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.

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
4.2.1 Wetland Storage Capacity (pre/post wetland condition) 10
4.3.1 Invasive Plant Species (pre/post wetland condition in BVW and wetland meadow) 11
4.2 Indirect Measures 12
4.2.1 Water Quality 12
4.2.2 Wildlife and Wetland Indicator Species Monitoring 12
4.3 External resources 13

5.0 References 16

Appendix A. - Wetland Restoration Plans 17

Appendix B Wetland Storage Capacity 20

Appendix C. Wetland Condition Monitoring 24

Appendix D. Water Quality Monitoring 33

Appendix E: Baseline Measures Sam Wright Field Wetland Restoration 34

List of Tables

Table 1. Project roles and responsibilities. 3
Table 2. Summary of Sampling Stations, Sam Wright Field Wetland Restoration. 11
Table 3. Summary of external data sources. 12

List of Figures

Figure 1. Location Sam Wright Field, Easton, MA 5
Figure 2. Wetland Area Depicting Wetland Restoration: Middle green concrete structure removal and regrading, 2. Proposed no mow zone expansion (pink and white). 6
Figure 3. Recommended no mow signs to be placed at edges of proposed no mow zones 6
Figure 4. Culverts in the vicinity of Sam Wright Field Wetland Restoration Project. 7

Figure 5. Locations of level loggers, Mulberry Meadow Brook, Easton, MA. 8
Figure 6. Wetland restoration (areas 1-4) and proposed no mow zone (areas 5 -7) monitoring plots and transects. 10
Figure 7. Water Quality Monitoring Locations, Easton Ma. 10

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
*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.

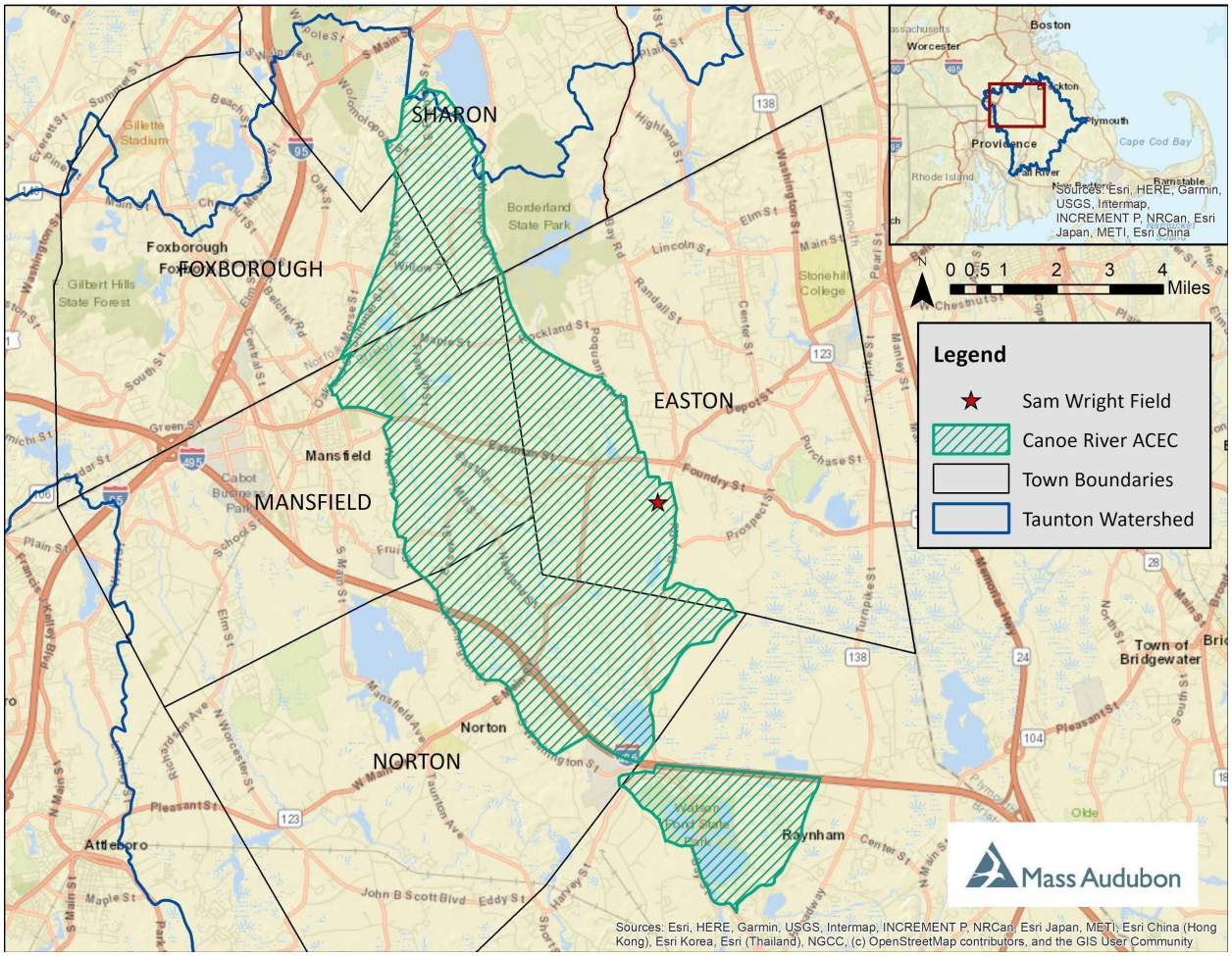


Figure 1. Location Sam Wright Field, Easton, MA

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.

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.



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.

<u>Primary Measures (comparison to quantifiable baseline)</u>

<u>Objective 1: Degraded habitat and water quality: Did the wetland interventions improve wetland habitat?</u>
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

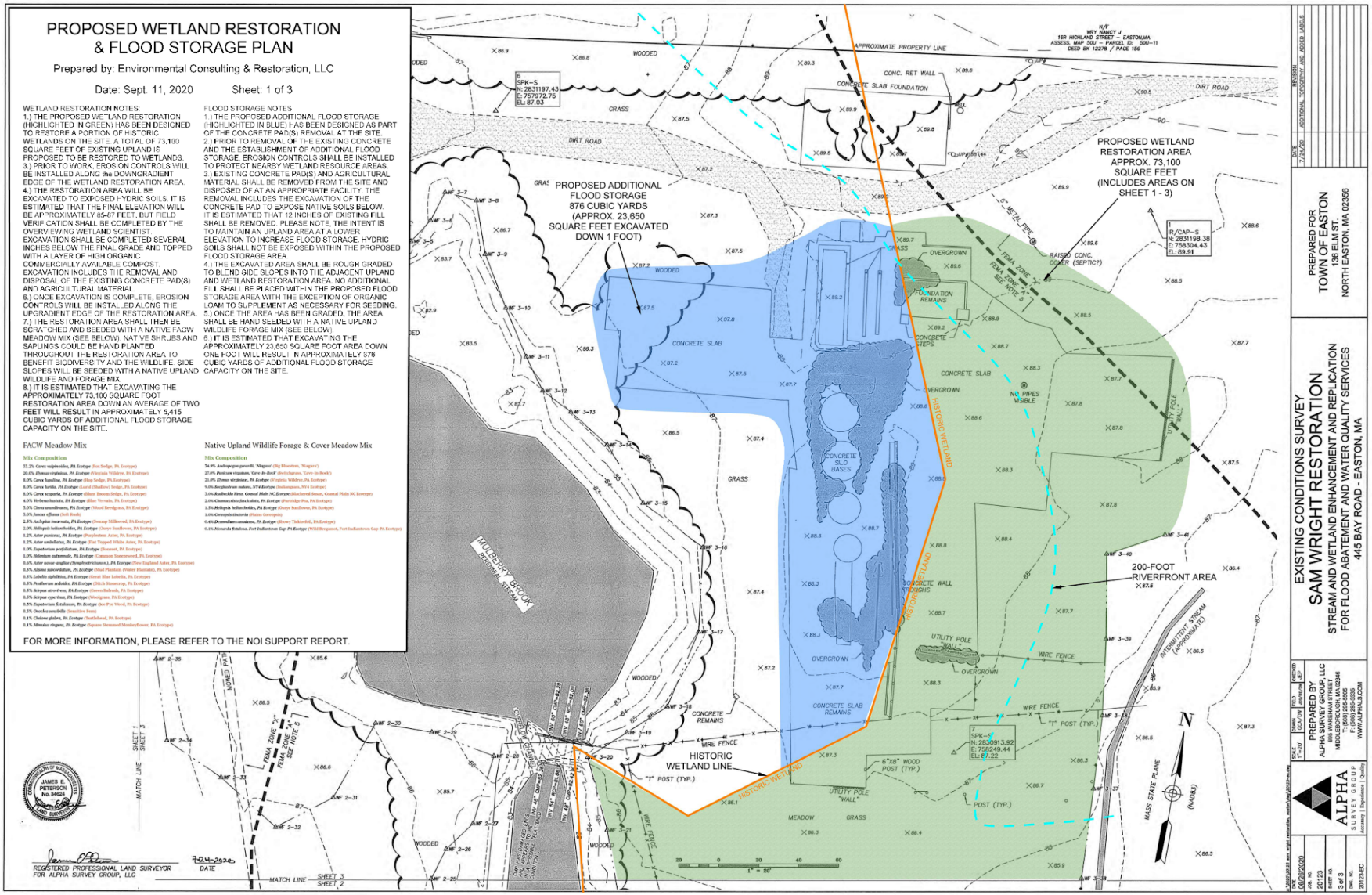
EPA (2020), Southeastern New England Program: Five Year Strategic Plan. https://www.epa.gov/snep/snep-strategic-plan.

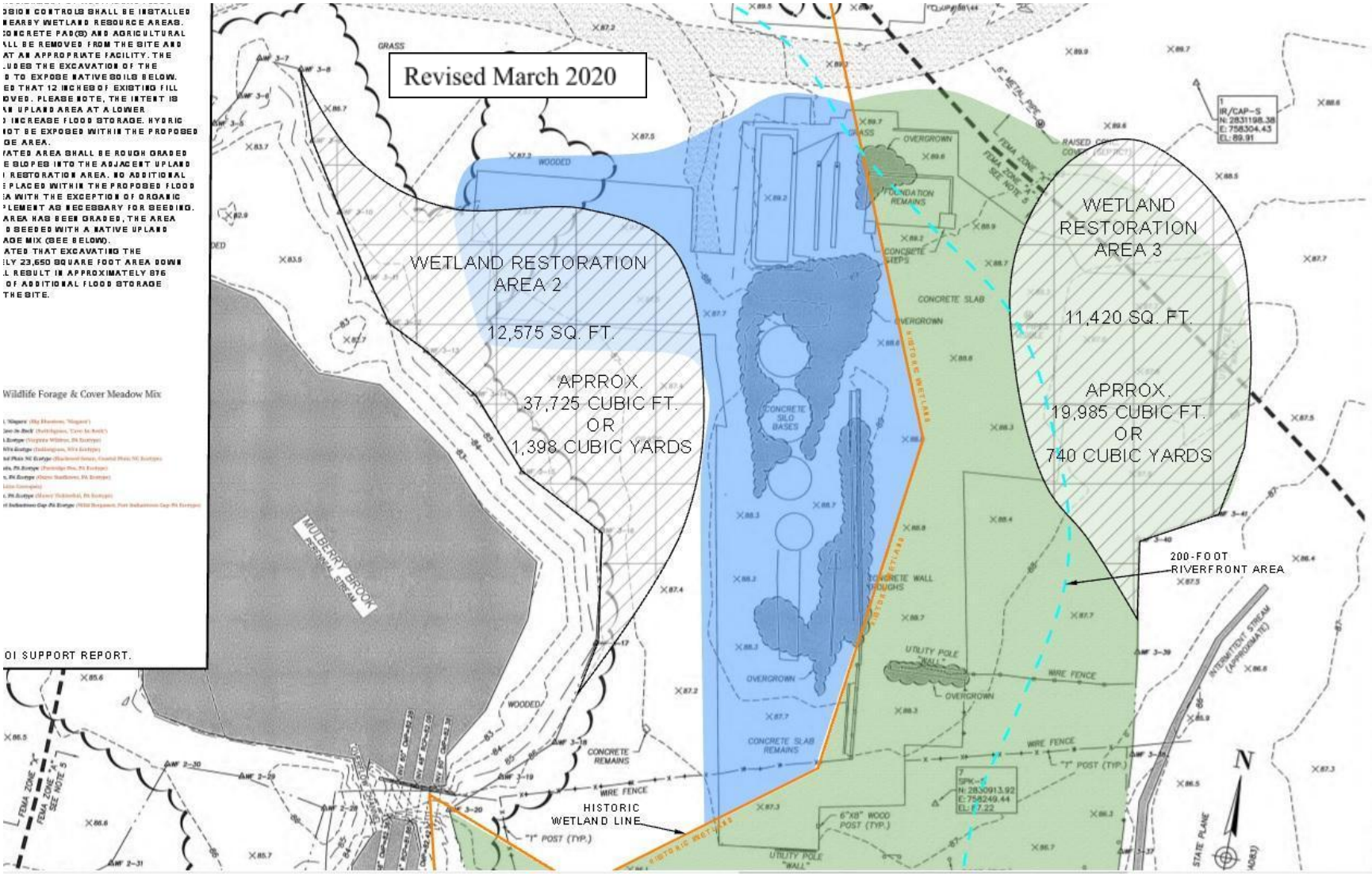
Holmes, B and C. Larson, 2020. Notice of Intent (NOI) Support Report, Environmental Consulting and Restoration, LLC, September 11, 2020.

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




OSION CONTROLS SHALL BE INSTALLED
NEARBY WETLAND RESOURCE AREAS.
ONCRETE PAD(S) AND AGRICULTURAL
LL BE REMOVED FROM THE SITE AND
AT AN APPROPRIATE FACILITY. THE
UDES THE EXCAVATION OF THE
TO EXPOSE NATIVE SOILS BELOW.
ED THAT 12 INCHES OF EXISTING FILL
OVED. PLEASE NOTE, THE INTENT IS
N UPLAND AREA AT A LOWER
INCREASE FLOOD STORAGE. HYDRIC
OT BE EXPOSED WITHIN THE PROPOSED
DE AREA.
ATED AREA SHALL BE ROUGH GRADED
E SLOPES INTO THE ADJACENT UPLAND
RESTORATION AREA. NO ADDITIONAL
PLACED WITHIN THE PROPOSED FLOOD
A WITH THE EXCEPTION OF ORGANIC
LEMENT AS NECESSARY FOR SEEDING.
AREA HAS BEEN GRADED, THE AREA
SEEDED WITH A NATIVE UPLAND
DE MIX (SEE BELOW).
ATED THAT EXCAVATING THE
LY 23,650 SQUARE FOOT AREA DOWN
L RESULT IN APPROXIMATELY 876
OF ADDITIONAL FLOOD STORAGE
THE SITE.
Wildlife Forage & Cover Meadow Mix
OI SUPPORT REPORT.
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 SILO BASES
CONCRETE SLAB REMAINS
CONCRETE REMAINS
CONCRETE WALL TROUGHS
UTILITY POLE
WIRE FENCE
"T" POST (TYP.)
6"X8" WOOD POST (TYP.)
OVERGROWN
WOODED
GRASS
FEMA ZONE "A" SEE NOTE 5
FEMA ZONE "X"
N
STATE PLANE

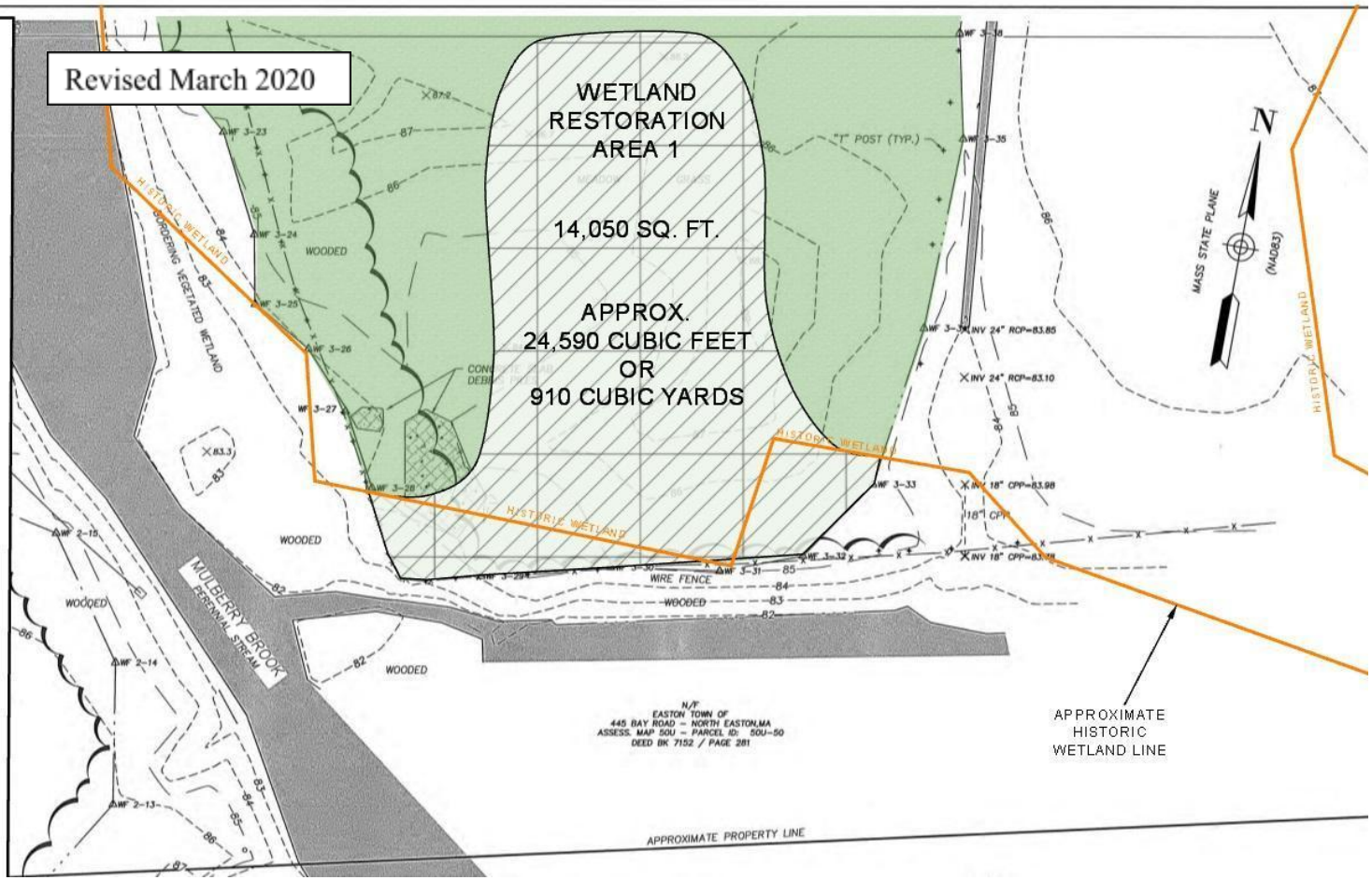
TORATION
PLAN

estoration, LLC

2 OF 3

E NOTES:
ED ADDITIONAL FLOOD STORAGE
N BLUE) HAS BEEN DESIGNED AS PART
ETE PAD(S) REMOVAL AT THE SITE.
EMOVAL OF THE EXISTING CONCRETE
LISHMENT OF ADDITIONAL FLOOD
SION CONTROLS SHALL BE INSTALLED
EARBY WETLAND RESOURCE AREAS.
NCRETE PAD(S) AND AGRICULTURAL
L BE REMOVED FROM THE SITE AND
T AN APPROPRIATE FACILITY. THE
IDES THE EXCAVATION OF THE
TO EXPOSE NATIVE SOILS BELOW.
THAT 12 INCHES OF EXISTING FILL
VED. PLEASE NOTE, THE INTENT IS
UPLAND AREA AT A LOWER
NCREASE FLOOD STORAGE. HYDRIC
OT BE EXPOSED WITHIN THE PROPOSED
E AREA.
TED AREA SHALL BE ROUGH GRADED
SLOPES INTO THE ADJACENT UPLAND
RESTORATION AREA. NO ADDITIONAL
PLACED WITHIN THE PROPOSED FLOOD
WITH THE EXCEPTION OF ORGANIC
EMENT AS NECESSARY FOR SEEDING.
REA HAS BEEN GRADED, THE AREA
SEEDED WITH A NATIVE UPLAND
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



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)

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

Precipitation Monitoring

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
(SOP 03)		Author: Kelly Addy and Elizabeth Herron

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.

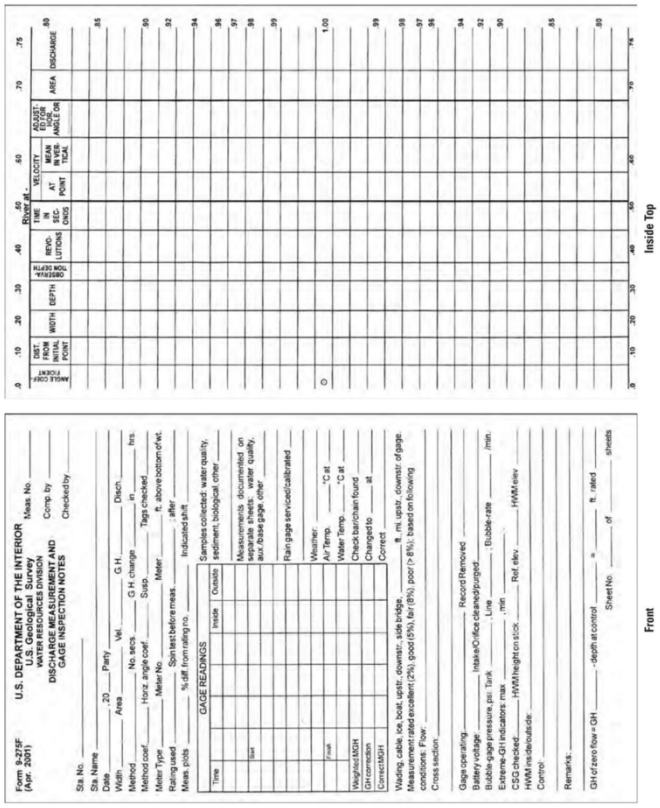
7 DATA PROCESSING/CALCULATIONS
Calculating discharge from depth-velocity data
The method used to compute discharge makes the following assumptions:
• The measured depth at the mid-point of each panel is considered to be the mean depth for the panel
• The mean velocity at an observation vertical is assumed 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

Buchanan, T.J., and W.P. Somers. 1982. Stage Measurement at Gaging Stations, Book 3, Chapter A7. Techniques of Water-Resources Investigations of the United States Geological Survey, U.S. Government Printing Office, Washington, DC.

Carter, R.W., and J. Davidian. 1989. General Procedure for Gaging Streams, Book 3, Chapter A6. Techniques of Water-Resources Investigations of the United States Geological Survey, U.S. Government Printing Office, Washington, DC.

Kindsvater, C.E. and R.W. Carter. 1957. Discharge characteristics of rectangular thin-plate weirs. 1957. Journal of the Hydraulics Division 93:1-36.

Kennedy, E.J. 1983. Computation of Continuous Records of Streamflow, Book 3, Chapter A13. Techniques of Water-Resources Investigations of the United States Geological Survey, U.S. Government Printing Office, Washington, DC.

Onset Company. N.D., Water Level Monitoring. https://www.onsetcomp.com/support/application_solutions/water-level-monitoring

Rantz, S.E., and others, 1982a. Geological Survey Water-Supply Paper 2175, Measurement and Computation of Streamflow: Volume 1 “Measurement of Stage and Discharge.” U.S. Government Printing Office, Washington, D.C. 1982.

Rantz, S.E., and others, 1982b. Geological Survey Water-Supply Paper 2175, Measurement and Computation of Streamflow: Volume 2 “Computation of Discharge.” U.S. Government Printing Office, Washington, D.C. 1982.

Smoot, G.F., and C.E. Novak, 1977. Techniques of Water-Resources Investigations of the United States Geological Survey Book 8: Instrumentation. Chapter B2 “Calibration and Maintenance of Vertical-Axis Type Current Meters.” U.S. Government Printing Office, Washington, D.C. http://pubs.usgs.gov/twri/twri8b2/pdf/twri_8-B2_a.pdf

C-1 Invasive Plant Species Monitoring Protocol

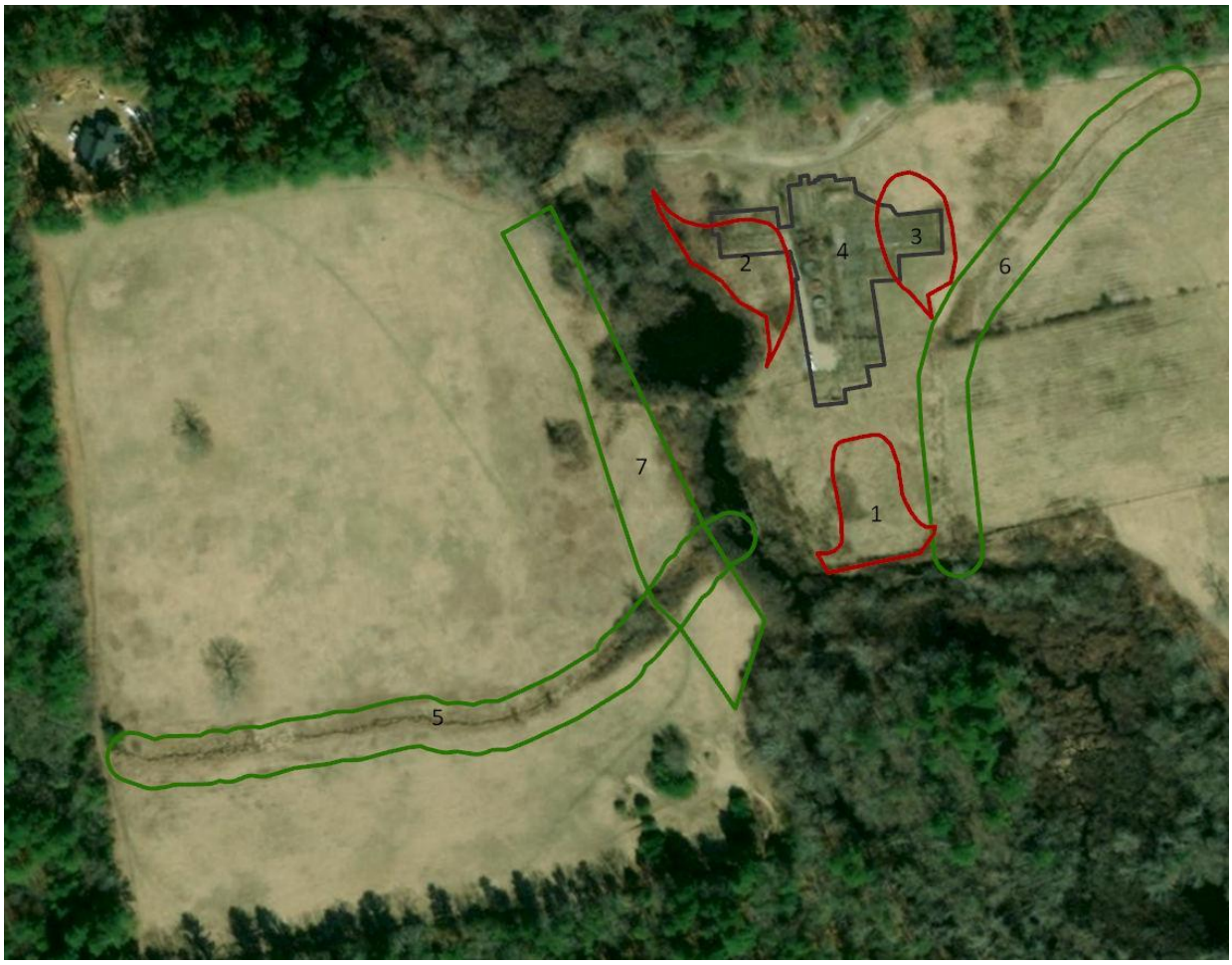


Fig. 1: Map of Sam Wright Field with restoration monitoring areas (1-7) labeled.

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*).

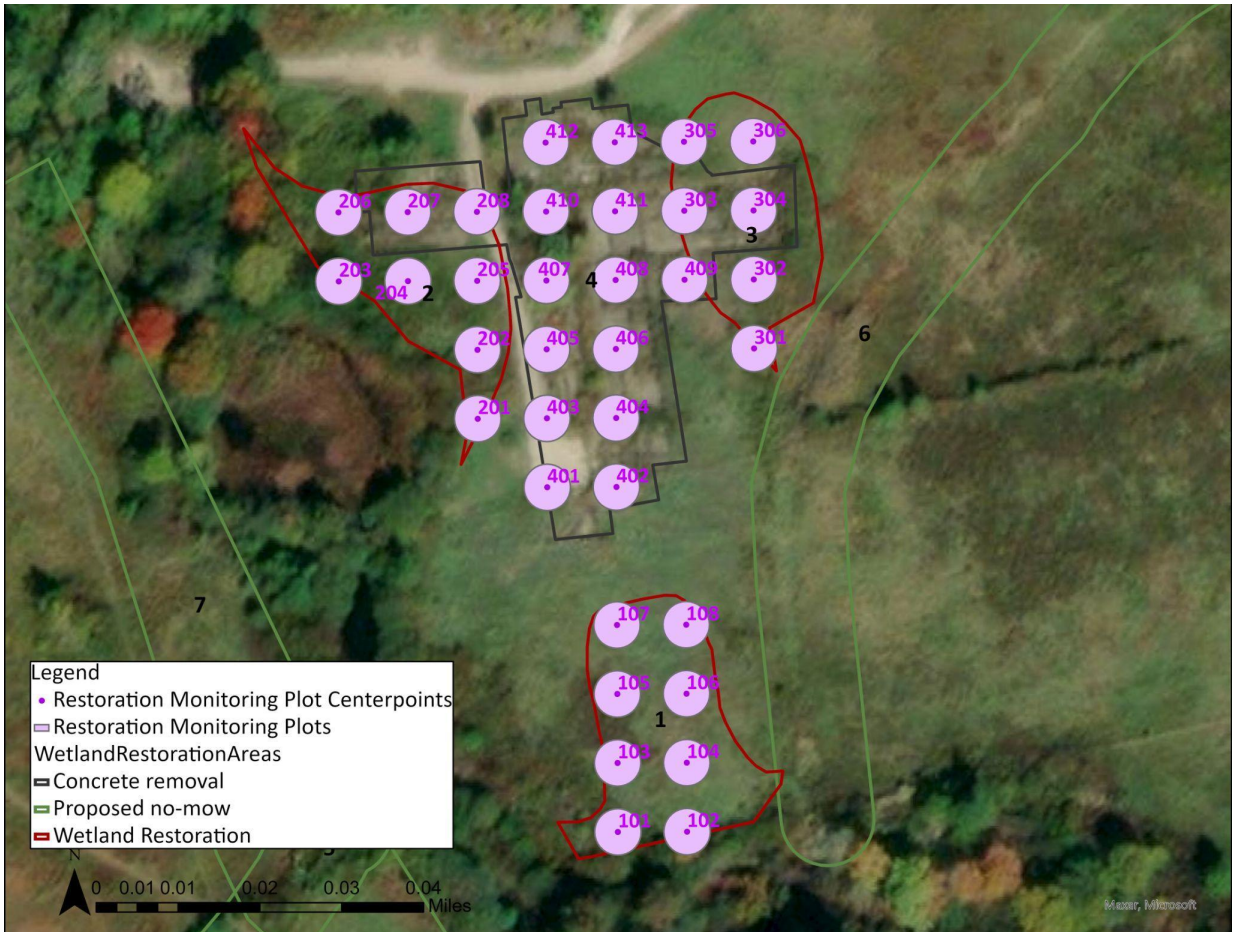


Fig. 2: Wetland restoration monitoring plots in areas 1-4.

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





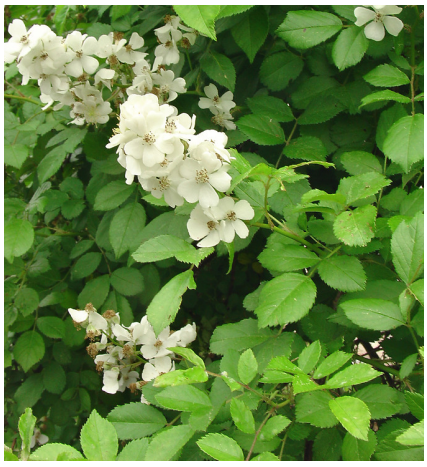
Autumn Olive, *Elaeagnus umbellata*

- 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

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