 1	BL 1
	WQ MMB 003	Upstream Wetland Pool	DUP 2	BL 2

APPENDIX A – Water Quality Monitoring Forms and Tools on the Easton Website

• Google Map of Monitoring Locations



• One-page summary of nitrate, total phosphorus, and enterococci sampling procedures along with procedures for collecting duplicate and blank samples: https://docs.google.com/document/d/1WI23TbFnxP_30E28Y7p8R8v2rdqQ21QV1LK5ioKwkTQ/edit?usp=sharing

• Blank monthly results reporting form for nitrate, total phosphorus, and enterococci indicating the locations where duplicate and blank samples are to be collected each month (lower section of spreadsheet pages):

https://docs.google.com/document/d/1FmImvdMYyJs6CwF_ctjfT8xFG7vXSPaGYtizwcTDLrs/edit?usp=sharing

• Blank Water Quality Monitoring Field and Chain of Custody Sheet:
https://docs.google.com/document/d/1S8_pGFlm4RjG76KOrXWIZzknfutKWyKUevQfJ0bPjaA/edit?usp=sharing

• Instructions and an example of how to fill out the Microbac contract laboratory sample bottle labels for Enterococci, Nitrate, and Total Phosphorus:
https://docs.google.com/document/d/1EWaVX64ZksJ5zibvamlDtqn5dN2BRVgvowClX3qV8d8/edit?usp=sharing

• Massachusetts Water Quality Standards excerpts from – 314 CMR: DIVISION OF WATER POLLUTION CONTROL: excerpts from 405: Class B and SB Water Quality Criteria, Narrative Nutrient Criteria, 403: Application of Standards for Establishment of Effluent Limitations, and 406: Basin Classification: https://www.mass.gov/doc/314-cmr-400-surface-water-quality-standards/download

2021 Sam Wright Field Water Quality Monitoring Program Sampling Instructions

Sampling

[Important Note] Always fill out the labels (except time of sample collection) on the three Lab sample bottles (Microbac or Alpha analytical) used for enterococci bacteria, nitrate, and total phosphorus sample collection with ball point pen (so it doesn't smear) on dry labels several days before the sampling date. Fill in the time of collection on the bottles in pen on site when the sample is collected and before filling the bottles.

Do not touch the inside of either the cap or the sample bottle with your fingers. - Lower bucket (or sample bottle if using a pole sampler) into river/stream near mid-point and fill with river water;
- Pull up and gently dump out the sampling container to the side of the river/stream so as not to disturb river sediment to rinse the sample bucket;
- Lower bucket again to collect the water used for sample collection;
- Write time of sample collection on the three lab sample bottles and field chain of custody sheet; - Fill sample bottles from the bucket or sample collection container in the following order:

1) Enterococci bacteria (EN) – clear cylindrical lab sample supplied 100 ml bottle – As mentioned above, be very careful not to touch the inside of either the bottle cap or the bottle with your fingers to avoid contamination of the bacteria sample;
2) Nitrate (NO_3) – smaller of two plastic opaque bottles 120 ml; and
3) Total Phosphorus (TP) – larger of two plastic opaque bottles 250 ml.

Duplicate and Blank Samples are taken at the last site you visit for the day. You need three sets of the Lab supplied bottles along with lab supplied deionized (DI or blank)

Duplicate Samples

- Take Duplicate sample (DUP 1 or DUP 2) from the same bucket of water used for your regular sample; - Take the samples sequentially (your regular site sample then the duplicate sample):

1) Two enterococci – regular and DUP 1 or 2 by monitoring team;
2) Two nitrate bottles – regular and DUP 1 or 2 by monitoring team; and
3) Two total phosphorus bottles – regular and DUP 1 or 2 by monitoring team.

Blank Samples

- Rinse your sampling bucket thoroughly with blank water carefully swirling it around to rinse all sides and dump it out, rinse and dump bucket again using a total of about ½ your blank water; - Pour remaining half of the blank (DI) water into your bucket so you can fill the sample bottles for enterococci, nitrate and total phosphorus analysis from the bucket just like you took the regular and duplicate samples. These bottles are labeled either Blank 1 or Blank 2 depending on your site's designation for that month. **[Note we are only doing blanks (designated and labeled Blank 1 or Blank 2) for the Microbac or Alpha analytical sample bottles (enterococci, nitrate and total phosphorus)].**

2021 Sam Wright Field Wetland Mulberry Meadow Brook Sampling Results for Nitrate (mg/l)				TARGET FOR CONCERN - GREATER THAN 0.4 MG/L							
Samp		**River & Location Description**	**Date #1**	**Date #2**	**Date #3**	**Date #4**	**Date #5**	**Date #6**	**Date #7**	**AVG****	
1	WQ MMB001	South Street Culvert, Easton, MA									
2	WQ MMB002	Highland Street Culvert, Easton, MA									
3	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton									
4	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton									
5	WQ MMB005	Upstream Ward Pond, Easton, MA									
Date	**Site No.**	**Duplicate and Blank Locations by Month**	**DUP #**	**Duplicate Results**		**BL #**	**Blank Results**		** Avg is for the water quality months		
Event	WQ MMB001	South Street Culvert, Easton, MA	DUP 1			BL 1			of May through October used in		
	WQ MMB002	Highland Street Culvert, Easton, MA	DUP 2			BL 2					
Event	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 1			BL 1					
	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 2			BL 2					
Event	WQ MMB005	Upstream Ward Pond, Easton, MA	DUP 1			BL 1					

	WQ MMB001	South Street Culvert, Easton, MA	DUP 2			BL 2				
Event	WQ MMB002	Highland Street Culvert, Easton, MA								
	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton								
Event	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton								
	WQ MMB005	Upstream Ward Pond, Easton, MA								

2021 Sam Wright Field Wetland Mulberry Meadow Brook Sampling Results for Total Phosphorus (mg/l)				**TARGET FOR CONCERN - GREATER THAN 0.100 mg/l**							
Samp		**River & Location Description**	**Date #1**	**Date #2**	**Date #3**	**Date #4**	**Date #5**	**Date #6**	**Date #7**	**AVG****	
1	WQ MMB001	South Street Culvert, Easton, MA									
2	WQ MMB002	Highland Street Culvert, Easton, MA									
3	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton									
4	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton									
5	WQ MMB005	Upstream Ward Pond, Easton, MA									
		Duplicate and Blank Locations by		**Duplicate**		**Blank Results**			** Avg is for the water quality months		

		Month		Results					
Event	WQ MMB001	South Street Culvert, Easton, MA	DUP 1		BL 1		of May through October (season AVG).		
	WQ MMB002	Highland Street Culvert, Easton, MA	DIP 2		BL 2		NPDES permits use TP mo. avg. limits.		
Event	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 1		BL 1		Based on observations TRWA considers		
	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 2		BL 2		a season AVG **≥ 0.05 mg/l is concern**.		
Event	WQ MMB005	Upstream Ward Pond, Easton, MA	DUP 1		BL 1				
	WQ MMB001	South Street Culvert, Easton, MA	DUP 2		BL 2				
Event	WQ MMB002	Highland Street Culvert, Easton, MA	DUP 1		BL 1				
	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 2		BL 2				
Event	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 1		BL 1				
	WQ MMB005	Upstream Ward Pond, Easton, MA	DUP 2		BL 2				

2021 Sam Wright Field Wetland Mulberry Meadow Brook Sampling Results for Enterococci (colonies/100 ml)				**TARGET FOR CONCERN - GREATER THAN 61 COLONIES/100 ML**							
Samp		**River & Location Description**	**Date #1**	**Date #2**	**Date #3**	**Date #4**	**Date #5**	**Date #6**	**Date #7**	**GEO MEAN May to Oct.**	

1	WQ MMB001	South Street Culvert, Easton, MA									
2	WQ MMB002	Highland Street Culvert, Easton, MA									
3	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton									
4	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton									
5	WQ MMB005	Upstream Ward Pond, Easton, MA									
		Duplicate and Blank Locations by Month		**Duplicate Results**		**Blank Results**			** Geometric Mean for the six months		
Event	WQ MMB001	South Street Culvert, Easton, MA	DUP 1			BL 1			from May to Oct. should not exceed		
	WQ MMB002	Highland Street Culvert, Easton, MA	DUP 2			BL 2			**33 colonies per 100 m**l.		
Event	WQ MMB003	Upstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 1			BL 1					
	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 2			BL 2					
Event	WQ MMB005	Upstream Ward Pond, Easton, MA	DUP 1			BL 1					
	WQ MMB001	South Street Culvert, Easton, MA	DUP 2			BL 2					
Event	WQ MMB002	Highland Street Culvert, Easton, MA	DUP 1			BL 1					
	WQ	Upstream Wetland Pool Culvert, Sam	DUP			BL 2					

	MMB003	Wright Field, Easton	2						
Event	WQ MMB004	Downstream Wetland Pool Culvert, Sam Wright Field, Easton	DUP 1		BL 1				
	WQ MMB005	Upstream Ward Pond, Easton, MA	DUP 2		BL 2				

Sample Analysis, Collection Method - Standard Operating Procedures (SOP) and Instream Target Values										
Samples Are Analyzed by:										
	Microbac, Dayville, CT		A MassDEP Certified Laboratory							
		https://www.microbac.com/our-laboratories/dayville-connecticut/#services								
	Alpha Analytical	https://www.alphalab.com	A MassDEP Certified Laboratory							
Samples Are Collected by Trained Easton Volunteers Using An SOP adapted from TRWA and Veolia North America:										
		https://savethetaunton.org/wp/wp-content/uploads/2020/02/TRWA-Sampling-SOP-1-22-2020.pdf								
Sampling Locations Map May Be Found At:										
	See Project SAP	https://drive.google.com/file/d/1XQBPNMBT_b4ynPYbNM4AVolN1EkSIDPD/view?usp=sharing								

Water Quality Protection **Insteam Target Values**:											Note targets are to be used with caution because this is a wetland dominated system and elevated levels may reflect natural conditions.	
	Nitrate											
	Water Quality Target Values for Nitrogen are expressed as Total Nitrogen = **Nitrate** + Organic Nitrogen + Ammonia + Nitrite											
		Like most environmental groups TRWA measures only **Nitrate** because of its low cost ($12 / sample) and low										
		reporting level (0.05 mg/l). The MassDEP in a large number of TMDLs for estuaries has recommended TN values										
		between 0.39 to 0.5 mg/l for estuaries without eel grass in good to fair condition. The Cape Cod Commission										
		recommends values 0.34 to 0.39 while the Buzzards Bay Project/ Massachusetts Coastal Zone Management										
		recommends 0.39 to 0.44 mg/l. After consultation with MassDEP and Rhode Island DEM (downstream state)										
		EPA selected a TN target estuary value of 0.45 mg/l as a medium target for the Taunton River.										
		Because Nitrate is only a portion of Total Nitrogen we consider **Nitrate values > 0.4 mg/l high for both the tidal**										
		portion of the estuary below Route 24 at the Raynham/Taunton Bridge and above because of transport concerns										
		to the salt waters of the estuary.										
	Total Phosphorus											

	The Water Quality Target Values for **Total Phosphorus are 0.100 mg/l for freshwaters** in free flowing streams and 0.050 mg/l										
		in lakes, ponds, impoundments and streams tributary to them. These Targets are from the EPA Suggested Criteria									
		for Water sometimes called the Gold Book.									
		Based on observation and photos of the shallow effluent dominated freshwaters of the watershed TRWA									
		considers **average TP greater than 0.05 mg/l** a value for concern in addition to **single month samples > 0.100 mg/l**.									
	Bacteria - Enterococci										
	The Water Quality Target Value used for **enterococci is 61 colonies per 100 ml as a single sample maximum (SSM)** and **33 colonies as geometric mean**										
		of all samples taken in the most recent six months. These targets are from the MA Water Quality Standards 314 CMR for Class B waters.									
		For Class SB waters the criteria are: SSM - 104 colonies/100 ml and Geo Mean for the last 6 months of samples - 35 colonies/100 ml.									
		TRWA sampling locations TNT-01 and TNT-02 are in SB waters all others are in Class B waters.									

Filling Out the Labels on the Microbac or Alpha Analytical Enterococci, Nitrate, and Total Phosphorus Sample Bottles

Below are instructions on how to fill in the sample bottle labels [Location, date, and time is important for these bottles even though you also have this info on the chain of custody form]:

I. Enterococci (the small round clear 100 ml plastic bottle with the label on both top and side)

Top of bottle (round cap)

ID collection location e.g. WQ MMB 00X
Type Enterococci
Date/Time Date of sample collection
Location Fill in Time of collection here

Side of bottle is filled out same as cap

ID collection location e.g. WQ MMB 00X
~~Collector~~ Enterococci
~~Chlorine~~ Date of sample collection
Fill in Time of collection here

*Always use a ball point pen (felt pen ink can run when wet) and fill out the first three lines at home. Fill in the time of collection in the field just before you dip the bottle into your bucket to fill it. Always write on a dry label.

II. Nitrate the smaller of the two opaque rectangular or circular 120 ml bottles says Non Preserved lower label

Label on side and front of Bottle

Client: Easton Sample ID: collection location e.g. WQ MMB 00x
Analysis: Nitrate Date ____/____/____
Time _____

* You can leave "Sampled By" blank - the names of the samplers are filled in at the top of the Field/Chain of Custody sheet used for the day. Fill everything out at home except sample time. Fill in time in the field on the dry label before filling the bottle.

III. Total Phosphorus the larger of the two opaque rectangular or circular 250 ml bottles says preserved with Sulfuric Acid (H_2SO_4)

Client: Easton Sample ID: collection location e.g. WQ MMB 00x
Analysis: Total Date ____/____/____
Phosphorus Time _____

* You can leave "Sampled By" blank if on the Field/Chain of Custody Sheet. Fill everything out at home except sample time. Fill in time in the field on the dry label before filling the bottle.

Sam Wright Field Easton, MA Water Quality Monitoring Field and Chain of Custody Sheet

Team (Site IDs):_____
Date:_____ Volunteer
Names:_____

Sample ID #	Collection Time	Water Temp. °C	Comments (see examples below)
			Water Color: e.g. Clear, Tea, Brown, Gray, Green
			Water Odor: e.g. None, Gas/Oil, Chlorine, Rotten Eggs
			Tide: e.g. High, Low, Outgoing, Incoming

Requested Analysis: [check one]

_____Contract Lab (Microbac)
Enterococci Bacteria (EN) Nitrate - Nitrogen (NO_3 - N) Total Phosphorus (TP)

_____Alpha Analytical Lab
Enterococci Bacteria (EN) Nitrate - Nitrogen (NO_3 - N) Total Phosphorus (TP)

Chain of Custody

Relinquished by: _____ Date: _____ Time:

_____ Received by: _____

Appendix E. Baseline Measures Sam Wright Field Wetland Restoration

EPA Dashboard Measure	Monitoring Objective	Priority (H, M, L)	Measure	Type of Measure	Frequency	Responsible Entity	Status	Pre-condition Baseline	Post-Construction Condition	Additional EPA guidance
	Wetland (Primary)									
Degraded Habitat Function: Spread of non-native species	Did control measures reduce invasive species in the BVW?	H	Eliminate invasive plants	GIS mapping: # acres managed to treat invasive plants	Pre-construction, monitor throughout growing season annually thereafter	Andrea Langhauser (Easton)	Underway	0		Enter # square feet of impervious surface removed, disconnected, or retrofitted. In NOTES section: describe the type of impervious surface removed
Degraded Habitat Function: Pond, Lake and Estuary Shoreline Buffer	Did the control measures improve wetland habitat?	H	Restore degraded waterbody buffer area	GIS mapping: # acres of restored water buffer area (non-riverine)	Pre-construction, annually thereafter	Andrea Langhauser (Easton), Kate McPherson (STB)	Underway	0		Enter # agricultural acres with farmers using nutrient management practices to reduce nitrogen and phosphorus discharged to ground water or waterways.
Degraded Water Quality: Stormwater	Did the control measures improve wetland habitat?	H	# square feet of impervious surface removed, disconnected, or retrofitted	GIS mapping: # square feet of impervious surface removed, disconnected, or retrofitted. In NOTES section: describe the type of impervious surface removed	calculate impervious cover removed, once post-construction	Andrea Langhauser (Easton), Kate McPherson (STB)		Need estimate		Enter # agricultural acres with farmers using conservation practices to improve soil health and reduce erosion and sedimentation to waterways.
Degraded Water Quality: Agriculture	Did the control measures improve wetland habitat?	H	# agricultural acres using nutrient management practices (no mow buffer)	Enter # agricultural acres with farmers using nutrient management practices to reduce nitrogen and phosphorus discharged to ground water or waterways.	calculate the number of acres inside no mow areas, once -post construction, annually thereafter	Andrea Langhauser (Easton), Kate McPherson (STB)		Need estimate		Enter # acres managed to treat invasive plants. In NOTES section: provide examples of invasive to be addressed and the method(s) of treatment
	Did control measures reduce invasives in the restored wetland/flood storage area?	H	Pre/post BVW survey	Field visual Observation of invasive species in test plot using standardized field sheet	Pre-construction, monitor throughout growing season annually thereafter	Andrea Langhauser (Easton)	Underway	TBD		
	Did control measures reduce invasive species in the BVW/wetland meadow transition areas?	H	Pre/post BVW survey	Field Visual Observation of invasive species in test plot using standardized field sheet	Pre-construction, monitor throughout growing season	Andrea Langhauser (Easton)	Underway	0		
	Change in Wetland restored wetland/flood storage area	H	Pre/Post Survey	Engineering, Plans	Pre-construction, annually thereafter	Easton, Brad Holmes (ECR)	Completed	0	96,750 sq ft	
Community Sustainability: Reduce Climate Stress: Floodplain Function	Change in restored wetland/flood storage area	H	Restore Floodplain areas: Pre/post Grading, elevation survey	Engineering, Plans: # acres of floodplain restored	Pre and post construction	Easton, Brad Holmes (ECR)	Completed	0	6,291 cu yard	Enter # acres of flood plain restored to serve its function to reduce storm impacts through removal of structures or planting of native vegetation.
	Did the wetland restoration enhance wetland storage capacity?	H	Pre/Post Construction: Flood storage capacity	Continuous Level Logger, with conversion to volumetric flow	Pre and post construction surface water level,	James Houle & Elizabeth Buschert (UNH)	Underway			
Community Sustainability: Track Environmental Change: Direct Work and Track Results	Did the wetland intervention result in environmental change?	H	Monitor to track change in environmental condition	# monitoring programs	varies by measure	SNEP Network	Underway	0	21 metrics to monitor environmental changes, weight of evidence approach	Enter # monitoring programs established or underway. In NOTES section: describe the type and scope of monitoring conducted e.g., parameter(s).
Lack of Awareness: Land Use Impacts on Environment and/or Sustainability	Engage volunteers	M	# volunteers participating	Enter # volunteers participating in the project. In NOTES section: provide a short description of the type of volunteer and the type of volunteer engagement	No. Volunteers engaged in data collection	MassAudubon, TNC, Easton	TBD	TBD		Enter # volunteers participating in the project. In NOTES section: provide a short description of the type of volunteer and the type of volunteer engagement

APPENDIX B: Laboratory Standard Operating Procedures for the Sam Wright Field

STANDARD OPERATING PROCEDURE FOR

Enterococci by Membrane Filtration

EPA 1600

Revision Author: Anthony Matarese

This SOP is effective upon signed approval by the following:

Nicole Paradise
Quality Assurance Officer

Ronald Warila
General Manager / Technical Director

DISCLAIMER: This SOP has been developed for use at the Microbac Laboratories, Dayville, Connecticut facility. It is intended for use by trained analysts. As written, this SOP may not be specifically applicable to the activities of other organizations.

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Reference

USEPA. 2006. Method 1600: Enterococci in Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-ß-D-Glucoside Agar (mEI). U.S. Environmental Protection Agency, Office of Water, Washington, DC, EPA-821-R-06-009

I. Applicability

1.1 Analyte: Enterococci

1.2 Matrix: Drinking Water, Aqueous

1.3 Regulation: SDWA, CWA, NPDES

II. Summary

2.1 This method provides a direct count of bacteria in water based on the development of colonies on the surface of the membrane filter. A water sample is filtered through the membrane which retains the bacteria. Following filtration, the membrane containing the bacterial cells is placed on a selective medium, mEI agar, and incubated for 24 hours at 41°C ± 0.5°C. All colonies greater than or equal to 0.5 mm in diameter (regardless of color) with a blue halo are recorded as enterococci colonies. A fluorescent lamp with a magnifying lens is used for counting to give maximum visibility of colonies.

III. Definitions

3.1 See the Quality Glossary and Acronyms document, SOP Q-024.

IV. Interferences and Important Notes

4.1 In Method 1600, enterococci are those bacteria which produce colonies greater than or equal to 0.5 mm in diameter with a blue halo after incubation on mEI agar. The blue halo should not be included in the colony diameter measurement. Enterococci include *Enterococcus faecalis (E. faecalis)*, *E. faecium*, *E. avium*, *E. gallinarium*, and their variants. The genus *Enterococcus* includes the enterococci formerly assigned to the Group D fecal streptococci.

4.2 The enterococci portion of the fecal streptococcus group is a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters. Studies at marine and fresh-water bathing beaches indicated that swimming associated gastroenteritis is related directly to the quality of the bathing water and that enterococci are the most efficient bacterial indicator of water quality. The proposed guideline for recreational fresh waters is 33 *Entercocci/*100 mL, while for marine waters it is 35/100mL.

4.3 Aseptic technique is of utmost importance. All glassware and instruments which come in contact with the sample during the procedure must be **sterile.**

4.4 Highly turbid samples display a diminished effect in the proper identification of enterococci bacteria using the membrane filtration method.

4.5 Enterococci are commonly found in the feces of humans and other warm-blooded animals. Although some strains are ubiquitous and not related to fecal pollution, the presence of enterococci in water is an indication of fecal pollution and the possible presence of enteric pathogens.

4.6 Epidemiological studies have led to the development of criteria which can be used to promulgate recreational water standards based on established relationships between health effects and water quality. The significance of finding enterococci in recreational fresh or marine water samples is the direct relationship between the density of enterococci and the risk of gastrointestinal illness associated with swimming in the water.

V. Sample Collection, Preservation and Storage

5.1 All samples to be analyzed for enterococci bacteria must be collected in pre-sterilized containers with secure lids (min. 100 mL) and stored at <10°C until the time of analysis.

5.2 Sample analysis should begin as soon as possible after receipt; sample incubation must be started no later than 8 hours from the time of collection.

VI. Equipment, Reagents and Materials

6.1 Filtration Unit: Constructed of glass, autoclavable plastic, or stainless steel

6.2 Pipettes and graduated cylinders: Sterilized and covered with metal foil

6.3 Culture Dishes: Disposable dishes 50mm X 9mm - VWR part # 7232 or equivalent

6.4 Membrane Filters: use membrane filters that give a complete retention of bacteria - Milllapore part # HAWG047S6 or equivalent

6.5 Forceps: Smooth tipped without corrugations on inner tips

6.6 Alcohol flame lamp: for forceps sterilization

6.7 Incubators: Must provide constant temperature of 41°C ± 0.5°C

6.8 mEI agar for *Enterococci* - Thomas Scientific part # C010Q66 or equivalent

6.8.1 The agar must contain the following:

Composition, per 1 liter of purified water	
Peptone	10.0 g
Sodium chloride (NaCl)	15.0 g
Yeast extract	30.0 g
Esculin	1.0 g
Actidione (Cycloheximide)	0.05 g
Sodium azide	0.15 g
Indoxyl ß-D-glucoside	0.75 g
Agar	15.0 g

6.9 Disposable nitrile examination gloves: appropriate sizes

6.10 Safety glasses

6.11 Lab coat

6.12 Common household bleach

6.13 Autoclave: Marketforge Sterilmatic STM-E, performance tested weekly using BT Sure brand spore ampule according to manufacturer's instructions and a 3M Comply® temperature strip test.

6.14 Nalidixic acid – Alfa Aesar part # J63550 or equivalent

6.15 Sodium Hydroxide (NaOH) pellets – Fisher part # S318-3 or equivalent

6.16 2,3,5-triphenyl tetrazolium chloride – Alfa Aesar part # A10870 or equivalent

6.17 mEI Agar Preparation

6.17.1 Dissolve 14.4g of mEI agar (Section 6.8) in 200mL DI. Autoclave at 121°C (15 PSI) for 15 minutes, then cool in a water bath at 44°C to 46°C.

6.17.2 Mix 0.048g nalidixic acid in 5 mL reagent grade water, add a few drops of 0.1N NaOH to dissolve the antibiotic, and add to the mEI agar.

6.17.3 Add 0.004 g of 2,3,5-triphenyl tetrazolium chloride and mix well to dissolve.

6.17.4 Pour the agar into 9mm X 50 mm petri dishes to a depth of 4 to 5 mm and let solidify. The final pH should be 7.1 ± 0.2.

6.17.5 Store poured plates in the dark at 2 to 10°C. Discard after 2 weeks.

6.17.6 Analyze a positive control and a negative control with each batch to confirm the quality of the new lot compared to the previous prior to use. Record the results in the media logbook.

6.18 *Enterococcus faecalis* (*E. faecalis*) used for positive controls – Kwik Stik part # 0367K or equivalent

6.19 *Escherichia coli* (*E. coli*) used for negative controls – IDEXX part # 9041001 or equivalent

6.20 Potassium Phosphate (KH_2PO_4) – Fisher part # P285-500 or equivalent

6.21 Phosphate Buffer Solution

6.21.1 Dissolve 34.0 g potassium phosphate (KH_2PO_4) in 500 mL reagent water and adjust the pH to 7.2 ± 0.5 with 15N NaOH. Dilute to a final volume of 1L. Discard turbid stock solutions. Autoclave for 15 minutes before storing.

6.22 Magnesium Chloride ($MgCl_2$) – Fisher part # M33-3 or equivalent

6.23 Magnesium Chloride Solution

6.23.1 Dissolve 81.1g of magnesium chloride ($MgCl_2$) in 500 mL reagent water and adjust the pH to 7.2 ± 0.2 with 0.02N NaOH. Dilute to a final volume of 1L. Autoclave for 15 minutes before storing.

6.24 Dilution Rinse Water

6.24.1 Dilution rinse water is prepared by adding 2.5mL volume of stock phosphate buffer solution and a 10 mL volume of magnesium chloride ($MgCl_2$) solution (81.1 g $MgCl_2$• $6H_20$) in 2L of reagent water.

6.24.2 Buffer water must be autoclaved for 60 minutes at 121°C for sterilization, free of turbidity and containers are labeled and dated. The final pH must be 7 – 7.4. The pH is adjusted using sterile pipet to a few drops of pre-sterilized 1N NaOH (for pH < 7) or 1N H_2SO_4 (for pH > 7.4).

VII. Procedure

7.1 Please refer to the following chart for dilution requirements. If it is unclear about what dilution to use, please consult the department manager for direction.

Storm water	0.1, 1, 10 mL dilutions
Beach, Pond, Stream	1,10 mL dilutions

7.2 Prepare the appropriate number of sterile petri dishes containing mEI agar.

7.3 Label each dish with the appropriate designation (Sample #, Blank #, etc.).

7.4 Sterilize forceps by soaking in alcohol and flaming the tip. Using the forceps, place a sterile 0.45-micron membrane filter, grid side up, on the filter assembly base so that the membrane filter is now held between the funnel and the base. A clamp may be used, if necessary.

7.5 Place a dilution (Section 7.1) of well-mixed sample into the funnel. Add sterile water to bring final volume of 100 mL.

7.5.1 When smaller sample sizes (e.g., <20mL, diluted or undiluted) are to be filtered, add approximately 20mL of sterile dilution water to the funnel before filtration or pipet the sample volume into a sterile dilution bottle, then filter the entire dilution.

7.5.2 This increase in water volume aids in uniform dispersion of the bacterial suspension over the entire effective filtering surface.

7.6 Filter the sample by applying a partial vacuum.

7.7 Rinse the funnel with three (3) 20-30 mL portions of sterile dilution water.

7.8 Turn off the vacuum and remove the funnel from the base.

7.9 Transfer the filter with sterile forceps to the agar using a rolling motion to prevent entrapment of air to mEI agar.

7.9.1 Reseat the membrane if bubbles occur.

7.10 Run the forceps around the edge of the filter outside the area of filtration, close to the edge of the dish, to be sure that the filter is properly seated on the agar.

7.11 Cover the petri dish and incubate **inverted** culture dishes, no more than 3 stacked plates high, at 41°C ± 0.5°C for 24 ± 2 hours.

VIII. Data Analysis

8.1 After incubation, count and record colonies on those membrane filters containing, if practical, 20-60 colonies >0.5 mm in diameter with a **blue halo regardless of colony color** as an enterococci.

8.1.1 **Note:** When measuring colony size **do not** include the halo. Use magnification for counting and a small fluorescent lamp to give maximum visibility of colonies.

8.2 Report results as colonies /100 mL.

8.3 If growth occurs that covers the entire filtration area of the membrane or a portion thereof, and colonies are not discreet, report results as Confluent Growth.

8.4 If the total number of bacterial colonies exceeds 200 or if the colonies are not distinct enough for accurate counting, report results as >200.

8.5 Use the following equation to calculate the enterococci count per 100mL:

$$\textbf{Total } \textit{Enterococci} \textbf{ colonies/ 100 mL} = \frac{\textit{Enterococci} \textbf{ colonies counted}}{\textbf{mL of sample filtered}} \times 100$$

IX. Quality Control

9.1 All quality control data should be maintained and available for easy reference or inspection.

9.2 Initial Demonstration of Capability (IDC) and Analyst Colony Counting Variability

9.2.1 The IDC analyses are used to demonstrate acceptable method performance. An IDC is to be performed by each laboratory analyst performing testing before the method is used for monitoring field samples by comparing counts to those of an experienced analyst. The colony counts should be within 10% between analysts.

9.2.2 Monthly thereafter, laboratories with two or more analysts should compare each analyst's colony counts from one positive field sample.

9.2.3 Colony counts should be within 10% between analysts.

9.2.4 Laboratories with a single analyst should have that analyst perform duplicate colony counts of a single membrane filter each month. Duplicate colony counts should be within 5% for a single analyst.

9.3 Filter sterility check

9.3.1 Place at least one membrane filter per lot of filters in tryptic soy broth and incubate for 48hrs at 35°C ± 0.5°C.

9.3.2 Absence of growth indicates sterility of the filter.

9.3.3 On an ongoing basis, the laboratory should perform a filter sterility check every day that samples are analyzed.

9.4 Sterile Dilution Water Check

9.4.1 The sterility of each batch of dilution water is checked by adding 50 mL of the water to 50 mL of double strength tryptic soy broth. This is incubated at 35°C ± 0.5 °C and checked for turbidity, indicating growth, after 24 and 48 hours.

9.4.2 If any turbidity is observed at any time, the entire lot must be discarded and a new lot prepared, sterilized and checked for sterility.

9.4.3 The results of the sterility check are recorded in the laboratory notebook.

9.5 Media sterility check

9.5.1 The laboratory should test media sterility by incubating one plate from each batch of mEI agar.

9.5.2 Absence of growth indicates media sterility.

9.5.3 On an ongoing basis, the laboratory should perform a media sterility check every day that samples are analyzed.

9.6 Blanks

9.6.1 A blank consisting of sterilized reagent water is analyzed at the beginning, after every 10 samples, and end of each run of samples through a set of sterile funnels.

9.6.2 Samples associated with a positive blank result must be qualified as suspect. The previous blank(s) must be acceptable in order to qualify.

9.6.2.1 The laboratory must be able to reasonably demonstrate/show, through the use of bench sheets/logbooks indicating the order of sample

analysis, that the contamination of the blank was caused by carryover from a sample with unusually high results.

9.6.2.2 The department manager and project manager must be notified so the client can be contacted. A re-collect may be desired by the client.

9.7 Control Cultures

9.7.1 A laboratory control sample of both a known positive and known negative control is analyzed daily to confirm the overall effectiveness of the method performance. Failure of either known must be investigated and remedied prior to analysis of samples. All remedial actions must be documented and recorded with the QA Office.

9.7.2 Positive control and/or spiking organism – stock cultures of *Enterococcus faecalis* (*E. faecalis*)

9.7.3 Negative control organism – stock cultures of *Escherichia coli* (*E. coli*)

X. Safety

10.1 Every sample should be considered a biohazard when performing the analysis. Standard laboratory safety guidelines must be adhered to. Gloves, eye protection, and lab coats must be worn during sample retrieval, analysis and disposal.

XI. Pollution Prevention

11.1 Any and all remaining sample must be sealed tightly in the original container and placed into the appropriate bin for disposal.

11.2 Benches and surrounding surfaces must be cleaned with a 10% bleach solution and wiped dry with paper towels.

11.3 All effected equipment must be sterilized to insure the removal of possible hazardous biological agents.

11.4 Used disposable equipment must be collected in a sealed biohazard container.

XII. Waste management

12.1 Biohazard bags containing discarded equipment must be sterilized in an autoclave at 121°C for at least 45 minutes. All other biohazards must be handled in accordance to Microbac Laboratory's Chemical Hygiene Plan.

XIII. Method Performance

13.1 Determination of Method Precision (Established in the EPA method)

13.1.1 Perform duplicate analyses on the first 15 positive samples of each type of sample examined.

13.1.2 Calculate the average range of logs (R_{ave}) for these samples as described in Section 9020B.8b of the *Standard Mehods for the Examination of Water and Wastewater* (SM) 20th edition.

13.1.3 Perform duplicate analyses on 10% of the routine samples. If the range is greater than 3.27(R_{ave}), variability is excessive and must be resolved before further analyses can proceed.

13.2 Precision - The degree of agreement of repeated measurements of the same parameter expressed quantitatively as the standard deviation or as the 95% confidence limits of the mean computed from the results of a series of controlled determinations. The precision among laboratories for marine water and surface water was 2.2% and 18.9%, respectively.

13.3 Bias - The persistent positive or negative deviation of the results from the assumed or accepted true value. The persistent positive or negative deviation of the results from the assumed or accepted true value was not significant.

13.4 Specificity - The ability of a method to select and/or distinguish the target bacteria from other bacteria in the same water sample.

13.5 The specificity characteristic of a method is usually reported as the percent of false positive and false negative results. The specificity for this medium as reported for various environmental water samples was 6.0% false positive and 6.5% false negative.

13.6 Multilaboratory variability - A collaborative study was conducted among fourteen collaborators at twelve laboratories to examine the interlaboratory reproducibility of the method. Reproducibility among laboratories (RSD_R) for freshwater, marine water, chlorinated secondary effluent, and non-chlorinated primary effluent ranged from 2.2% for marine water to 18.9% for freshwater with a low enterococcal density.

SOP Revision History

Revision No.	Description of Changes	Effective Date	Initiated by
1.2	Added revision history table	6/24/09	LM
1.3	Clarified transport/process time requirement in Section V Changed max time prepared plates are kept to 2 weeks in Section VI Added requirement to check each batch of media with (+) and (-) controls in Section VI Added requirement for weekly autoclave performance check in Section V	11/5/09	LM
1.4	Added range of logs procedure to Section XV.	11/12/09	LM
1.5	Changed format	4/10/12	LM
2	Changed header Changed approval signatures	10/11/12	LM
3	Created cover page Added Sections 1.1-1.3, III, 5.2, 6.14-6.16, 6.18-6.24, 7.5.1, 7.5.2, 7.9.1, 7.10, 8.5, 9.1, 9.4, 9.6.2 Added purchasing information to Section VI Revised mEI agar preparation in Section 6.17 Combined previous Sections 9.4 & 9.6 into current Section 9.2 Revised BLK frequency in Section 9.6.1 Combined previous Sections 9.8 & 9.8 into current Section 9.7 Revised Sections 7.4, 7.11, 9.3.1, 9.5.1 Deleted previous Sections 1.1, 5.2-5.4, 9.2, 9.7	9/25/2020	ARM/NJP

STANDARD OPERATING PROCEDURE FOR

Phosphorus, All Forms

EPA 365.1

Revision Author: Nicole Paradise

This SOP is effective upon signed approval by the following:

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Quality Assurance Officer

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DISCLAIMER: This SOP has been developed for use at the Microbac Laboratories, Dayville, Connecticut facility. It is intended for use by trained analysts. As written, this SOP may not be specifically applicable to the activities of other organizations.

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Reference

Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Method 365.1, Revision 2.0, 1993

Standard Methods for the Examination of Water and Wastewater, 2011, Method 4500P-F

Technical Report EPA/ CE-81-1, Procedures for Handling and Chemical Analysis of Sediment and Water Samples, 1995

QuikChem® Method 10-115-01-1-A, Lachat Instruments, Milwaukee, WI, 2000.

SmartChem 170/200 Method PHO-001-A

TNI Standard, Volume 1: Management and Technical Requirements for Laboratories Performing Environmental Analysis, EL-V1-2016-Rev. 2.1

I. Applicability

1.1 Analyte: Total Phosphorus, Orthophosphate

1.2 Matrix: Drinking water, Aqueous, Solid

1.3 Regulation: NPDES, CWA, SDWA

1.4 Reporting Limit:

1.4.1 Drinking Water & Aqueous: 0.01mg/L

1.4.2 Solid: 0.02mg/L

II. Summary

2.1 Ammonium molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color is proportional to the phosphorus concentration.

2.2 Only orthophosphate forms a blue color in this test. Phosphates (and some organic phosphorus compounds) may be converted to the orthophosphate form by manual sulfuric acid hydrolysis. Organic phosphorus compounds may be converted to the orthophosphate form by manual persulfate digestion. The developed color is measured automatically.

III. Definitions

3.1 **Calibration Blank (CB)** – A volume of reagent water in the same matrix as the calibration standards, but without the analyte.

3.2 **Calibration Standard (CAL)** – A solution prepared from the primary dilution standard solution or stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.3 **Instrument Performance Check Solution (IPC)** – A solution of one or more method analytes used to evaluate the performance of the instrument system with respect to a defined set of criteria.

3.4 **Blank Spike (BS)** – An aliquot of reagent water or other blank matrices to which known quantities of the method analytes are added in the laboratory. The BS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

3.5 **Matrix Spike (MS)** – An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for background concentrations.

3.6 **Laboratory Reagent Blank (BLK)** – An aliquot of reagent water or other blank matrices that is digested exactly as a sample in including exposure to all glassware, equipment, and reagents that are used with other samples. The BLK is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents or the apparatus.

3.7 **Linear Calibration Range (LCR)** – The concentration range over which the instrument response is linear.

3.8 **Method Detection Limit (MDL)** – The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.

3.9 **Quality Control Sample (ICV)** – A solution of method analytes of known concentrations that is used to spike an aliquot of BLK or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

3.10 **Stock Standard Solution (SSS)** – A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

3.11 For additional definitions, see the Quality Glossary and Acronyms document, SOP Q-024.

IV. Interferences

4.1 Concentrations of ferric iron (Fe^{3}-) greater than 50 mg/L will cause a negative error due to precipitation of, and subsequent loss, of orthophosphate. Samples high in iron can be pretreated with sodium bisulfite to eliminate this interference. Treatment with bisulfite will also remove the interference due to arsenates.

4.2 Sample turbidity must be removed by filtration prior to analysis for orthophosphate. Samples for total or total hydrolyzable phosphorus should be filtered only after digestion. Sample color that absorbs in the photometric range used for analysis will also interfere.

4.3 Glassware contamination is a problem in low level phosphorus determinations. Glassware should be washed with 1:1 HC1 and rinsed with deionized water. Commercial detergents should rarely be needed but, if they are used, use special phosphate-free preparations for lab glassware.

V. Sample Collection, Preservation and Handling

5.1 Samples should be collected in plastic or glass containers. Volume collected should be sufficient to ensure a representative sample, allow for replicate analysis (if required), and minimize waste disposal.

5.2 Samples must be preserved with H_2SO_4 to a pH <2 and cooled to >0 - ≤6°C at the time of collection.

5.2.1 If samples are received at the laboratory non-preserved, they must be preserved within 48 hours of collection.

5.3 Samples should be analyzed as soon as possible after collection. If storage is required, preserved samples are maintained at >0 - ≤6°C and may be held for up to 28 days.

5.4 Orthophosphate is **never preserved** and may be held for up to 48 hours.

5.4.1 Samples for dissolved orthophosphate must be filtered within 15 minutes of collection.

VI. Procedure

6.1 Orthophosphate

6.1.1 Analyze unfiltered, with no digestion or hydrolysis.

6.1.2 Samples for dissolved ortho-phosphorus must be filtered through a 0.45µm filter within 15 minutes of collection.

6.1.3 Batch QC Preparation

6.1.3.1 Prepare the following QC samples for orthophosphate batches.

6.1.3.2 Blank (BLK)

6.1.3.2.1 The BLK is reagent water.

6.1.3.3 Blank Spike (BS)

6.1.3.3.1 An orthophosphate BS is prepared by adding 5mL of the 50mg/L PO_4 stock solution to a 250mL volumetric flask. Dilute to volume and mix. The orthophosphate BS is not digested.

6.1.3.4 Duplicate (DUP)

6.1.3.4.1 The DUP is a separate aliquot of one of the samples in the batch.

6.1.3.5 Matrix Spike (MS)

6.1.3.5.1 One MS must be prepared for every 10 samples in the batch. Therefore, if a full batch of 20 samples is being analyzed, 2 MS samples must be prepared with it.

6.1.3.5.2 An orthophosphate MS is prepared by adding 0.1 mL of 250mg/L stock to 25 mL of sample. This will result in a 1.0mg/L spike. The orthophosphate MS is not digested.

6.2 Total Phosphorus – Autoclave Digestion Procedure (SmartChem170)

6.2.1 Samples are digested in an autoclave for 30 minutes at 121ºC and 15-20 psi with ammonium persulfate and sulfuric acid to convert all phosphorus to orthophosphate.

6.2.2 Load metal rack with 16 x 100 mm glass test tubes. Add 8 mL of sample or standard to each tube.

6.2.3 Batch QC Preparation

6.2.3.1 Prepare the following batch QC samples and carry each through the entire digestion procedure.

6.2.3.2 Blank (BLK)

6.2.3.2.1 The BLK is 8mL of reagent water.

6.2.3.3 Blank Spike (BS)

6.2.3.3.1 The total phosphate BS is prepared by adding 200mL of the 5mg/L intermediate stock solution to 1L to create a 1.0mg/L BS. Digest 8mL of the BS with the sample batch for total phosphate.

6.2.3.4 Duplicate (DUP)

6.2.3.4.1 The DUP is a separate aliquot of one of the samples in the batch.

6.2.3.5 Matrix Spike (MS)

6.2.3.5.1 One MS must be prepared for every 10 samples in the batch. Therefore, if a full batch of 20 samples is being digested, 2 MS samples must be prepared with it.

6.2.3.5.2 Each total phosphate MS is prepared by adding 0.04 mL of 250mg/L stock to 8 mL of sample. This will result in a 1.25mg/L spike.

6.2.4 Add 0.5 mL of working acid/persulfate digestion solution to each tube. Vortex and cap loosely.

6.2.5 Fill autoclave with water to fill line as needed. Place rack on tray and place inside autoclave. Close and securely latch door. Be careful of thermometer gauge when closing the door.

6.2.6 Autoclave the digestion tubes for 30 minutes at 121 °C and 15-20 psi.

6.2.7 When finished, the Temp and Time indicator lights will turn off. Allow to cool to less than 90ºC before opening.

6.3 Total Phosphorus – Hot Plate Digestion of Aqueous Samples (Lachat Backup Procedure)

6.3.1 Add 1 mL of sulfuric acid solution to a 50 mL sample, blank, and/or standard in a 125 mL Erlenmeyer flask.

6.3.2 Add 0.4g mL of the ammonium persulfate.

6.3.3 Boil gently on a pre-heated hot plate for approximately 30-40 minutes or until a final volume of about 10 mL is reached. Do not allow sample to go to dryness. Alternately, heat for 30 minutes in an autoclave at 121°C (15-20 psi). See Section 6.2 for Total Phosphorus procedure using autoclave digestion for details.

6.3.4 Cool and dilute the sample to 50mL. If sample is not clear at this point, filter.

6.4 Persulfate Digestion for Sediment Samples

6.4.1 Weigh 0.5-1.0g dry weight equivalent of the sample and transfer to a 150-mL beaker. Add approximately 5 boiling stones.

6.4.2 Batch QC Preparation

6.4.2.1 Prepare the following batch QC samples and carry each through the entire digestion procedure.

6.4.2.2 Blank (BLK)

6.4.2.2.1 The BLK is 100mL of reagent water.

6.4.2.3 Blank Spike (BS)

6.4.2.3.1 The total phosphate BS is prepared by adding 200mL of the intermediate stock solution to 1L to create a 1.0mg/L BS. Digest 100mL of the BS with the sample batch.

6.4.2.4 Duplicate (DUP)

6.4.2.4.1 The DUP is a separate aliquot of one of the samples in the batch.

6.4.2.5 Matrix Spike (MS)

6.4.2.5.1 One MS must be prepared for every 10 samples in the batch. Therefore, if a full batch of 20 samples is being digested, 2 MS samples must be prepared with it.

6.4.2.5.2 Each total phosphate MS is prepared by adding 1mL of 250mg/L stock to the sample. This will result in a 2.5mg/L spike.

6.4.3 Add 10 mL of 11N H_2SO_4 and 2 g potassium persulfate to each beaker.

6.4.4 Mix the suspension and boil gently on a hot plate for 1 hr.

6.4.5 Let cool and add 2ml of 10N NaOH. Dilute to volume.

6.4.6 Filter with a pre-rinsed paper filter (Advantec 5B or equivalent) into a l00-mL volumetric flask.

6.5 Hydrolyzable Phosphorus

6.5.1 Add 1 mL of sulfuric acid solution to a 50 mL sample, blank, and/or standard in a 125 mL Erlenmeyer flask.

6.5.2 Boil gently on a pre-heated hot plate for approximately 30-40 minutes or until a final volume of about 10 mL is reached. Do not allow sample to go to dryness. Alternately, heat for 30 minutes in an autoclave at 121°C (15-20 psi). See Section 6.2 for Total Phosphorus procedure using autoclave digestion for details.

6.5.3 Cool and dilute the sample to 50mL. If sample is not clear at this point, filter.

VII. Analysis

7.1 Instrument Quality Control Preparation

7.1.1 Prepare the following quality control samples and carry each through the procedure detailed in Section 7.2.

7.1.1.1 The Low Calibration Verification (LCV) is prepared by adding 2.5mL of the 50mg/L stock solution to a 250mL volumetric flask and diluting to volume with reagent water. This will create a 0.5 mg/L standard.

7.1.1.2 The High Calibration Verification (HCV) is prepared by adding 7.5mL of the 50mg/L stock solution to a 250mL volumetric flask and diluting to volume with reagent water. This will create a 1.5 mg/L standard.

7.1.1.3 The Minimum Reporting Level (CRL) is prepared by adding 1.25mL of the 2mg/L PO_4 stock solution to a 250mL volumetric flask and diluting to volume with reagent water. This will create a 0.01mg/L CRL standard.

7.1.1.4 The ICV is prepared by spiking with Simple Nutrients standard to a 200mL to achieve ~1.25mg/L. Dilute to volume with DI and invert to mix.

7.2 SmartChem 170 Analysis

7.2.1 The calibration standards (0.01 mg/L, 0.02 mg/L, 0.04 mg/L, 0.125 mg/L, 0.5 mg/L, 1.0 mg/L, 2.0mg/L) are prepared automatically by dilution of the 2.0 mg/L standard (Section 10.25).

7.2.1.1 For more details see the SmartChem Operation Manual Chapter 3 for instructions how to configure the Methods Parameter File.

7.2.1.2 The correlation coefficient must be greater than 0.995.

7.2.1.3 Back calculate the concentration of at least the low and mid-level calibration points. The back-calculated and true concentrations should agree within ±10% of expected value for the mid-level calibration point, and within ±50% for the low-level.

7.2.2 The instrument has a system wash feature that will automatically clean each cuvette.

7.2.3 Fill clean reagent bottles with the appropriate reagents for this method. When filling the bottles pour the solutions slowly to minimize foaming.

7.2.4 Select the existing method or create a new method in the software with the following parameters.

7.2.5 Analyze the samples and QC in the established sequence.

7.2.6 Sample results that exceed the calibration range are automatically diluted.

7.2.7 SmartChem Start-Up Routine

7.2.7.1 Go to Sample Entry.

7.2.7.2 Double click on the desired Method to be run.

7.2.7.3 Enter # of samples.

7.2.7.4 Click on the check mark "√".

7.2.7.5 Enter Sample ID's.

7.2.7.6 Review the Run Plan Sample ID's and click Save.

7.2.7.7 Enter the Run Plan description and click Save.

7.2.7.8 Go to System Monitor.

7.2.7.9 Select and Click on the Run Plan that was created.

7.2.7.10 Verify that the selected Run Plan is correct.

7.2.7.11 Load Samples, Standards, Controls, Diluent and Empty Cups as displayed in the System Monitor.

7.2.7.12 Check the Probe Rinse, DI Water and Cleaning Solution bottles.

Note: When filling the Probe Rinse and Cuvette Wash Reservoirs, pour the solutions slowly to minimize foaming. If the probe, DI Water, and/or Cuvette Wash reservoirs require filling while a run is in progress, do not remove the cap and lift the siphon tube above the liquid surface. Insert a long stem funnel through the open port in the reservoir cap and fill the container slowly with the respective solution to minimize foaming.

7.2.7.13 Click Start in System Monitor to display user selectable options before beginning the analysis.

7.2.7.14 If a Wash Cuvettes and/or WBL is required before the start of the analysis, then click on the appropriate box. It is recommended that a Wash Cuvette and WBL be run at the start of each day.

Note: It is recommended that a new WBL be run after a Wash Cuvette operation is performed and/or after the removal and/or replacement of the same or a new cuvette into the reaction tray.

7.2.7.15 Click the Start Button to begin the analysis.

7.3 Lachat Analysis (Backup Analysis)

7.3.1 pH Adjustment of Samples

7.3.1.1 Test the pH of all samples submitted for orthophosphate analysis using the pH test strip method.

7.3.1.2 If samples have a pH >8, add 1 drop of phenolphthalein indicator to a 50 mL aliquot of sample. If a red color develops, add 11 N sulfuric acid (310 mL concentrated H_2SO_4/L) drop-wise to just discharge the color. Acidic samples (pH<4) must be neutralized with 1 N NaOH (40 g NaOH/L).

7.3.2 Prepare reagent and standards as described in Section 10.9.

7.3.3 Set up manifold as shown in Diagram 1.

7.3.4 Pump DI water through all reagent lines and check for leaks and smooth flow. Switch to reagents and allow the system to equilibrate until a stable baseline is achieved.

7.3.5 Input the sample data into the sample tray application.

7.3.6 Calibrate using the prepared standards to create a curve with a correlation coefficient of 0.995 or better.

7.3.7 Back calculate the concentration of at least the low and mid-level calibration points. The back-calculated and true concentrations should agree within ±10% of expected value for the mid-level calibration point, and within ±50% for the low-level.

7.3.8 Analyze the samples and QC in the established sequence.

7.3.9 Dilute any sample that results exceed the calibration range.

VIII. Calculations

8.1 Report only the values that are less than 90% of the highest standard in the calibration. Dilute appropriately and re-analyze samples that do not meet these criteria.

8.2 Aqueous Samples

8.2.1 Direct reading in mg/L.

8.3 Solid Samples

8.3.1 Calculate the phosphate concentration on a dry weight basis as follows:

$$\textbf{Total phosphate mg/kg (dry weight)} = \frac{(x)(y)(1000)}{(g)(\%S)}$$

where: x = phosphate concentration in sediment digest, **mg/L**
y = final volume of sediment digest, **L**
g = wet weight of sample digest, **g**
%S = percent of solids in sediment sample, **as a decimal fraction**

IX. Quality Control

9.1 All quality control data should be maintained and available for easy reference or inspection.

9.2 Method Detection Limit (MDL)

9.2.1 Method detection limits must be determined before analysis for any method can begin. Method detection limits are performed as required by a method, when a new analysis method is performed or when the laboratory management determines that a change in the instrument hardware, operating conditions or analytical procedure would cause changes in the analytical performance.

9.2.2 Refer to Corporate Document Q-029 for requirements and guidelines.

9.3 Limit of Quantitation (LOQ) Verification

9.3.1 All sample-processing and analysis steps of the analytical method shall be included in the determination of the LOQ.

9.3.2 The LOQ study is not required for any component or property for which spiking solutions or quality control samples are not available or otherwise inappropriate (e.g., pH).

9.3.3 The validity of the LOQ shall be verified through analysis of initial verification samples. An initial verification sample consists of a spiked matrix blank at or below the selected LOQ.

9.3.3.1 **This requirement is satisfied if the MDL study was spiked at or below the LOQ.**

9.3.4 The LOQ is verified if the following criteria are met:

9.3.4.1 All results are quantitative (above zero and meet the qualitative identification criteria of the method; e.g., recognizable spectra, signal to noise requirements, and presence of qualifier ions). If a result from an LOQ verification sample is not above zero and/or does not meet the qualitative identification criteria in the method, the problem shall be corrected and the verification repeated, or the LOQ verification shall be repeated at a higher concentration.

9.3.4.2 Recovery of each analyte is within the laboratory established accuracy acceptance criteria.

9.3.4.3 The LOQ is greater than the established DL and at or above the spiking concentration. If the LOQ is less than or equal to the DL, the LOQ shall be raised to greater than the DL.

9.3.5 The LOQ shall be verified quarterly for each quality system matrix, technology and analyte.

9.3.5.1 **This requirement is satisfied if the MDL study was spiked at or below the LOQ, and the quarterly MDL verification samples are at the same concentration as the initial study.**

9.4 Linear Calibration Range (LCR)

9.4.1 The LCR must be determined initially and verified daily.

9.4.2 The initial demonstration of linearity must use sufficient standards to ensure that the resulting curve is linear.

9.4.3 The verification of linearity must use a minimum of a blank and three standards. If any verification data exceeds the initial values by 10%, linearity must be reestablished. If any portion of the range is shown to be nonlinear, sufficient standards must be used to clearly define the nonlinear portion.

9.4.3.1 This is accomplished by analyzing the LCV, HCV, and IPC daily before sample analysis begins. The recovery limits are 90-110%.

9.5 Initial Calibration Verification (ICV)

9.5.1 Immediately following the calibration, verify the calibration standards and acceptable instrument performance with the preparation and analyses of an ICV.

9.5.2 If the determined concentrations are not within 10% of the stated values, performance of the determinative step of the method is unacceptable. The source of the problem must be identified and corrected before either proceeding with the initial determination of MDLs or continuing with on-going analyses.

9.6 Minimum Reporting Limit (MRL) Check (CRL)

9.6.1 Verify quantitation at the MRL daily before sample analysis begins.

9.6.2 The validity of the MRL shall be verified by successful analysis of a 0.01mg/L CRL standard. A passing analysis is one where the recovery is within 50-150% of the assigned value of the QC sample.

9.6.3 If the calibration cannot be verified within the specified limits, reanalyze the CRL solution. If the second analysis of the CRL solution confirms calibration to be outside the limits, sample analysis must be discontinued, the cause determined and/or in the case of drift, the instrument recalibrated.

9.7 Instrument Performance Check Solution (CCV and CCB)

9.7.1 For all determinations the CCV (a mid-range check standard) and a calibration blank (CCB) must be analyzed immediately following daily calibration, and after every tenth sample (or more frequently, if required) and at the end of the sample run.

9.7.2 Analysis of the CCV and calibration blank immediately following calibration must verify that the instrument is within 10% of calibration. Subsequent analyses of the CCV must verify the calibration is still within 10%.

9.7.3 If the calibration cannot be verified within the specified limits, reanalyze the CCV.

9.7.4 If the second analysis of the CCV confirms calibration to be outside the limits, sample analysis must be discontinued, the cause determined and/or in the case of drift, the instrument recalibrated.

9.7.5 All samples following the last acceptable CCV must be reanalyzed.

9.8 Laboratory Reagent Blank (BLK)

9.8.1 The laboratory must prepare and analyze at least one BLK with each batch of 20 samples or less.

9.8.2 Data produced are used to assess contamination from the laboratory environment.

9.8.3 Values that exceed the MDL indicate laboratory or reagent contamination should be suspected and corrective actions must be taken before continuing the analysis.

9.9 Blank Spike (BS)

9.9.1 At least one BS must be prepared and analyzed with each batch of 20 samples or less.

9.9.2 Calculate accuracy as percent recovery using the following equation:

$$R = \frac{BS}{S} * 100$$

where: R = percent recovery
BS = laboratory fortified blank
S = concentration of the analyte added to fortify the BS solution

9.9.3 If the recovery of any analyte falls outside the required control limits of 90-110%, that analyte is judged out of control, and the source of the problem should be identified and resolved before continuing analyses.

9.10 Matrix Spike (MS)

9.10.1 The laboratory must add a known amount of analyte to a minimum of 10% of the routine samples.

9.10.2 In each case the MS aliquot must be a duplicate of the aliquot used for sample analysis.

9.10.3 For total phosphate, the MS undergoes the digestion process.

9.10.4 Calculate the percent recovery for each analyte, corrected for concentrations measured in the unfortified sample, and compare these values to the designated MS recovery range 90-110%. Percent recovery may be calculated using the following equation:

$$R = \frac{C_s - C}{s} \times 100$$

where: R = percent recovery
C_s = fortified sample concentration
C = sample background concentration
s = concentration equivalent of analyte added to sample

9.10.5 If the recovery of any analyte falls outside the designated MS recovery range and the laboratory performance for that analyte is shown to be in control, the recovery problem encountered with the MS is judged to be either matrix or solution related, not system related.

9.11 Sample Duplicate (DUP)

9.11.1 Analyze one duplicate sample for every 20 samples or less.

9.11.2 A duplicate sample is a sample brought through the entire sample preparation and analytical process.

9.11.3 A control limit of ± 20% for RPD shall be used for sample values greater than 5 times the instrument detection limit.

9.11.4 A difference of detection limit is to be used to evaluate samples below 5 times the detection limit.

X. Equipment, Reagents and Standards

10.1 SmartChem170 Discrete Analyzer

10.2 Glass sample vials used in autoclave – C&G Scientific part # LT23-A020-A01B-ZS1 or equivalent

10.3 Autoclave

10.4 Sample Cups for Discrete Analyzer – 4mL

10.5 Various Class A Volumetric Flasks – ranging in volumes

10.6 Various Mechanical Pipettes – ranging in volumes

10.7 Various Glass Pipettes – ranging in volumes

10.8 Porous Boiling Chips – VWR Scientific part # 26397-409 or equivalent

10.9 Potassium Persulfate – Alfa Aesar part # 13145 or equivalent

10.10 Ammonium Persulfate – Fisher part # A682-500 or equivalent

10.11 10N Sodium Hydroxide (NaOH) – LabChem part # LC145004 or equivalent

10.12 Anhydrous Potassium Phosphate Monobasic (KH_2PO_4) – Fisher part # P285-500 or equivalent

10.13 Sulfuric Acid – Fisher part # A30051-212 or equivalent

10.14 Potassium Antimonyl Tartrate, Trihydrate ($K(SbO)C_4H_4O_6 \cdot ½H_2O$) – Fisher part # A867-500 or equivalent

10.15 Antimony Molybdate tetrahydrate ($(NH_4)_6Mo_7O_{24} \cdot 4H_2O$) – Acros Organics part # 42331-5000 or equivalent

10.16 Sodium Dodecyl Sulfate ($CH_3(CH_2)_{11}OSO_3Na$) – Fisher part # BP166-100 or equivalent

10.17 Ascorbic Acid ($C_6H_8O_6$) – Fisher part # A62-500 or equivalent

10.18 Probe Rinse – Unity Scientific part # 3AS-RN00-21 or equivalent

10.19 Cuvette Cleaning Solution – Unity Scientific part # 365-0366-900 or equivalent

10.20 EDTA (disodium) – Fisher part # S311-500 or equivalent

10.21 1000mg/L Organic Nutrients (TKN Total Phosphate Solution) - Absolute Standards part # 54152 or equivalent

10.22 Phenolphthalein Indicator Solution – J.T. Baker part # 287.04 or equivalent

10.23 250.0 mg/L of Phosphate as P

10.23.1 In a 1000 mL volumetric flask dissolve 1.099 g primary standard grade anhydrous potassium phosphate monobasic (KH_2PO_4) that has been dried for one hour at 105°C in approximately 400 mL water.

10.23.2 Dilute to the mark with DI water and invert to mix.

10.24 50.0 mg/L of Phosphate as P

10.24.1 In a 200 mL volumetric flask, dilute 40.0 mL Stock Standard Solution #1 to the mark with DI water.

10.24.2 Invert to mix.

10.25 2.0mg/L Working Standard Solution

10.25.1 Prepare a 2mg/L intermediate stock solution by adding 10mL of 50.0mg/L stock standard to a 250mL volumetric flask. Dilute to volume and invert to mix.

10.25.2 For the Total Phosphate analysis, add 200ul of sulfuric acid into 100ml of 2 mg/L standard.

10.26 5mg/L Intermediate Solution

10.26.1 Prepare an 5mg/L intermediate solution by adding 5mL of 1000mg/L Organic Nutrients and 2mL sulfuric acid to a 1L volumetric flask. Dilute to volume and invert to mix.

10.27 Reagent water: Distilled or de-ionized water, free of the analyte of interest, ASTM type II or equivalent.

10.28 Sulfuric acid solution, 5N

10.28.1 Slowly add 70 mL of conc. H_2SO_4 to approximately 400 mL of reagent water.

10.28.2 Cool to room temperature and dilute to 500 mL with reagent water.

10.29 11N (5.6M) Stock Acid Solution

10.29.1 Carefully add 310 mL concentrated H_2SO_4 to approximately 690mL of distilled water and dilute to 1L with distilled water.

10.30 Acid-Persulfate Digestion Solution

10.30.1 Dissolve 6.4g of ammonium persulfate and 16 mL of 5.6M stock sulfuric acid solution in a 50 mL volumetric flask. Dilute to the mark with distilled water and spin until dissolved.

10.30.2 Prepare fresh daily.

10.31 **Reagents and Standards – Smart Chem 170**

10.31.1 Potassium antimonyl tartrate solution (0.3%)

10.31.1.1 Weigh 0.6 g potassium antimonyl tartrate trihydrate $K(SbO)C_4H_4O_6 \cdot ½H_2O$; dissolve in 50 mL distilled water in a 100 mL volumetric flask, dilute to volume.

10.31.1.2 Store at >0 - ≤6°C in a dark, glass-stoppered bottle.

10.31.2 Ammonium molybdate solution (4 %)

10.31.2.1 Dissolve 8 g ammonium molybdate tetrahydrate $(NH_4)_6Mo_7O_{24} \cdot 4H_2O$ in 200 mL reagent water.

10.31.2.2 Store in an acid washed plastic bottle at >0 - ≤6°C.

10.31.3 Ascorbic acid (0.1M):

10.31.3.1 Dissolve 1.8 g ascorbic acid $C_6H_8O_6$ in 100 mL reagent water.

10.31.3.2 Add 1.0 mL 15 % SDS (Section 10.31.5 and swirl gently to mix minimizing foaming.

10.31.3.3 Prepare this solution fresh daily.

10.31.3.4 ***Do not refrigerate the ascorbic acid solution containing SDS***.

10.31.4 Color Reagent

10.31.4.1 Mix the above reagents in the following proportions for 100 mL of the mixed reagent:

a. 37 mL 5N H2SO4 (Section 10.28)

b. 5 mL antimony potassium tartrate solution (Section10.31.1)

c. 15 mL ammonium molybdate solution (Section 10.31.2)

d. 5 mL 15% w/w Sodium dodecyl sulfate (Section 1031.5)

e. 38 mL reagent water

10.31.4.2 Mix after addition of each reagent.

10.31.4.3 Store in an acid washed plastic bottle at room temperature.

10.31.4.4 ***Do not refrigerate the mixed color reagent solution containing SDS***.

10.31.4.5 It is recommended that this solution be prepared fresh weekly.

10.31.5 Sodium dodecyl sulfate (SDS) 15% w/w: Use only purest grade. Phosphate concentration in the SDS reagent should be ≤0.0001%.

10.31.5.1 Dissolve 15 g SDS $CH_3(CH_2)_{11}OSO_3Na$ in 85 mL reagent water.

10.31.5.2 May require gentle stirring and heat to fully dissolve.

10.31.6 Cuvette cleaning solution

10.31.6.1 Add 30 mL of Cuvette Cleaning Solution to approximately 700 mL of reagent water and dilute to 2 L with reagent water. Invert five times to mix.

10.31.6.2 Store the solution at room temperature.

10.31.7 Probe rinse solution

10.31.7.1 Add 1.0 mL of Probe Rinse Solution 2L of reagent water. Invert five times to mix.

10.31.7.2 Store the solution at room temperature.

10.31.8 The Reagent #1 Diluent is reagent water or the appropriate sample matrix blank. To 98 mL of reagent water or the appropriate sample matrix blank in a clean plastic bottle, add 2.0 mL of 15 % w/w SDS. Cap the bottle and invert five times to mix. Pour the solution slowly when filling a clean reagent bottle to minimize foaming**.**

10.32 **Preparation of Lachat Reagents and Standards**

10.32.1 Use deionized water for all solutions.

10.32.2 Degassing with helium

10.32.2.1 To prevent bubble formation, degas the carrier solution with helium. Use He at 5-20 psi through a disposable narrow tip pipette. Bubble He vigorously through the solution for one minute. Dispose of the pipette after each use.

10.32.3 Stock Ammonium Molybdate Solution

10.32.3.1 In a 1 L volumetric flask dissolve 40.0 g ammonium molybdate tetrahydrate [$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$] in approximately 800 mL DI water.

10.32.3.2 Dilute to the mark and stir for four hours.

10.32.3.3 Store in plastic and refrigerate.

10.32.3.4 May be stored up to two months when kept refrigerated.

10.32.4 Stock Antimony Potassium Tartrate Solution

10.32.4.1 In a 1L volumetric flask, dissolve 3.22 g antimony potassium tartrate (potassium antimony tartrate trihydrate $K_2(C_4H_2O_6Sb)_2 \cdot 3H_2O$) in approximately 80 mL of DI water.

10.32.4.2 Dilute to the mark and invert three times.

10.32.4.3 Store in a dark bottle and refrigerate.

10.32.4.4 May be stored up to two months when kept refrigerated.

10.32.5 Molybdate Color Reagent

10.32.5.1 To a 1 L volumetric flask add about 500 mL DI water.

10.32.5.2 Add 35.0 mL concentrated sulfuric acid and swirl to mix.

(**CAUTION**: The reaction is exothermic; it will get warm!)

10.32.5.3 When it can be comfortably handled, add 72.0 mL Stock Antimony Potassium Tartrate Solution (Reagent 2) and 213 mL Stock Ammonium Molybdate Solution (Reagent 1).

10.32.5.4 Dilute to the mark and invert three times.

10.32.5.5 Degas with helium.

10.32.5.6 Prepare fresh weekly.

10.32.6 Ascorbic Acid Reducing Solution, 0.33 M

10.32.6.1 In a 1 L volumetric flask dissolve 60.0 g granular ascorbic acid in about 700 mL of DI water.

10.32.6.2 Dilute to the mark and invert to mix.

10.32.6.3 Degas the solution before proceeding or it will get extremely soapy.

10.32.6.4 Add 1.0 g dodecyl sulfate ($CH_3(CH_2)_{11}OSO_3Na$).

10.32.6.5 Prepare fresh weekly.

10.32.6.6 Discard if the solution becomes yellow.

10.32.7 Sodium Hydroxide - EDTA Rinse

10.32.7.1 Dissolve 65 g sodium hydroxide (NaOH) and 6 g tetrasodium ethylenediamine tetraacetic acid (Na_4EDTA) in 1.0 L DI water.

10.32.8 **Lachat Calibration**

10.32.8.1 Prepare fresh daily using deionized H_2O as shown below:

Standard	A	B	C	D	E	F	G	Blank
Conc., mg/L	2	1	0.5	0.2	0.05	0.02	0.01	--

Volume 50mg/L Phosphate Standard, mL	10	5	2.5	1.0	0.25	0.1	--	--
Volume 2mg/L Phosphate Standard, mL	--	--	--	--	--	--	1.25	--
Final Vol., mL	250							

XI. Safety

11.1 Every sample should be considered hazardous when performing the analysis. Standard laboratory safety guidelines must be adhered to. Gloves, eye protection, and lab coats must be worn during sample retrieval, analysis and disposal.

11.2 Refer to SDS on file at http://microbac.online-msds.com/index.php .

XII. Pollution Prevention

12.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in the laboratory. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice.

12.2 Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation by the following means:

12.2.1 Ensure that the quantity of the chemicals purchased is based on expected usage during its shelf life and the disposal cost of unused material.

12.2.2 Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

12.2.3 Control the usage by closely monitoring the instrument operation to avoid pumping reagents through after sample run has completed.

XIII. Waste Management

13.1 All waste is handled in accordance with Microbac's Chemical Hygiene Plan, which is mandatory reading for all employees and is readily available for any interested parties.

XIV. Method Performance

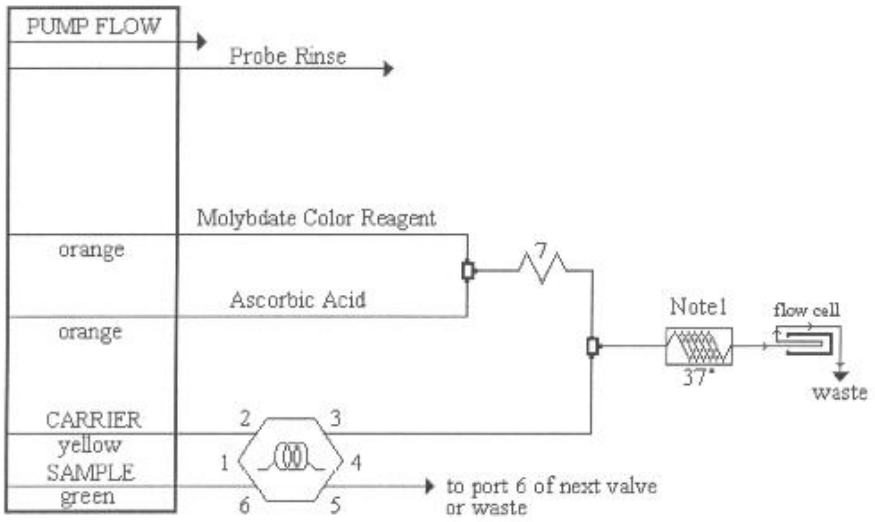
14.1 Initial Demonstration of Capability

14.1.1 Before new analysts run any samples, verify their capability with the method. Run a laboratory fortified blank four times and compare to the limits listed in Section 9.9.3.

14.2 Continuing Demonstration of Capability

14.2.1 On an annual basis, each analyst must verify their continuing capability. This may be done by passing a proficiency test or by running a laboratory fortified blank four times and comparing to the limits listed in Section 9.9.3.

Diagram 1: Phosphate Manifold Setup



Carrier: DI water
Manifold Tubing: 0.8 mm (0.032 in) i.d. This is 5.2 µL/cm.
AE Sample Loop: 70 cm x 0.8 mm i.d.
QC8000 Sample Loop: 75.5 cm x 0.8 mm i.d.
Interference Filter: 880 nm

Apparatus: An injection valve, a 10 mm path length flow cell , and a colorimetric detector module is required. The  shows 175 cm of tubing wrapped around the heater block at 37°C.

7: 135 cm of tubing on a 7 cm coil support

Note 1: 175 cm of tubing on the heater.

Appendix I

Smart Chem method setup.

Note: The method as described here is equivalent to the EPA protocol 365.1. Modifications to this test method may void equivalency. If modifications are made, then the user must perform the required testing to document the method performance in accordance with EPA/NELAC requirements.

Method Code: WP1W **Range: 0.01 – 1.00 mg P/L**	**Vol., µL**	**Delay Time, sec.**	**Read Time, sec.**	**Rinse, µL**	**Code**
Sample Volume	290				
Reagent 1: Reagent Dilution (See Section XX Note 1)	9	36	0	0	DIL1
Reagent 2: Color Reagent (See Section XX and XX	65	0	0	0	MOL1
Reagent 3: Ascorbic Acid	28	0	342	0	ASC1

Note (1): If the method is modified, then the combined Sample + Reagent 1 + Rinse volume must be ≤ 390µL. If the method is modified, and sample blanking is used, then the combined volume of sample + Reagent 1 volume must be ≥ 290 µL and ≤ 390 µL.

Note (2): The maximum total reaction volume is 670 µL. The recommended maximum total reaction volume is 500 µL.

Note (3): The minimum sample and reagent volume is 3 µL. The recommended minimum sample and reagent volume is 5 µL.

Note (4): If the method is modified and the combined Sample + Reagent 1 volume is ≤ 290 µL , then the Sample Blanking option should not be used after Reagent 1. If Sample blanking is desired, create a new method file using the following parameters (Section xxx) and select the Sample Blanking Option after the addition of Reagent 1.

- Extending the Range of the Method: The range of the method can be extended by dilution using Reagent 1 as the diluent as shown below.
  - In the extended range method **the total volume of Sample plus Reagent 1 must equal 299 µL and** the diluent matrix (Reagent 1) in the extended range must match (be the same) as that of the sample matrix.
  - For example the Reagent 1 diluent, (290-X) shown in the parameter file below, for orthophosphate determinations of unpreserved samples would be reagent water, and for acid preserved samples the diluent

would be reagent water containing the same strength H_2SO_4 (2 mL conc. H_2SO_4 per liter) used to preserve the samples.

- To prepare the Reagent 1 diluent, combine 9 mL of Reagent1 with (290 - X) mL of the appropriate diluent as stated above.
- The dilution equation $C_1V_1 = C_2V_2$ is used to calculate the new sample and Reagent 1 (diluent) volumes.
- The value of C_1 is 1.00 mg/L P and the V_1 volume is 299 µL; C_2 is the target high calibrant standard for the extended range method; and V_2 is the new sample volume "**X**" shown below in the "Extended Range Parameter File With or Without Sample Blanking" after the addition of Reagent 1.

Extended Range with or without Sample Blanking after Reagent 1					
Method Code: User Assigned **Range: 0.01 – X.XX mg P/L**	**Vol., µL**	**Delay Time, sec.**	**Read Time, sec.**	**Rinse, µL**	**Code**
Sample Volume	X				
Reagent 1: Reagent Dilution (See Section XX Note 1)	9 + (290-X)	36	0	0	DILX
Reagent 2: Color Reagent (See Section XX and XX	65	0	0	0	MOL1
Reagent 3: Ascorbic Acid	28	0	342	0	ASC1

SOP Revision History

Revision No.	Description of Changes	Effective Date	Initiated by
2.3	Added revision history table	6/8/09	LM
2.4	Clarified addition of H2SO4 in Section 5.1.1 Clarified filtration requirement in Section 5.1.5 Added requirement to prepare LFB, LRB, and LFM/LFMD for sediments in Section 5.2.1.5 Changed standards preparation instructions for smaller amounts in Section 7.2	2/25/11	BS, LM
3	Added Section 5.3 for autoclave digestion procedure Added Section 7.3 for SmartChem 170 analysis Added Section 8.2 for SmartChem 170 analysis	1/14/14	GP LM
4	Created cover page Updated entire document to reflect Element nomenclature Updated references Reformatted Section I Added Section II, 3.11, 4.2, 5.2.1, 5.4.1, 6.1.2, 6.4.5, 7.2.6, 7.2.7, 7.3.7, 7.3.9, 10.1-10.22, 10.31.8, 10.32.6.3, XI, XIV Updated Sections 5.1, 6.2.6, 6.2.7, 6.4.3, 9.1, 9.9.3.9, 10.5, 10.32.4.1 Added Batch QC Preparation – Sections 6.1.3, 6.2.3, 6.4.2 Combined previous Sections 5.1 and 8.2.4 into current Section 6.3 Added instrument QC preparation – Section 7.1 Added calibration preparation instructions – Section 7.2.1 Added calibration acceptance criteria – Section 7.2.1.2 Added requirement to back calculate calibration points – Section 7.2.1.3 Revised MDL Section 9.2	12/21/2020	NJP/KL

Revision No.	Description of Changes	Effective Date	Initiated by
	Added LOQ requirement – Section 9.3 Changed LCR frequency to daily in Section 9.4.1 and added acceptance criteria in Section 9.4.3.1 Added Section 9.6 – MRL Check Added Section 9.11 – Duplicate Added all purchasing information to Section X Updated the 250mg/L standard preparation in Section 10.23.1 Added Section 10.25 – 2mg/L Standard Preparation Added Section 10.26 – 5mg/L Standard Preparation Added requirement to spin acid-persulfate digestion solution until dissolved to Section 10.30.1 Updated standard storage temperature in Sections 10.31.1.2 and 10.31.2.2 Updated color reagent preparation in Section 10.31.4 Updated cuvette cleaning solution preparation in Section 10.31.6 Updated probe rinse solution preparation in Section 10.31.7 Revised Lachat calibration table in Section 10.32.8 Deleted notes from Previous Sections 8.2.9 and 7.3.6.5 Deleted previous Sections 7.3.6 – 7.3.10, 7.3.14, 8.1.5, 8.2.1 – 8.2.3, 8.2.6 – 8.2.8, 8.2.11.3, 8.2.11.5, 9.2.1, 9.4.2.1, 9.4.5, 9.6.3, 9.6.7, 9.6.9,		
5	Updated reference methods	7/13/2021	NJP

Revision No.	Description of Changes	Effective Date	Initiated by

STANDARD OPERATING PROCEDURE FOR

Determination of Nitrate and Nitrite

SM 4500NO_3-F

Revision Author: Kasia Laliberte

This SOP is effective upon signed approval by the following:

Kasia Laliberte
Quality Assurance Officer

Ronald Warila
General Manager / Technical Director

DISCLAIMER: This SOP has been developed for use at the Microbac Laboratories, Dayville, Connecticut facility. It is intended for use by trained analysts. As written, this SOP may not be specifically applicable to the activities of other organizations.

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Reference

Standard Methods for the Examination of Water and Wastewater, SM4500 NO_3 F, 21st ED, 2000

Standard Methods for the Examination of Water and Wastewater, SM4500 NO_3 F, 2011

Determination of Nitrate and Nitrite by Flow Injection Analysis, Method 10-107-04-1-A, Lachat Instruments, Inc

TNI Standard, Volume 1: Management and Technical Requirements for Laboratories Performing Environmental Analysis, EL-V1-2016-Rev. 2.1

I. Applicability

1.1 Analyte: NO_2, NO_3, Nitrate-Nitrite Combined

1.2 Matrix: Drinking Water, wastewater, soil

1.3 Regulation: NPDES, SDWA, CWA

1.4 Reporting Limit:

1.4.1 Drinking Water & Wastewater: 0.01mg/L NO_2, 0.05mg/L NO_3

1.4.2 Soil: 0.1mg/kg NO_2, 0.5mg/kg NO_3

II. Summary

2.1 Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water-soluble dye has a magenta color that is read at 520 nm. Nitrite alone also can be determined by removing the cadmium column.

III. Definitions

3.1 **Calibration Blank (CB)** – A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analytes.

3.2 **Calibration Standard (CAL)** – A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.3 **Sample Duplicates (DUP)** – A duplicate sample is a second sample aliquot brought through the entire sample preparation and analytical process.

3.4 **Instrument Performance Check Solution (IPC)** – A solution of one or more method analytes, surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

3.5 **Blank Spike (BS)** – An aliquot of reagent water or other blank matrices to which known quantities of the method analytes are added in the laboratory. The BS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

3.6 **Matrix Spike (MS)** – An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for background concentrations.

3.7 **Laboratory Reagent Blank (BLK)** – An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The BLK is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

3.8 **Linear Calibration Range (LCR)** – The concentration range over which the instrument response is linear (correlation coefficient >0.995).

3.9 **Material Safety Data Sheet (MSDS)** – Written information provided by vendors concerning a chemical's toxicity, health hazards, physical properties, fire, and reactivity data including storage, spill, and handling precautions.

3.10 **Method Detection Limit (MDL)** – The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.

3.11 **Performance Evaluation Sample (PE)** – A solution of method analytes distributed by the Quality Assurance Research Division (QARD), Environmental Monitoring Systems Laboratory (EMSL-Cincinnati), U. S. Environmental Protection Agency, Cincinnati, Ohio, to multiple laboratories for analysis. A volume of the solution is added to a known volume of reagent water and analyzed with procedures used for samples. Results of analyses are used by QARD to determine statistically the accuracy and precision that can be expected when a method is performed by a competent analyst. Analyte true values are unknown to the analyst.

3.12 **Quality Control Sample (ICV)** – A solution of method analytes of known concentrations that is used to fortify an aliquot of BLK or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

3.13 **Stock Standard Solution (SSS)** – A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

3.14 See the Quality Glossary and Acronyms document, SOP Q-024.

IV. Interferences

4.1 Residual chlorine can interfere by oxidizing the cadmium column.

4.2 Low results would be obtained for samples that contain high concentrations of iron, copper, or other metals. In this method, EDTA is added to the buffer to reduce this interference.

4.3 Samples that contain large concentrations of oil and grease will coat the surface of the cadmium. This interference is eliminated by either filtering or pre-extracting the sample with an organic solvent.

4.4 Sample turbidity may interfere. Turbidity can be removed by filtration through a 0.45-µl membrane filter prior to analysis.

4.5 Sample color that absorbs in the photometric range used for analysis also will interfere.

V. Sample Collection, Preservation and Storage

5.1 Samples should be collected in plastic or glass bottles. All bottles must be thoroughly cleaned and rinsed with reagent water. Volume collected should be sufficient to insure a representative sample.

5.2 Samples for nitrate-nitrite (combined) may be preserved with H_2SO_4 to a pH<2 and cooled to >0 - ≤6°C at the time of collection. Preservation should be avoided in order to minimize premature breakdown of the cadmium column.

5.3 Samples should be analyzed as soon as possible after collection. If storage is required, preserved samples are maintained at >0 - ≤6°C and may be held for up to 28 days.

5.4 Samples to be analyzed for nitrate or nitrite only must not be preserved. They should be cooled to >0 - 6≤°C and analyzed within 48 hours.

5.5 All samples analyzed must be free of suspended matter that will clog the reduction column and restrict sample flow. The samples must be pre-filtered if any suspended matter is present.

VI. Sample Analysis

6.1 Calibration

6.1.1 Prepare a calibration curve by transferring the appropriate aliquot of 100mg/L stock nitrate standard or 100mg/L nitrite standard to a volumetric flask. Dilute to volume with DI and invert to mix.

6.1.2 The following tables show how the NO_2 and NO_3 calibration standards are prepared.

NO_2 Standards			
Volume 100mg/L NO_2 Stock, mL	**Volume 2mg/L NO_2 Stock, mL**	**Final Volume, mL**	**Final Concentration, mg/L**
5	-	250	2.0
5	-	500	1.0
1.25	-	250	0.5
0.25	-	250	0.1
-	1.25	250	0.01
DI H_2O		250	0

NO_3 Standards		
Volume 100mg/L NO_3 Stock, mL	**Final Volume, mL**	**Final Concentration, mg/L**
50	500	10.0
50	1000	5.0
10	500	2.0
2.5	500	0.5
0.5	500	0.1
0.25	500	0.05
DI H_2O	500	0.0

6.1.3 The correlation coefficient must be greater than 0.995. Back calculate the concentration of each calibration point. The back-calculated and true concentrations should agree within ±10% of expected value. Wider acceptance criteria are allowed for lower standards (calibration point at the MRL, which can be ±50%).

6.1.4 The efficiency of the cadmium column must be verified daily, before sample analysis begins. This can be calculated using the following equation:

$$\text{Efficiency of cadmium column (\%)} = \frac{\text{area 2mg/L } NO_3}{\text{area 2mg/L } NO_2} * 100$$

6.1.4.1 The efficiency must be greater than 75% and recorded with sample analysis and in the Element sequence. If the efficiency cannot be verified, recalibrate the instrument.

6.2 Analysis

6.2.1 Set up manifold as shown in Figure 1.

6.2.2 Input data system parameters.

6.2.3 Pump DI water through all reagent lines and check for leaks and smooth flow. Switch to reagents and allow the system to equilibrate until a stable baseline is achieved.

6.2.4 Soil Extraction

6.2.4.1 Add 10g of sample and 100mL of reagent water to a beaker and agitate for 30 minutes.

6.2.4.2 Filter the suspension using a medium grade filter paper.

6.2.4 Check the pH of all samples. If needed, adjust sample pH to between 5 and 9 before analysis with either concentrated HCl or 15N NaOH for preserved samples.

6.2.4.1 On the Element bench sheet, record that sample was pH checked and/or pH adjusted.

6.2.5 Place calibration standards in the autosampler. Input the information required by the data system.

6.2.6 Calibrate the instrument by injecting the standards. The data system will then associate the concentrations with the peak area for each standard to determine the calibration curve.

6.2.6.1 Trouble-shooting Guide is in the System Operation Manual along with instructions for repacking a cadmium column.

VII. Data Analysis and Calculations

7.1 Calibration is done by injecting standards. The data system will then prepare a calibration curve by plotting peak area versus standard concentration. Sample concentration is calculated from the regression equation.

7.2 Report only those values that fall between the lowest and the highest calibration standards. Samples greater than 90% of the highest standard must be diluted and re-analyzed.

7.3 Report sample results for nitrate/nitrite in ug N/L as NO_3 or NO_2 to three significant figures for samples above the reporting limit. Enter results below the reporting limit as zero in the Element LIMS system.

7.4 Report soils in mg/kg.

VIII. Quality Control

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Method Detection Limit (MDL)

8.2.1 A method detection limit (MDL) study must be completed before samples can be analyzed. Method detection limits are performed as required by a method, when a new analysis method is performed or when the laboratory management determines that a change in the instrument hardware, operating conditions or analytical procedure would cause changes in the analytical performance.

8.2.2 Refer to Corporate Document Q-029 for additional requirements and guidelines.

8.3 Minimum Reporting Level (MRL) Check

8.3.1 Verify quantitation at the MRL daily before sample analysis begins.

8.3.2 The validity of the MRL shall be verified by successful analysis of a QC sample containing the analytes of concern in each quality system matrix at 1 to 2 times the claimed MRL. A passing analysis is one where the recovery of each analyte is within 50-150% of the assigned value of the QC sample.

8.3.3 If the calibration cannot be verified within the specified limits, reanalyze the MRL check solution. If the second analysis of the MRL check solution confirms calibration to be outside the limits, sample analysis must be discontinued, the cause determined and/or in the case of drift, the instrument recalibrated.

8.3.4 The NO_2 MRL check is prepared by adding 1.25mL of the 2mg/L nitrite standard to a 250mL volumetric flask. Dilute to the mark with DI and invert to mix. This will create a 0.01mg/L Nitrite (NO_2) as N standard.

8.3.5 The NO_3 MRL check is prepared by adding 0.25mL of the 100mg/L nitrate standard to a 500mL volumetric flask. Dilute to the mark with DI and invert to mix. This will create a 0.05mg/L Nitrate (NO_3) as N standard.

8.4 Quality Control Sample (ICV)

8.4.1 Verify the accuracy of the calibration curve by analyzing a mid-level second source standard. The ICV must be made from an outside second source different from that of the calibration standards' stock solutions.

8.4.2 The ICV is used to verify the calibration standards or stock solutions. The ICV recovery must be ±10% of the true value.

8.4.3 If the calibration cannot be verified within the specified limits, reanalyze the ICV solution. If the second analysis of the ICV solution confirms calibration to be outside the limits, sample analysis must be discontinued, the cause determined and/or in the case of drift, the instrument recalibrated.

8.4.4 The NO_2 ICV is prepared by adding 0.5mL of the 1000mg/L second source nitrite standard to a 500mL volumetric flask. Dilute to the mark with DI and invert to mix. This will create a 1mg/L Nitrite (NO_2) as N ICV standard.

8.4.5 The NO_3 ICV is prepared by adding 10mL of the 100mg/L second source nitrate standard to a 200mL volumetric flask. Dilute to the mark with DI and invert to mix. This will create a 5mg/L Nitrate (NO_3) as N ICV standard.

8.5 Laboratory Reagent Blank (BLK)

8.5.1 The laboratory must analyze at least one BLK with each batch of 20 samples or less.

8.5.2 Data produced are used to assess contamination from the laboratory environment. The result for the reagent blank must be less than the quantitation limit. If recoveries are greater than the reporting limit, and sample concentrations are either less than the reporting limit or greater than ten times the contamination level in the BLK, the sample results may be accepted. All other samples must be re-prepared and re-analyzed.

8.5.3 If any samples in the batch are filtered, an aliquot of the BLK must be filtered as well.

8.6 Blank Spike (BS)

8.6.1 A BS must be prepared and analyzed with each batch of 20 samples or less. If the recovery falls outside the required control limits of 90-110%, that analyte is judged out of control, and the source of the problem should be identified and resolved before continuing analyses.

8.6.2 Calculate accuracy as percent recovery using the following equation:

$$\mathbf{R = \frac{BS}{s} \times 100}$$

where: R = percent recovery
BS = blank spike
s = concentration of the analyte added to fortify the BLK solution

8.6.3 The NO_2 BS is prepared by adding 5.0mL of the 100mg/L nitrite standard to a 500mL volumetric flask. Dilute to the mark with DI and invert to mix. This will create a 1.0mg/L Nitrite (NO_2) as N standard.

8.6.4 The NO_3 BS is prepared by adding 50mL of the 100mg/L nitrate standard to a 1L volumetric flask. Dilute to the mark with DI and invert to mix. This will create a 5.0mg/L Nitrate (NO_3) as N standard.

8.6.5 If any samples in the batch are filtered, an aliquot of the BS must be filtered as well.

8.7 Duplicates (DUP)

8.7.1 Analyze one duplicate sample for every 20 or less samples. A duplicate sample is a sample brought through the entire sample preparation and analytical process.

8.7.2 The control limit for relative percent difference is 20% for sample values greater than 5 times the instrument detection limit. A difference of detection limit is to be used to evaluate samples below 5 times the detection limit.

8.8 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

8.8.1 Prepare and analyze a matrix spike and matrix spike duplicate for every batch of 20 or less samples. The MS and MSD aliquots must be a duplicate of the aliquot used for sample analysis. The added analyte concentration should be the same as that used in the laboratory fortified blank.

8.8.2 The matrix spike and matrix spike duplicate are prepared by adding 1.25mL of the 100mg/L NO_3 stock and 0.25mL of the 100mg/L NO_2 stock to two separate 25mL aliquots of sample.

8.8.2.1 The MS and MSD **must** be prepared from two separate aliquots of the same sample.

8.8.3 The matrix spike recovery should be within ±25% of the true value. If the concentration of fortification is less than 25% of the background concentration of the matrix, the matrix recovery should not be calculated.

8.8.3.1 The RPD between the MS and MSD must be <20%.

8.8.4 Percent recovery may be calculated using the following equation:

$$\mathbf{R = \frac{C_s - C}{S} \times 100}$$

where: R = percent recovery
C_s = fortified sample concentration
C = sample background concentration
s = concentration equivalent of analyte added to sample

8.8.5 If the recovery of any analyte falls outside the designated MS recovery range and the laboratory performance for that analyte is shown to be in control (Section 8.6), the recovery problem encountered with the MS is judged to be either matrix or solution related, not system related.

8.9 Continuing Calibration Verification (CCV)

8.9.1 Verify calibration by periodically analyzing a CCV standard after each batch of ten samples and at the end of the run.

8.9.2 The CCV recovery must be ±10% of the true value.

8.9.3 If the calibration cannot be verified within the specified limits, reanalyze the CCV solution. If the second analysis of the CCV solution confirms calibration to be outside the limits, sample analysis must be discontinued, the cause determined and/or in the case of drift, the instrument recalibrated. All samples following the

last acceptable CCV solution must be reanalyzed. The analysis data of the calibration blank and CCV solution must be kept on file with the sample analyses data.

8.10 Continuing Calibration Blank (CCB)

8.10.1 Analyze a CCB every 10 samples and at the end of each analytical sequence.

8.10.2 The result for the reagent blank must be less than the quantitation limit.

8.10.3 If results for the reagent blank are greater than the quantitation limit, but the sample results are either greater than ten times the contamination level or lower than the quantitation limit, sample results may be accepted.

8.11 Limit of Quantitation (LOQ) Verification

8.11.1 The Limit of Quantitation (LOQ) shall be verified quarterly for each quality system matrix, technology and analyte. However, the LOQ verification is not required if the LOD was determined or verified on that instrument or if the MDL study was spiked at or below the LOQ, and the quarterly MDL verification samples are at the same concentration as the initial study.

8.11.2 The validity of the LOQ shall be verified by successful analysis of a QC sample containing the analytes of concern in each quality system matrix at or below the lowest corresponding calibration standard concentration. A passing analysis is one where the recovery of each analyte is within 50-150% of the assigned value of the QC sample.

8.11.2.1 This requirement is satisfied if the MDL study was spiked at or below the LOQ.

8.11.3 When an LOD is determined or verified by the laboratory, the LOQ shall be above the LOD.

IX. Equipment, Reagents and Standards

9.1 Balance – analytical, capable of accurately weighing to the nearest 0.0001 g

9.2 Glassware – Class A volumetric flasks and pipettes or plastic containers as required. Samples may be stored in plastic or glass.

9.3 Flow injection analysis equipment designed to deliver and react sample and reagents in the required order and ratios.

9.3.1 Lachat 8500

9.3.1.1 Autosampler

9.3.1.2 Colorimetric detector

9.3.1.3 Data system

9.3.1.4 10 nm band pass, 80 µL, glass flow cell

9.3.1.5 520 nm interference filter

9.4 Special Apparatus

9.4.1 Cadmium, (Copper Sulfate activated) Reduction Column (Lachat part #50237)

9.5 Degassing with helium

9.5.1 To prevent bubble formation, degas all solutions, except the standards, with helium. Use He at 140 kPa (20 lb/in2) through a helium degassing tube (Lachat part #50100). Bubble He through one liter of solution for one minute.

9.6 Sodium Hydroxide pellets - Fisher part # S318-3 or equivalent; CAS #1310-73-2

9.7 Ammonium Chloride – Fisher part # A649-3 or equivalent; CAS#12125-09

9.8 Disodium Ethylenediamine Tetra-acetic Acid Dihydrate ($Na_2EDTA{\cdot}2H_2O$) – Fisher part # S311-500 or equivalent; CAS#6381-92-6

9.9 85% Phosphoric Acid – Fisher part # A242-212 or equivalent; CAS#7664-38-4

9.10 Sulfanilamide - Alfa Aesar part # A13001 or equivalent; CAS#63-74-1

9.11 N-(1-naphthyl) ethylenediamine dihydrochloride (NED) - Alfa Aesar part # J63214 or equivalent; CAS#1465-25-4

9.12 Potassium Nitrate (KNO_3) - JT Baker part # 3190-01 or equivalent; CAS#7757-79-1

9.13 Potassium Nitrite (KNO_2) - Alfa Aesar part # 14245 or equivalent; CAS#7758-09-0

9.14 100% Chloroform - Fisher part # C297-4 or equivalent; CAS#67-66-3

9.15 Reagent 1, 15N Sodium Hydroxide

9.15.1 By Volume: Add 150 g NaOH very slowly to 250 mL or g of water. CAUTION: The solution will get very hot! Swirl until dissolved. Cool and store in a plastic bottle.

9.15.2 This solution is stable for up to 4 months.

9.16 Reagent 2, Ammonium Chloride buffer, pH 8.5

9.16.1 By Volume: In a 2L volumetric flask, dissolve 170.0 g ammonium chloride (NH_4Cl) and 2.0 g disodium ethylenediamine tetra-acetic acid dihydrate ($Na_2EDTA{\cdot}2H_2O$) in about 1600 mL water. Dilute to the mark and invert to mix. Adjust the pH to 8.5 with 15 N sodium hydroxide solution.

9.16.2 ACS grade ammonium chloride has been found occasionally to contain significant nitrate contamination. USP grade is the only grade to be used. (VWR # EM-AX1277-1, 500g bottle or equivalent)

9.16.3 The buffer is stable for up to 1 month.

9.17 Reagent 3, Sulfanilamide color reagent

9.17.1 By Volume: In a 2L volumetric flask, add approximately 1200 mL DI water. Then add 200 mL 85% phosphoric acid (H_3PO_4), 80.0 g sulfanilamide, and 2.0 g N-(1-naphthyl) ethylenediamine dihydrochloride (NED). Shake to wet, and stir

to dissolve for 30 minutes. Dilute to the mark, invert to mix, and filter through 0.45µm filter. Store in a dark bottle.

9.17.2 This solution is stable for one month.

9.18 Stock Nitrate Standard: 100 mg N/L as NO_3

9.18.1 In a 500mL volumetric flask, dissolve 0.361 g potassium nitrate (KNO_3) into approximately 300 mL water. Add 1.0 mL 100% concentrated chloroform, dilute to the mark with DI, and invert to mix.

9.18.2 This solution is stable for one month.

9.19 Stock Nitrite Standard: 100 mg N/L as NO_2

9.19.1 In a 500mL volumetric flask, dissolve 0.3039 g potassium nitrite (KNO_2) in approximately 300 mL water. Add 0.5 mL of 100% concentrated chloroform, dilute to the mark with DI, and invert to mix.

9.19.2 This solution is stable for 5 days.

9.20 1000mg/L Nitrite (NO_2) as N second source standard – Absolute part # 54104 or equivalent

9.21 100mg/L Nitrate (NO_3) as N second source standard – Ricca part # 5457-16 or equivalent

X. Safety

10.1 The toxicity or carcinogenicity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable. Cautions are included for known extremely hazardous materials.

10.2 The following chemicals have the potential to be highly toxic or hazardous. For detailed explanations, consult the MSDS.

a. Cadmium granules- **highly toxic!** Always wear protective clothing, gloves, and eyewear.
b. Ammonium hydroxide
c. Sodium hydroxide
d. Phosphoric acid
e. Sulfanilamide

10.3 Refer to SDS on file at http://microbac.online-msds.com/index.php .

XI. Pollution Prevention

11.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a

preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice.

11.2 Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

11.3 Quantity of the chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

11.4 All remaining unused sample must be returned to the >0 - ≤6°C storage, sealed tightly in the original container. Equipment, benches and surrounding surfaces must be cleaned and wiped dry with paper toweling.

XII. Waste Management

12.1 All waste is handled in accordance with Microbac Laboratory's Chemical Hygiene Plan, which is made available to all employees and interested parties.

12.2 Cadmium waste must be disposed of in strict accordance with Microbac Laboratory's Chemical Hygiene Plan requirements for hazardous solid waste. See the laboratory safety officer for detailed instructions if necessary.

XIII. Method Performance

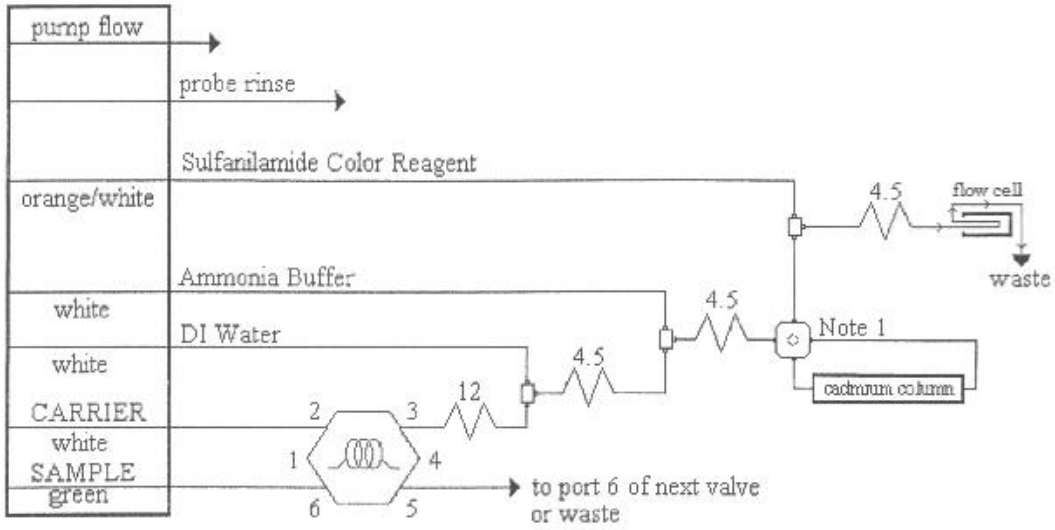
13.1 Initial Demonstration of Capability

13.1.1 Before new analysts run any samples, verify their capability with the method. Run a laboratory fortified blank four times and compare to the limits listed in Section 8.6.

13.2 Continuing Demonstration of Capability

13.2.1 On an annual basis, each analyst must verify their continuing capability. This may be done by passing a proficiency test or by running a laboratory fortified blank four times and comparing to the limits listed in Section 8.6.

Figure 1.



QC8000 Sample loop = 13 cm x 0.5 mm i.d. Interference filter = 520 nm
AE sample loop = 7.5 cm x 0.5 mm i.d.

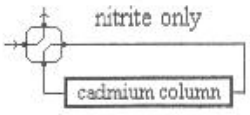
CARRIER is helium degassed DI water

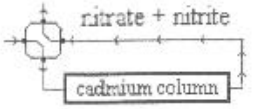
Manifold tubing is **0.5 mm (0.022 in)** i.d. This is 2.5 uL/cm.

4.5	is	**70**	cm of tubing on a 4.5 cm coil support
12	is	**255**	cm of tubing on a 12 cm coil support

APPARATUS: An injection valve, a 10 mm path length flow cell , and a colorimetric detector module is required..

Note 1: This is a two state switching valve used to place the cadmium column in-line with the manifold.





SOP Revision History

Revision No.	Description of Changes	Effective Date	Initiated by
1.2	Added revision history table	6/8/09	LM
1.3	Changed format	2/3/12	LM
2	Changed approval signatures Changed header	12/6/12	LM
3	Changed frequency of LFM in Section 9.4.1 Changed frequency of sample duplicates in Section 9.4.6 Changed "nitrate only" to "nitrate-nitrite (combined)" in Section 8.2	4/25/13	LM
4	Corrected calibration standard tables for nitrate and nitrite	2/1/16	LM
5	Reference – method edition updated, Sec. I – Analyte added, matrix updated, RL added, Sec. II – Definitions updated and sec 3.14 added. Sec. IV – filter type updated and sec 4.5 added. Sec. VI – Added: Calibration standards table, passing calibration and column efficiency requirements, sec. 6.2.4 – pH check, and sec. 6.2.6.1 Sec VII – Sec 7.3 updated. Sec. VIII – updated: MDL and MRL requirements, QC samples preparation Sec. IX – updated Stock Standard preparation, Sec. X – sec. 10.3 added , Sec. XII – sec 12.2 added, Sec. XIII - added	1/24/2020	NJP/KL
6	Updated sample storage temperature in Section 5.2-5.4, and 11.4 Added reference to Element to Sections 6.1.4.1 and 6.2.4.1 Updated significant figures in Section 7.3 Revised NO_3 ICV preparation in Section 8.4.5 Added Section 9.6-9.14 Deleted previous Note in Section 9.19.2 Added purchasing information to Sections 9.20 and 9.21	5/1/2020	NJP
7	Added Sections 1.4.2 and 7.4 Added soil extraction – Section 6.2.4	9/14/2020	NJP

8	Sec. 6.1.4 Column efficiency equation revised. TNI reference added Sec. 8.11 LOQ added	3/24/21	KL
9	Updated reference methods	7/13/2021	NJP

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CHAIN OF CUSTODY RECORD

Number _____

Instructions on back

TO BE COMPLETED BY MICROBAC

Temperature Upon Receipt (ºC)
Therm ID
Holding Time
Samples Received on Ice? Yes No N/A
Custody Seals Intact? Yes No N/A

Lab Report Address	**Invoice Address**	**Turnaround Time**
Client Name:	**Client Name:**	**[x] Routine** (5 to 7 business days) **[ ] RUSH*** (notify lab)
Address:	**Address:**	
City, State, Zip:	**City, State, Zip:**	(needed by)
Contact:	**Contact:**	**Report Type**
Telephone No.:	**Telephone No.:**	**[x] Results Only [ ] Level 1 [ ] Level 2 [ ] Level 3 [ ] Level 4 [ ] EDD**

Send Report via: [ ] Mail [ ] Fax [ ] e-mail (address) **Send Invoice via:** [ ] Mail [ ] Fax [ ] e-mail (address)

Project: *Grab* **Location:** **PO No.** **Compliance Monitoring?** [ ] Yes [ ] No ( ) Agency/Program

Sampled by (PRINT): **Sampler Signature:** **Sampler Phone No.:**

* Matrix Types: Soil/Solid (S), Sludge, Oil, Wipe, Drinking Water (DW), Groundwater (GW), Surface Water (SW), Waste Water (WW), Other (specify)

** Preservative Types: (1) HNO3, (2) H2SO4, (3) HCl, (4) NaOH, (5) Zinc Acetate, (6) Methanol, (7) Sodium Bisulfate, (8) Sodium Thiosulfate, (9) Hexane, (U) Unpreserved

REQUESTED ANALYSIS

Lab ID	Client Sample ID	Date Collected	Time Collected	No. of Containers	Matrix	Grab / Comp	Preservative Types **	Bottle Type	Bottle Size										*Additional Notes*

Possible Hazard Identification [ ] Hazardous [ ] Non-Hazardous [ ] Radioactive **Sample Disposition** [ ] Dispose as appropriate [ ] Return [ ] Archive

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