# Tidal Restriction Restoration at Wallace Shore Road

## 2015 Monitoring Report:
## Year 1 of 5, Post-Construction

*Prepared For:*

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Submitted: March 1, 2016

# Contents

# 1. Overview

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|---|---|
| Project Name: | Tidal Restriction Restoration at Wallace Shore Road |
| Project Location: | Appletree Marsh, Harpswell |
| Project Sponsor: | Casco Bay Estuary Partnership (CBEP) |
| Contractor and/or Consultant: | Shaw Brothers Construction; Wright Pierce |
| Start and Completion Dates: | 12/15/2014 – 12/29/2014. |
| Corps and DEP Permit Numbers: | Corps Permit #: NAE-2014-01922; State ID#: NRPA/PBR #58778 |

## 1.1 Project Summary

The primary objective of this project was to reestablish natural hydrology, and specifically, to restore natural tidal variability into the Appletree Marsh adjacent to Wallace Shore Road in Harpswell (Fig. 2, following page). Two existing culverts were replaced according to amended designs provided with permit applications: A 3.3' box culvert was replaced with a 15' open bottom span concrete box culvert, and a 18" HDPE culvert was replaced with a 5' pre-cast concrete culvert (Fig. 1). At the 15' open bottom box, remnant slugs of fill from the original crossing structure were dredged from the channel immediately adjacent to the crossing in order to promote the free exchange of water into and out of the marsh.


*Figure 1. Installation of open bottom concrete box culvert at the lower site (9079, left) and embedded concrete round pipe at the upper site (9078, right).*

Engineering services were provided by Wright Pierce, construction services were provided by Shaw Brothers, and the Cumberland County Soil and Water Conservation District administered the construction contract. The project was managed by the Casco Bay Estuary Partnership. Construction activities began on 12/15/14 at the north (secondary) culvert and concluded on 12/24/2014 at the primary crossing. Finishing road work was completed on 12/29/2014 following a break from 12/24 – 12/28/2014 over the holidays.

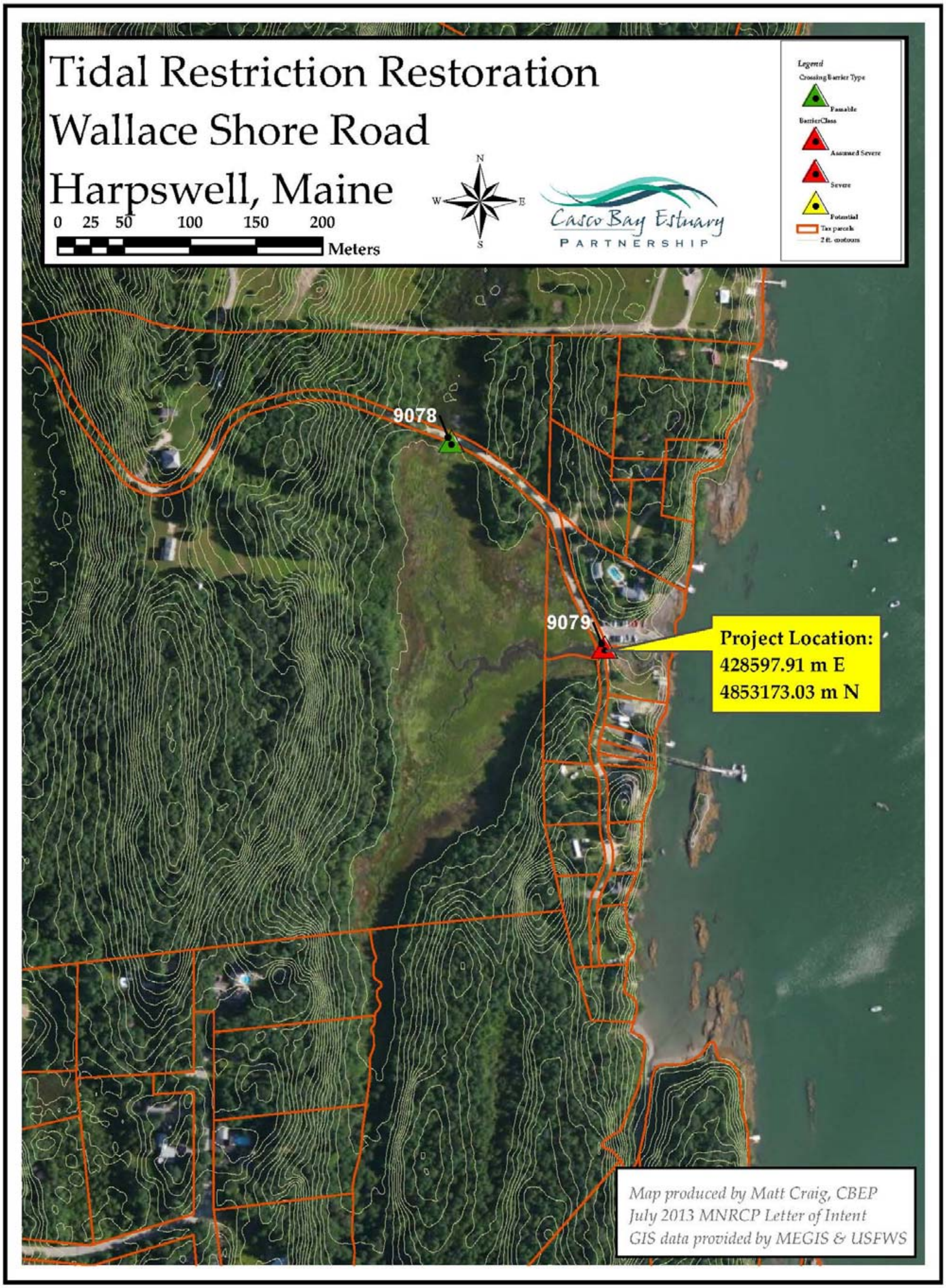


*Figure 2. Map of project locations, parcels, and topography.*

## 1.2 Project Monitoring

A monitoring plan was incorporated into the *Wallace Shore Road Restoration Work Plan.* CBEP is conducting pre- and post- project monitoring in the wetland adjacent to the project area (crossings 9079 and 9078). Following one season of collecting pre-project data, CBEP will collect five years of post-project data. CBEP, one of 28 National Estuary Programs nationwide, has focused on assessment, restoration, and monitoring at tidal marshes in Casco Bay since 1999.

The *Restoration Work Plan* summarizes the project goal to increase tidal exchange at two road/stream crossings where privately owned Wallace Shore Road crosses a tidal wetland in Harpswell. To monitor ecosystem change in response to the tidal restoration project, CBEP established 10 monitoring Stations at Appletree Marsh, spaced so that they were evenly distributed. Station 1 was located downstream of the primary crossing (9079), immediately to the north of Wallace Shore Road; Stations 2-9 are located in the marsh between the two road crossings, and Station 10 is located upstream of the secondary road crossing (9078; Fig. 3).

The *Restoration Work Plan* described the current (pre-construction) condition of the marsh and incorporated data on channel morphology, surface water hydrology and salinity, pore water salinity, vegetation, species of concern and other parameters. This report summarizes monitoring results from Year 1, post-construction, and where illustrative, provides a comparison with pre-construction data in the *Restoration Work Plan.* Monitored parameters include:

- Hydrology signal – using continuous water level recorders deployed upstream and downstream of Long Reach Lane.
- Pore water and surface water salinity.
- Vegetation – abundance (percent cover) of halophytic, brackish, freshwater, and invasive plant species.
- Channel morphology – cross sectional area.
- Erosion – post-project visual surveys within the construction area.
- Photo stations.

Monitoring is intended to document changes in the marsh following the restoration of tidal exchange at the two road crossings. Monitoring is designed to detect changes such as:

- Channel depth within the construction area compared with the longitudinal profile of the channel's gradient outside the area of impact.
- Halophytes as a percentage of overall species composition.
- Groundwater depth variability in response to tidal cycles.
- Pore water salinity variability in response to tidal cycles.
- Surface water salinity upstream of Wallace Shore Road variability in response to tidal cycles.


*Figure 3. Map of monitoring stations.*

## 2. Performance Standards/Requirements

The *Restoration Work Plan* defines performance standards for this project as follows (p. 26-7):

- Erosion control: All the constructed features such as slopes, soils, and substrates within the mitigation site will be stabilized and free from erosion, with erosion control materials removed once the site is stable.
- Invasive species: Invasive *Phragmites australis* is not introduced to the site, or if invasive *Phragmites australis* does colonize the project area, it is eliminated.
- Hydrology signal: Tidal restriction at the primary crossing, defined as the difference between highest observed water (HOW) downstream and upstream, will be less than or equal to .3' by the conclusion of the five year post-construction monitoring period.

## 3. Monitoring Results

This section describes the current conditions on the site focused on the condition of the mitigation project to replace two road crossings and restore tidal hydrology, as well as conditions in the marsh, in order to substantiate the success and/or potential challenges associated with the project. For full photo documentation, see Appendix A.

### 3.1 Monitoring Dates

This report summarizes data gathered over the course of 21 distinct visits to the site for the purposes of observing site conditions and monitoring both the project area and the adjacent marsh. Eighteen (18) visits were to conduct ecosystem monitoring in conjunction with the project's Monitoring Plan.

*Table 1. List of monitoring and site inspections.*

| Date | Name* | Activity |
|---|---|---|
| 12/29/2014 | MC, JM | Final walk through for certificate of substantial completion for Shaw Bros. |
| 3/9/2015 | MC | Observe winter conditions of project area and wetland |
| 4/29/2015 | MC | Pore water salinity samples; set up hydrology; remove debris |
| 5/8/2015 | MC, MS | Pore water salinity samples; set up hydrology |
| 5/22/2015 | MS | Pore water salinity samples |
| 6/12/2015 | MS, RS | Pore water salinity samples |
| 6/30/2015 | MC, MS | Channel morphology (longitudinal profile); remove debris |
| 7/9/2015 | MS, RS | Pore water salinity samples |
| 7/14/2015 | MC, MS | Flag vegetation transects and cross sections; remove lg. barberry |
| 7/14/2015 | CB, RS | Vegetation surveys |
| 7/16/2015 | CB, RS | Vegetation surveys |
| 7/22/2015 | MC | MNRCP site visit with ACOE, MDEP |
| 7/28/2015 | MS, RS | Pore water salinity samples; channel morphology (cross sections) |
| 8/4/2015 | MS | Channel morphology (cross sections) |
| 8/6/2015 | MS, RS | Pore water salinity samples; invasive species mapping |
| 8/18/2015 | MC, MS | Channel morphology (longitudinal profile); set up hydrology |
| 9/18/2015 | MC | Pore water salinity samples |
| 9/25/2015 | MC, MS | Remove hydrology monitoring equipment |
| 10/15/2015 | MC, MS | Remove remaining hydrology monitoring equipment |
| 10/30/2015 | MC | Pore water salinity samples |
| 1/12/2016 | JM | Inspect construction area for payment of final retainage to Shaw |

* MC = Matt Craig, CBEP Habitat Program Manager; JM = Joseph McLean, Wright Pierce; CB = Curtis Bohlen, CBEP Director; MS = Melissa Smith, CBEP Field Technician.; RS = Rachel Sclafani, EPA Intern hosted by CBEP

## 3.2 Erosion Control

For this project, all erosion control measures were temporarily installed before and during construction to minimize the potential for soil erosion while the crossings were being replaced. Shaw Brothers removed all temporary erosion control measures, as well as excavated fill, the temporary pedestrian bridge, stored materials/supplies, and miscellaneous equipment, by the conclusion of construction activity on 12/29/2014.

Erosion control elements were designed into the structures. The constructed road stream crossings (open bottom concrete box at the lower site; embedded round pipe at the upper site) were stable throughout the year 1 post-construction monitoring period.

Changes to channel morphology were anticipated to result from the replacement of the two road/stream crossings due to the alteration of site hydrology, and the monitoring plan outlines how changes in channel morphology will be tracked. Year 1 results are presented in Section 3.9, Channel Morphology.

## 3.3 Status of Performance Standards

A summary of the status of the project's performance standards, along with accompanying ecological monitoring parameters, is presented in Table 2.

*Table 2. Summary of Performance Standards and Monitoring Parameters*

| Performance Standard/ Monitoring Parameters | 2015 Findings (Year 1 post-construction) | Meet Standard? |
|---|---|---|
| **Erosion control** | *Slopes, soils, substrates within the mitigation site are stable* | On-track |
| **Invasive species** | *Phragmites australis is not present in the Project Area* | On-track |
| **Hydrology signal** | *Tidal restriction at the primary crossing ≤ .3' at Highest Observed Water* | Yes |
| **Pore water salinity*** | *Mean pore water salinity levels and maximum pore water salinity increased at almost every station.* | On-track |
| **Vegetation community*** | *Changes in the plant community indicate adjustment to the new hydrology.* | On-track |
| **Channel morphology*** | *Channel cross sectional area increased throughout Project Area.* | On-track |

* *Hydrology signal, invasive species, and erosion control are the three core performance standards defined by the Restoration Work Plan.*

## 3.4 Corrective Actions

A summary of corrective actions taken during the monitoring period is provided in Table 3.

*Table 3. List of corrective actions taken during the monitoring period.*

| Date(s) | Observation | Corrective Action |
|---|---|---|
| **4/29/15** | CBEP observed scattered ~2" crushed rock leftover on the marsh surface and road shoulder near the construction staging area. | CBEP hand removed two 5 gallon buckets of crushed rock and transported materials offsite. |
| **4/29/15; 6/30/15** | CBEP observed that channel scour of mobile sediments revealed extensive debris in the creek channel, including trash, fishing gear, boards, tires, and saw-cut branches, affecting sediment mobility, water flow, AOP, and channel geomorphic response. | CBEP hand removed debris from creek channel and disposed of offsite as needed. CBEP will continue as additional debris by channel downcutting. |
| **7/14/15** | CBEP observed that the large Japanese bayberry growing off the road shoulder near crossing 9078 was outside the range of tidal inundation and did not appear stressed by exposure to salt water. | CBEP cut back the plant to the ground, transported all seeds, limbs, and roots offsite in contractor bags, and ensured that debris was incinerated. Care was taken not to destabilize soils. CBEP will continue treatments as needed. |
| **None.** | Over the course of several visits, CBEP observed that water is now pooling in the excavated channel outlet of crossing 9078 due to a lack of channel development/scour. Probing suggests that coarse grained sediments are present on the marsh surface and are not mobilizing due to a lack of velocity/volume. Anecdotes from abutters confirms that several years ago the culvert blew out at this location, washing road fill onto the downstream marsh. | No action was taken during the monitoring period. See Section 4.2, Recommendations for Adaptive Management. |

## 3.5 Vegetation

Although vegetative community is not a performance standard, CBEP will monitor vegetation throughout the five year post-project period. Vegetation transects were established and surveyed on July 15 and 17, 2014, and re-set and surveyed on July 14 and 16, 2015. A total of 110 plots were sampled in 2014 and 2015 (12 plots along Station 1a and 1b, and 98 plots along transects at Stations 2-10). Plot locations in 2014 and 2015 were at identical distances along each transect for most stations. The transect at Station 2 was not identical in 2014 and 2015, attributed to the fact that the wooden stake marking the start of the transect at the channel could not be located in 2015, possibly due to heavy winter ice accumulation and movement in the winter of 2014 - 2015. Selected photos from vegetation monitoring are included with the appendices.

All vegetation data and descriptive analyses are preliminary. Further analysis will be conducted for subsequent reports. In addition, further field assessment appears needed to verify species type where identities varied from 2014 and 2015 within the same plot.

A combined total of 78 plant species were identified across all Stations. Of those, 61 were observed during 2014 vegetation surveys, and 67 were observed during 2015 surveys. Of the 10 species that were observed in 2014 but not in 2015, 9 are freshwater/glycophytic, and 1 is brackish. Of the 16 species that were observed in 2015 but not in 2014, 10 are fresh, 5 are brackish, and 1 is halophytic (Table 4).

*Table 4. Plant species observations and community type. Groupings based on graduate work by Verrill 2014..*

| Latin Name | Common Name | Community Group | 2014 | 2015 |
|---|---|---|---|---|
| ***Acer rubrum*** | Red Maple | Fresh | X | X |
| ***Agrostis stolonifera*** | Creeping Bent Grass | Brackish | X | X |
| ***Alnus incana*** | Speckled Alder | Fresh | X | X |
| ***Argentia anserina*** | Common Silverweed | Brackish | X | X |
| ***Atriplex prostrata*** | Orach | Brackish | X | X |
| ***Betula populifolia*** | Gray birch | Fresh | X | |
| ***Bolboschoenus maritimus*** | Alkali Bulrush | Brackish | X | X |
| ***Calamagrostis Canadensis*** | Bluejoint Grass | Fresh | | X |
| ***Calla palustris*** | Wild Calla | Fresh | X | X |
| ***Carex hystericina*** | Bottlebrush Sedge | Fresh | X | |
| ***Carex lacustris*** | Lake Sedge | Fresh | X | X |
| ***Carex scoparia*** | Broom Sedge | Fresh | X | X |
| ***Carex trisperma*** | Three-Seeded Sedge | Fresh | X | X |
| ***Carex utriculata*** | Common Beaked Sedge | Fresh | | X |
| ***Carex spp.*** | Unk. Sedge | Fresh | X | X |
| ***Drosera rotundifolia*** | Sundew | Fresh | X | |
| ***Dryopteris cristata*** | Crested Wood Fern | Fresh | | X |
| ***Elymus pycnanthus*** | Tick Quackgrass | Fresh | X | X |
| ***Elymus repens*** | Creeping Wild Rye | Fresh | X | X |
| ***Epilobium leptophyllum*** | American Marsh Willow-Herb | Fresh | X | X |
| ***Festuca rubra*** | Red Fescue | Brackish | X | X |
| ***Galium palustre*** | Marsh Bedstraw | Brackish | X | X |
| ***Galium trifidum*** | Threepetal Bedstraw | Fresh | X | X |
| ***Glaux maritima*** | Milkwort | Brackish | | X |
| ***Glyceria grandis*** | American Manna Grass | Fresh | X | X |
| ***Hypericum mutilum*** | St. John's Wort | Fresh | X | X |
| ***Ilex verticillata*** | Winterberry | Fresh | X | X |
| ***Impatens capensis*** | Jewelweed | Fresh | X | X |
| ***Juncus arcticus*** | Arctic Rush | Brackish | X | X |
| ***Juncus gerardii*** | Black Grass | Salt | X | X |
| ***Juniperus communus*** | Common Juniper | Fresh | X | X |
| ***Lemna minor*** | Duckweed | Fresh | X | |
| ***Limonium carolinianum*** | Sea Lavender | Salt | X | X |
| ***Lycopus americanus*** | American Water Horehound | Fresh | X | |
| ***Lycopus uniflorus*** | Northern Bugleweed | Fresh | X | X |
| ***Lysimachia terrestris*** | Swamp Candle | Fresh | X | X |
| ***Lythrum salicaria*** | Purple Loosestrife | Fresh | X | X |
| ***Onoclea sensibilius*** | Sensitive Fern | Fresh | X | X |
| ***Osmunda regalis*** | Royal Fern | Fresh | X | X |
| ***Persicaria sagittata*** | Tearthumb | Fresh | X | |
| ***Phragmites americanus*** | American Reed | Brackish | X | |
| ***Picea glauca*** | White Spruce | Fresh | X | |
| ***Picea rubens*** | Red Spruce | Fresh | | X |
| ***Pinus strobus*** | White pine | Fresh | | X |
| ***Populus grondidentata*** | Poplar | Fresh | | X |
| ***Populus tremuloides*** | Quaking Aspen | Fresh | X | X |
| ***Proserpinaca palustris*** | Marsh Mermaidweed | Fresh | X | X |
| ***Puccinellia tenella*** | Alkali Grass | Brackish | | X |
| ***Quercus rubra*** | Northern Red Oak | Fresh | X | X |
| ***Rosa palustris*** | Swamp Rose | Fresh | | X |
| ***Rubus hispidus*** | Bristly Blackberry | Fresh | X | X |
| ***Rubus sp.*** | Blackberry | Fresh | | X |
| ***Rumex pallidus*** | Seabeach Dock | Brackish | X | X |
| ***Ruppia maritima*** | Widgeon Grass | Salt | X | X |
| ***Salicornia depressa*** | Common Glaswort | Salt | | X |
| ***Schoenoplectus pungens*** | Three-Square Bulrush | Fresh | X | X |
| ***Scirpus cyperinus*** | Woolgrass | Fresh | X | |
| ***Scirpus sp.*** | Sedge | Brackish | | X |
| ***Scutellaria galericulata*** | Hooded Skullcap | Fresh | X | X |

| | | | | |
|---|---|---|---|---|
| ***Solidago altissima*** | Tall Goldenrod | Fresh | X | X |
| ***Solidago sempervirens*** | Seaside Goldenrod | Brackish | X | X |
| ***Sparganium americanum*** | American Bur-Reed | Fresh | X | X |
| ***Spartina alterniflora*** | Smooth Cordgrass | Salt | X | X |
| ***Spartina patens*** | Salt Hay | Salt | X | X |
| ***Spartina pectinata*** | Freshwater Cordgrass | Brackish | X | X |
| ***Sphagnum spp.*** | Unk. Sphagnum moss | Fresh | | X |
| ***Spirea alba var. latifolia*** | White Meadowsweet | Fresh | X | X |
| ***Suaeda maritima*** | Herbacious Seepweed | Salt | X | X |
| ***Symphyotricum novi-belgii*** | Aster | Brackish | X | X |
| ***Thelypteris palustris*** | Eastern Marsh fern | Brackish | | X |
| ***Triglochin maritimum*** | Seaside Arrowgrass | Salt | X | X |
| ***Typha angustifolia*** | Narrow-Leaf Cattail | Brackish | X | X |
| ***Typha latifolia*** | Broad-Leaf Cattail | Fresh | X | X |
| ***Typha x glauca*** | Hybrid Cattail | Brackish | | X |
| ***Vaccinium corymbosum*** | High Bush Blueberry | Fresh | X | |
| ***Vaccinium macrocarpon*** | Large Cranberry | Brackish | X | X |
| ***Viola pallens*** | Smooth White Violet | Fresh | | X |

### 3.5.1 Percent Cover

Figure 4 illustrates community type abundance (mean percent cover) at each Station transect (all plots combined) in 2014 and 2015. All vegetation data are presented as preliminary.

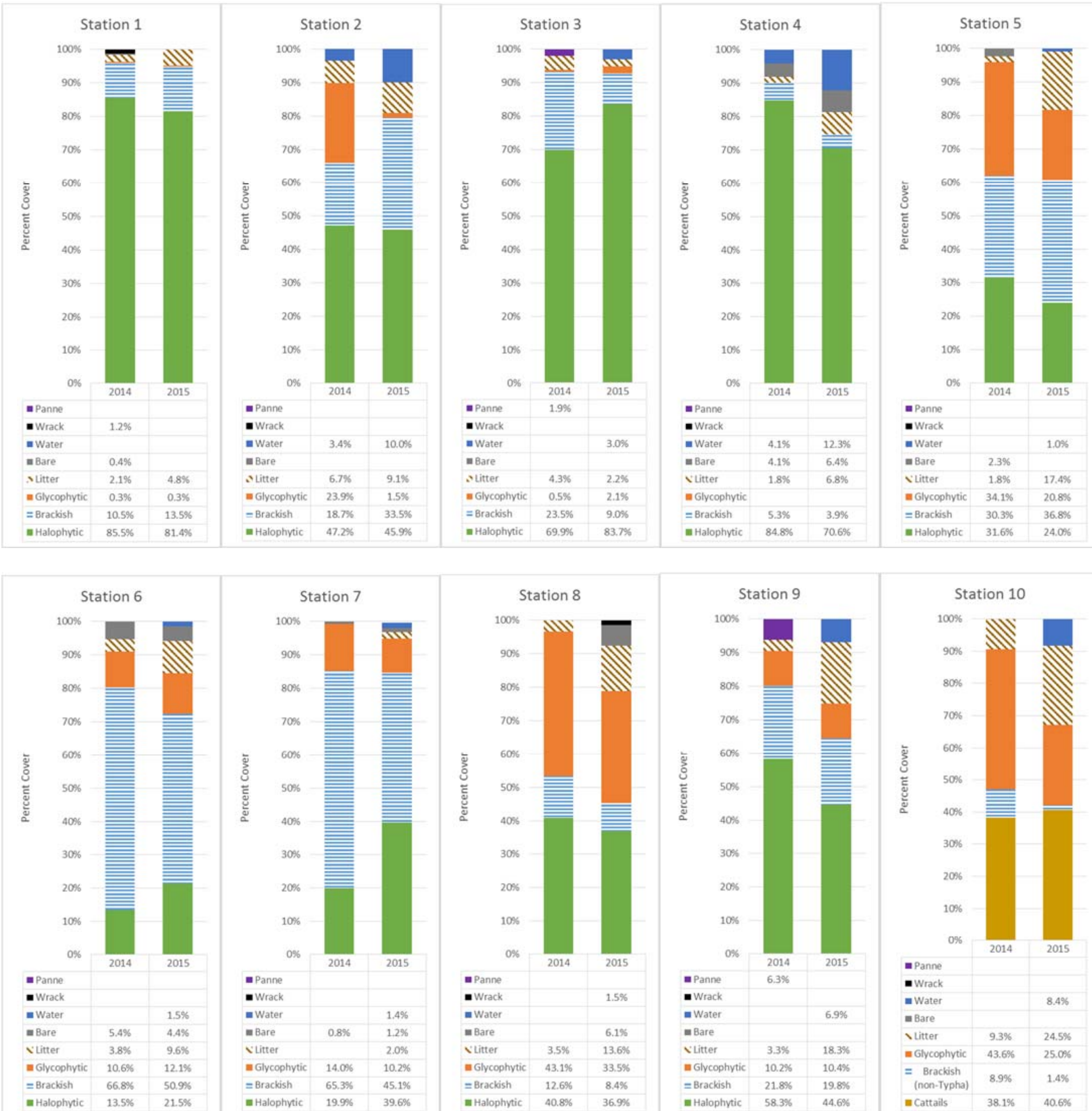


*Figure 4. Community type by station transect, 2014 and 2015.*

### 3.5.2 Plant Survival

*If applicable, by species planted, describe the general health and vigor of the surviving plants, the prognosis for their future survival, and a diagnosis of the cause(s) of morbidity or mortality. Outline any plans for replanting if recommended.*

Not applicable. No vegetation was planted as part of this project.

## 3.6 Fish and Wildlife

CBEP incidentally recorded use of the marsh and immediate vicinity (marsh perimeter) by fish and wildlife when on site for other monitoring tasks. Species observed are listed in Table 5. Note: additional data about bird use may be available from Project SHARP (Saltmarsh Habitat Avian Research Program) based at the University of Maine, which has a long-term monitoring station in the middle of the marsh.

*Table 5. Fish and wildlife observed at the site during the monitoring period.*

| Common name | Scientific name | Uses/notes |
|---|---|---|
| Great blue heron | *Ardea herodias* | Feeding in pools |
| Snowy egret | *Egretta thula* | Feeding in pools |
| Pileated woodpecker | *Hylatomus pileatus* | Feeding at snag |
| Osprey | *Pandion haliaetus* | Soaring |
| Greater yellowlegs | *Tringa melanoleuca* | Feeding in pools |
| Turkey vulture | *Cathartes aura* | |
| Black duck | *Anas rubripes* | Creek channel |
| Mallard | *Anas platyrhynchos* | Creek channel |
| Canada goose | *Branta canadensis* | Creek channel; marsh surface |
| Salt marsh sparrow | *Ammodramus caudacutus* | |
| Mink | *Neovison vison* | Feeding in channel |
| Coyote | *Canis latrans* | Sign (bones) |
| Soft shell clam | *Mya arenaria* | Upstream flats |
| Silverside | *Menidia menidia* | Creek channel |
| Mummichog | *Fundulus heteroclitus* | Creek channel |
| Green crab | *Carcinus maenas* | Creek channel |
| American eel | *Anguilla rostrate* | Creek channel |

## 3.7 Soils Data

*If applicable, soils data, commensurate with the requirements of the soils portion of the Corps Wetlands Delineation Manual (Technical Report Y-87-1 and approved regional supplements) New England District data form, should be collected after construction and every alternate year throughout the monitoring period.*

Not applicable for this project.

## 3.8 Hydrology

CBEP collected continuous data on water levels, salinity, and other parameters at the site using In Situ AquaTroll 200 data loggers with vented cables in order to monitor tidal hydrology, which defines a specific performance standard for the project. CBEP has collected four hydrology data sets to date (Table 6). Pre-project data were collected in 2013, and again from 7/9/15 – 7/25/14. The 2013 data were used by the project engineer to characterize local hydrology. Results of the 2014 data are included in this report for comparison of pre- and post- restoration data. Post-project water level data were collected between 4/30/15 – 6/30/15. (An additional data set was collected between 8/18/15 – and 10/18/15, but is not included in this report).

*Table 6. Hydrology monitoring deployments.*

| Dates | St. 1 (Surface Water) | St. 2 (Surface Water) | St. 3 (Groundwater) | St. 10 (Groundwater) |
|---|---|---|---|---|
| **2013 (pre)** | 5/21 – 6/17* | 5/21 – 6/17* | | |
| **2014 (pre)** | 7/9 – 8/26 | 7/9 – 8/26 | 7/9 – 8/26* | 7/9 – 8/26 |
| **2015 (post)** | 4/30 – 6/30<br>8/8 – 10/15* | 4/30 – 6/30<br>8/8 – 10/15* | | 5/8 – 6/30<br>8/18 – 9/25* |

* Data sets not covered in this report.

### 3.8.1 Stage Height

Pre- and post- project water levels are plotted in Figures 5 and 6, with Station 1 downstream of the primary crossing #9079, Station 2 upstream of 9079, and Station 10 upstream of the secondary crossing #9078. Station 1 and Station 2 plot surface water elevations, and Station 10 plots groundwater/surface water elevations through a piezometer due to the lack of a channel. Both graphs clearly show spring/neap tide cycles.

Figure 5 illustrates the effect of tidal restriction upstream of 9079 (St. 2), with lower maximum height during spring tides and impounded water during low tide. At Station 10, water levels were generally flat and unaffected by tides, with exception of a peak associated with a > 2.5" rain event over two days in mid-August. Salinity data recorded simultaneously (see Table 8; Figure 13) confirm that tidal water did not reach the Station 10 logger during the 2014 peak.

Figure 6 illustrates the effect of the two new crossings on site hydrology and water levels. At high tide, surface water elevations are virtually identical at St. 1 and St. 2, while the surface water level upstream of 9079 fell by over 1.5 feet, allowing for complete drainage of the upstream marsh at low tide. Groundwater levels at Station 10 fell by about .5 feet, indicating improved drainage through the new embedded round pipe at 9078. The new culvert is also providing two-way flow into the upstream wetland for likely the first time in several decades. During a spring tide event in May 2015, water levels at Station 10 clearly rose and fell with the tides, confirming that tide water is now accessing the cattail stand upstream of 9078 during astronomical high tides.

Figures 7 and 8 illustrate the instantaneous difference in water levels upstream and downstream of 9079 in 2014 (Fig. 7) and 2015 (Fig. 8). The difference is calculated as the water elevation at St. 1 – the elevation at St. 2, so that a positive number would indicate tidal restriction. In 2014, instantaneous water levels differed by as much as .85 feet during a spring tide, with a difference in range of approximately 4 feet over a single spring tide cycle due to water levels at low tide typically at least 3 feet higher upstream than downstream.

In 2015, the instantaneous difference in water level at high tide was negligible, with a maximum difference of .093 feet during a spring tide event. This affirms that the project has met its hydrological performance standard: *Tidal restriction at the primary crossing ≤ .3' at Highest Observed Water.* The remaining difference in instantaneous water level at low tide is a result of the higher channel bottom elevations at Station 2 and grade controls formed by the movement of coarse grained sediments out of the system in response to the new hydrology.

Figures 9 and 10 illustrate that the effect of tidal restriction on the timing of hydrology has been eliminated as well. The obvious lag in upstream water levels in 2014 (60 minutes to reach high water, Fig. 8) is no longer evident in 2015 (Fig. 9). Figure 9 also illustrates the increase in water levels at Station 10, that are clearly associated with the diurnal high tide during the May spring tide cycle.

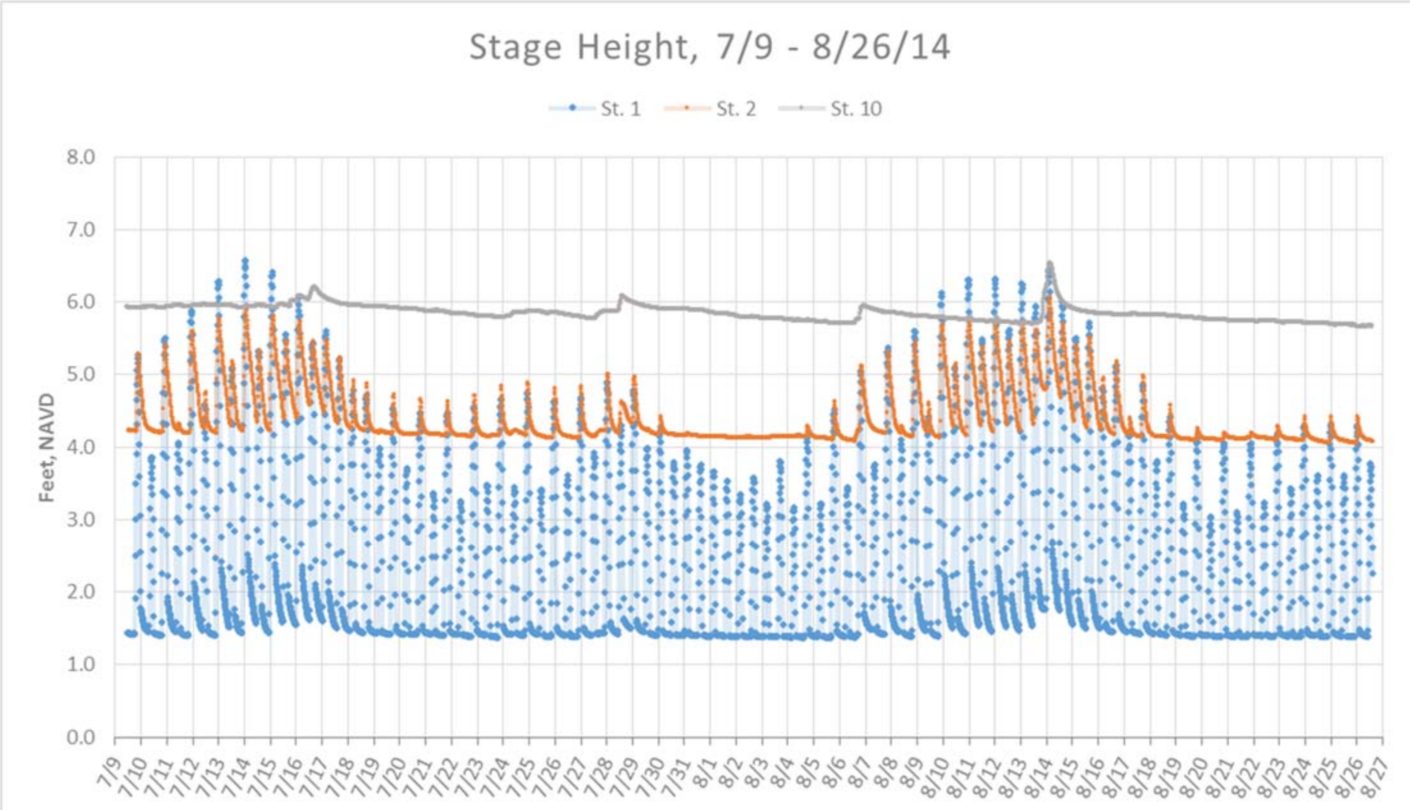


*Figure 5. Pre-project water levels (2014).*

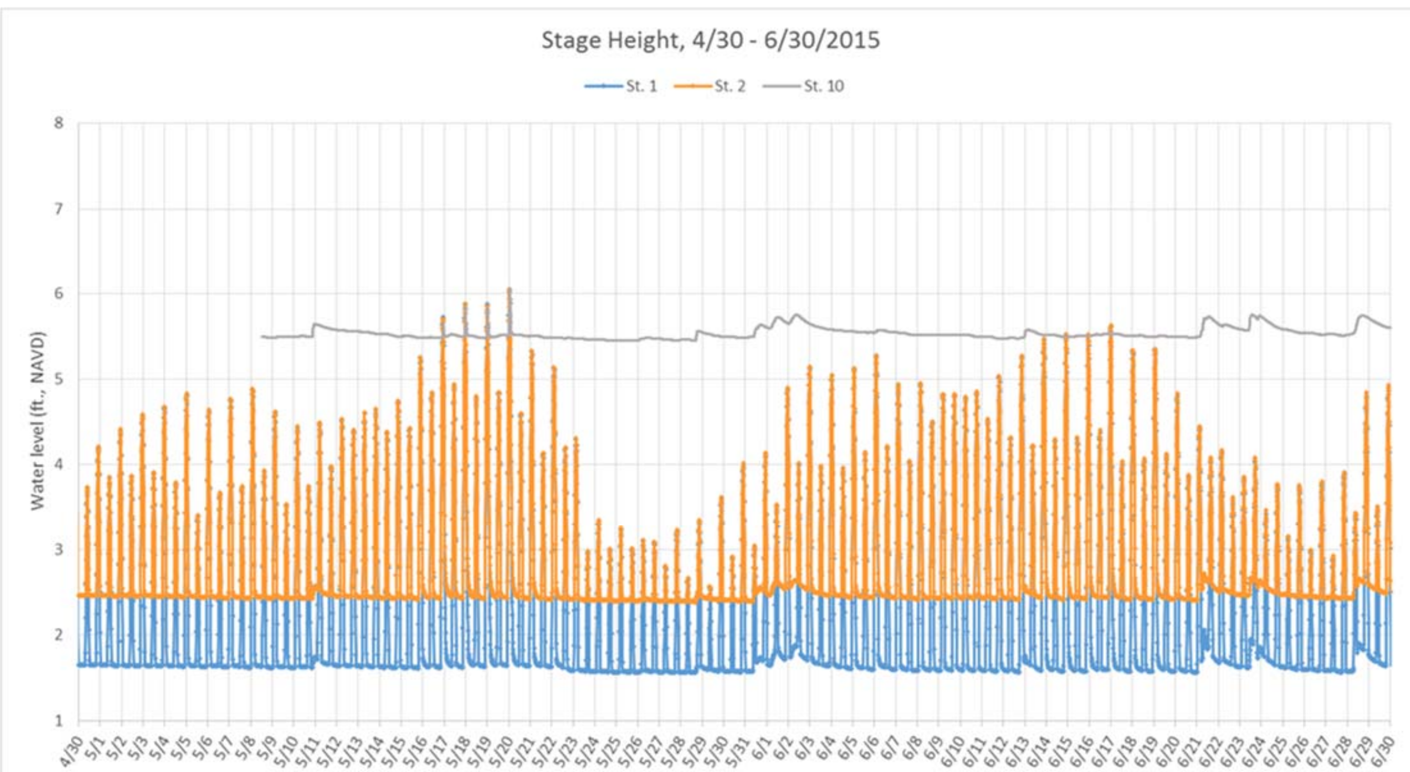


*Figure 6. Post-project water levels (2015).*

### 3.8.2 Instantaneous Difference in Stage Height

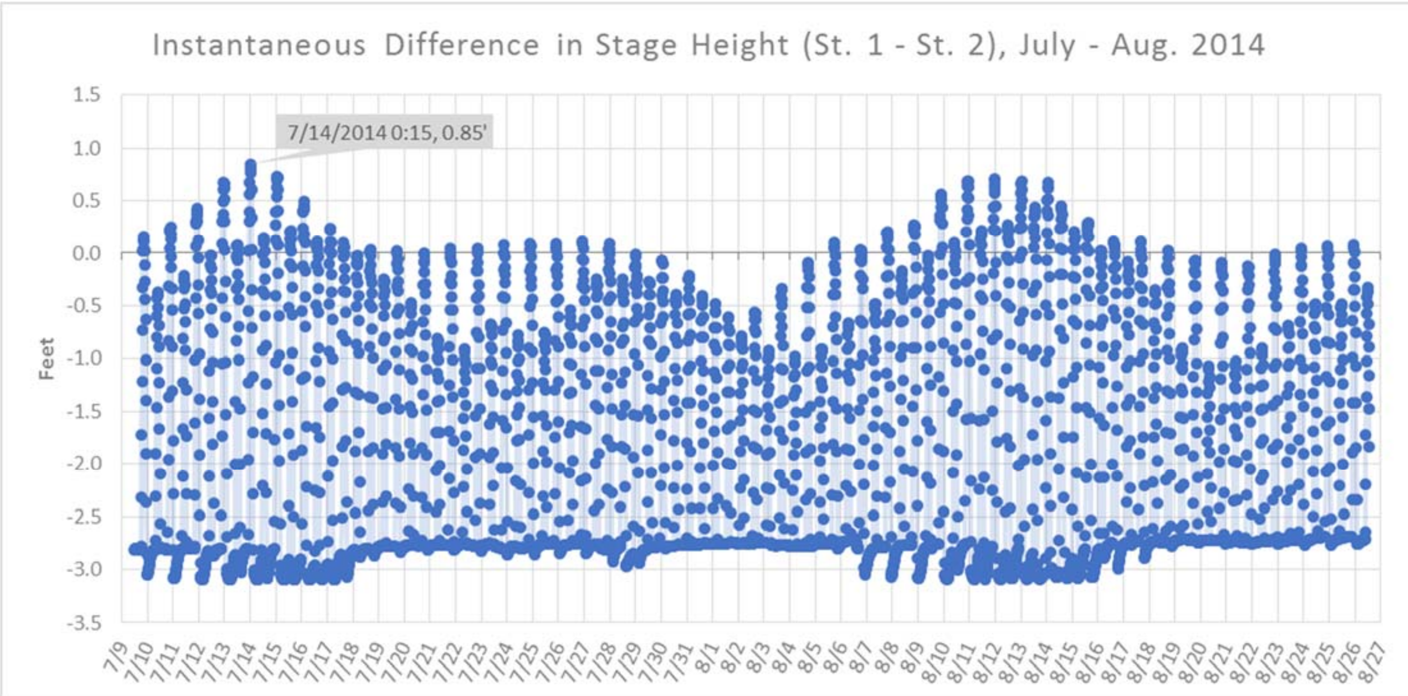


*Figure 7. Instantaneous difference in stage height, pre-project (2014).*

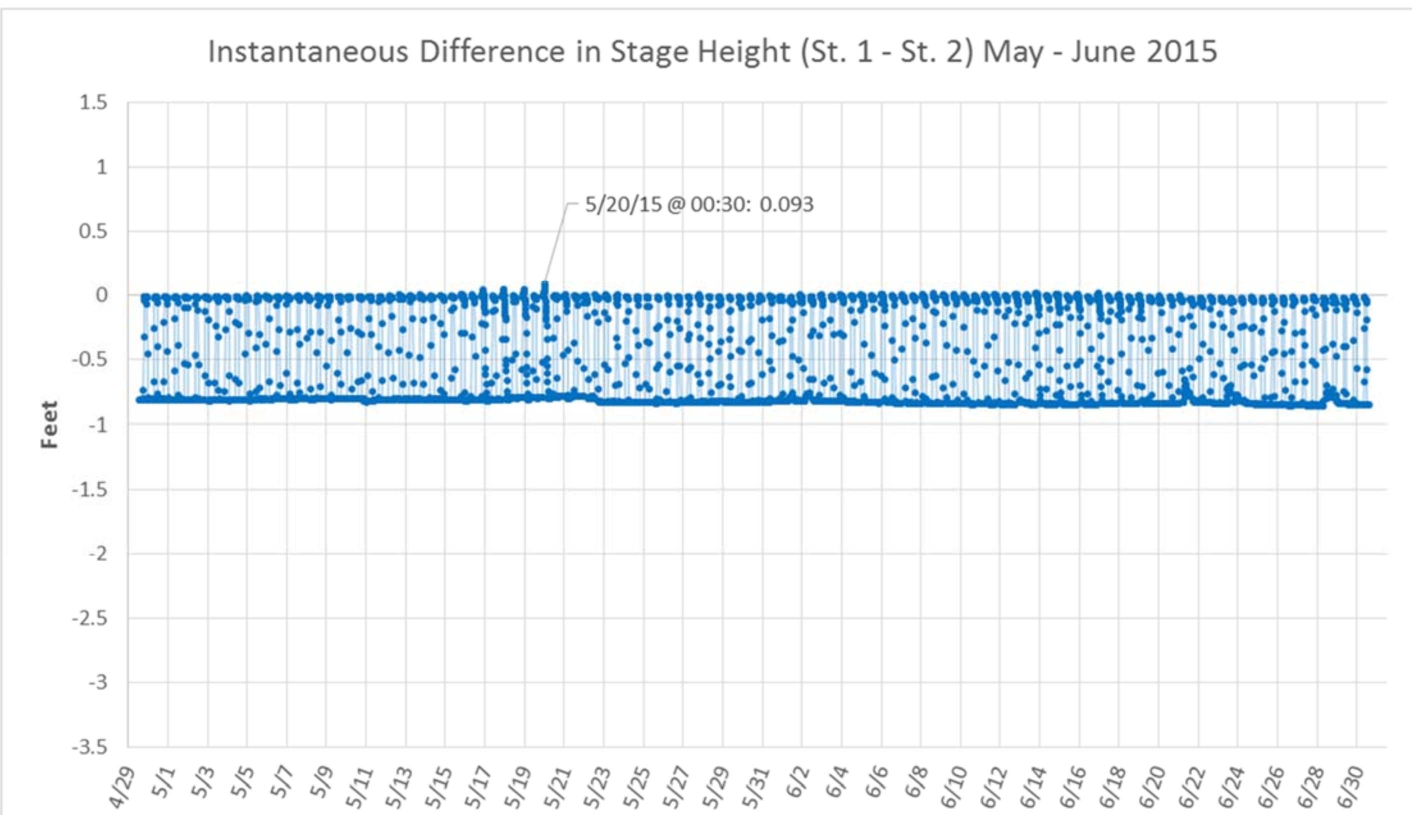


*Figure 8. Instantaneous difference in stage height, post-project (2015).*

### 3.8.3 Tidal Metrics

Tidal metrics were developed for the surface water hydrology data sets, as well as for the Portland Tide Station data during the deployment period presented for reference. Tables 7 and 8 summarize pre- and post-project tidal metrics at Station 1 and Station 2 for Mean Water Level (MWL), Highest Observed Water (HOW), Mean Higher High Water (MHHW), and Mean High Water (MHW). (Low-tide metrics were not evaluated due to the fact that the site sits in the upper end of the tide range and the wetland is primarily influenced by inundation at the upper end of the tide cycle). Elevations are provided in NAVD. NOTE: the tables summarize tidal metrics for the deployment period and should not be interpreted as datums for the site.

Over 4,600 data points were collected for the 2014 data set, and over 5,900 data points for the 2015 data set. Despite the longer deployment in 2015, the observed tidal metrics were lower across each elevation. The lower observations for MWL, MHHW, MHW, and HOW in 2015 are partially explained by the fact that the 2014 and 2015 data sets captured quite different spring tide events, based on comparison with Portland data. Another cause for this difference may be that fewer data points were collected during the neap tide phase in 2014, skewing the metrics higher. Other regional/Gulf of Maine circulation changes may also be at play.

For the pre-project data set, HOW was 6.584 at Station 1 (7/14/14), and 60 minutes later, HOW was 5.911 at Station 2, a difference of .673'. Post-project, HOW for the data set was observed to be 6.052 feet at Station 1 on 5/20/15, and 6.045 feet at Station2, with HOW occurring simultaneously. Based on the data, the project appears to have relieved the tidal restriction at the primary crossing (9079).

Portland's tide data is useful as a reference. Comparison of the 2014 and 2015 Portland Tide Station data shows that HOW was 6.783 feet during the 2014 deployment period, but just 6.203 feet during the 2015 deployment period. The 2014 data set captured unusually high tides that happened to occur during the deployment period. Comparison with epochal elevations on the Portland Tide Station Datum suggest that the 2015 data set is more representative of typical elevations at the Portland Tide Gauge, with the epochal datum MHW of 4.21 feet NAVD (compared with 4.365 at Portland, 4.245 at St. 1, and 4.262 at St. 2 for the 2015 deployment period). In contrast, MHW was 4.778' at Portland for the 2014 deployment period and 4.532 at St. 1, considerably higher than normal.

*Table 7. Pre-restoration tidal metrics for the 7/9 – 8/26/2014 data set (elevations in NAVD).*

| 7/9 – 8/26/14 (4,617 obs.) | Portland | St. 1 | St. 2 | Difference (St.1 - St. 2) | Difference (Portland – St. 1) |
|---|---|---|---|---|---|
| Mean water level | -0.060 | 2.296 | 4.410 | -2.113 | -2.357 |
| HOW | 6.783 | 6.584 | 5.911 | 0.673 | 0.199 |
| MHHW | 5.234 | 4.957 | 4.967 | -0.010 | 0.276 |
| MHW | 4.778 | 4.532 | 4.734 | -0.202 | 0.246 |

*Table 8. Post-restoration tidal metrics for the 4/30 – 6/30/2015 data set.*

| 4/30 – 6/30/2015 (5,955 obs.) | Portland | St. 1 | St. 2 | Difference (St.1 - St. 2) | Difference (Portland – St.1) |
|---|---|---|---|---|---|
| Mean water level | -0.290 | 2.281 | 2.841 | -0.560 | -2.571 |
| HOW | 6.203 | 6.052 | 6.045 | 0.007 | 0.151 |
| MHHW | 4.748 | 4.618 | 4.633 | -0.015 | 0.131 |
| MHW | 4.365 | 4.245 | 4.262 | -0.017 | 0.120 |

### 3.8.4 Highest Observed Water

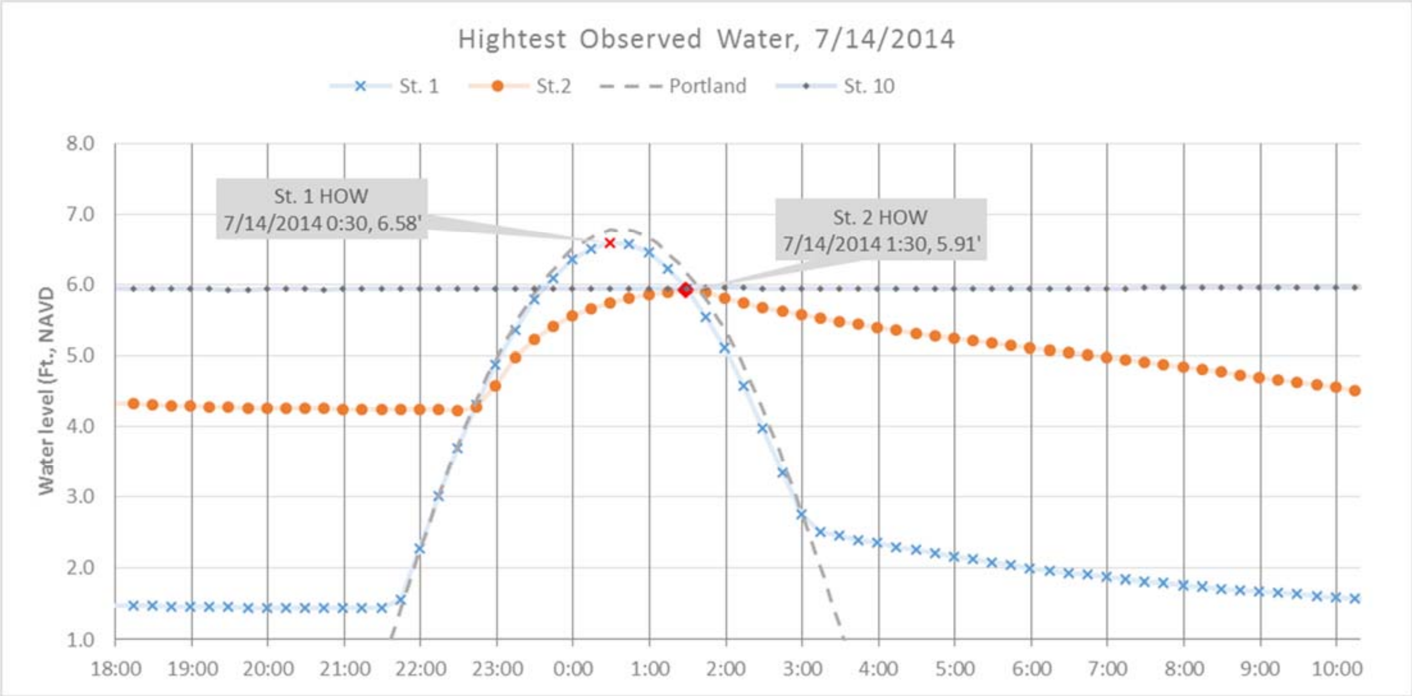


*Figure 9. Highest observed water for the 2014 deployment period.*

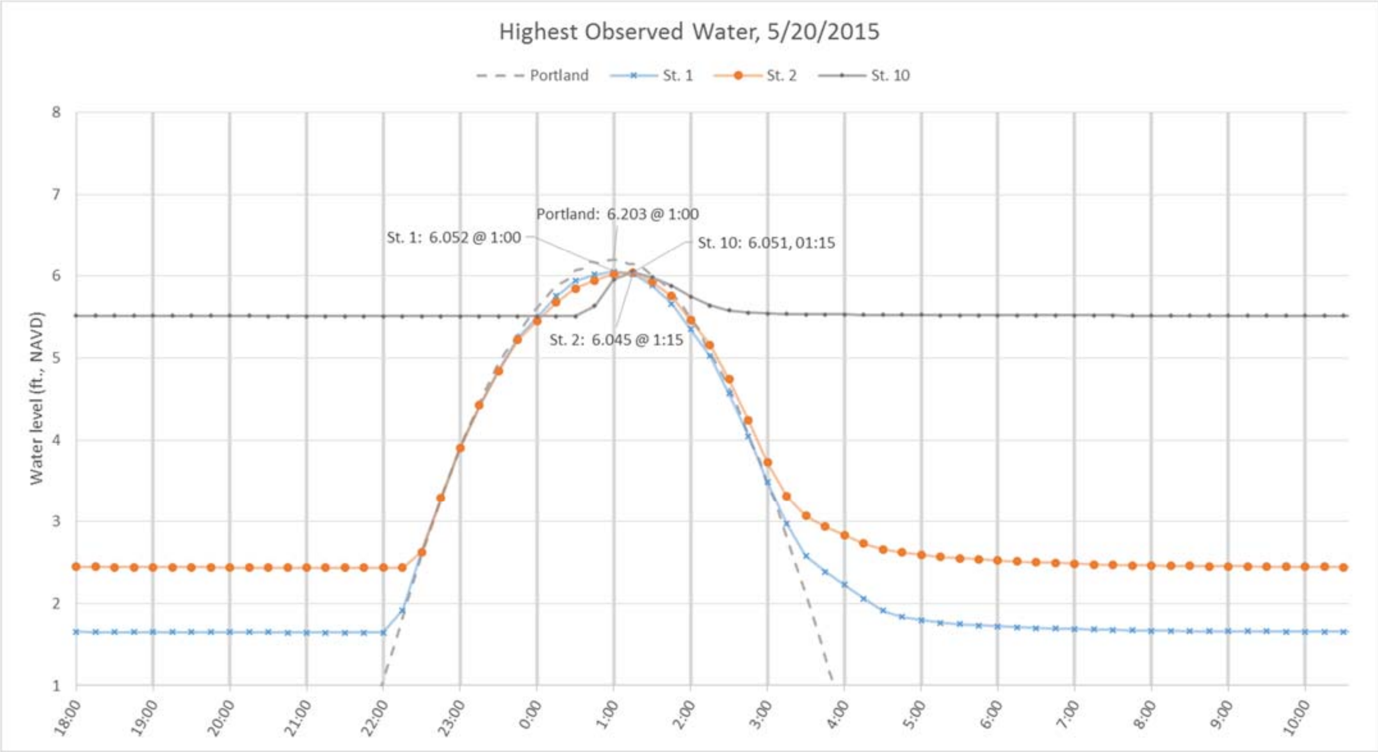


*Figure 10. Highest observed water for the 2015 deployment period.*

## 3.9 Salinity

CBEP monitored surface water salinity at Stations 1 and 2, groundwater salinity at Station 10, and pore water salinity at Stations 1, 3, 4, 6, 7, 8, 9, and 10.

### 3.9.1 Surface water salinity

Continuous surface salinity data was recorded using In Situ AquaTroll 200 loggers in conjunction with water level monitoring at Station 1 and Station 2. Fig. 11 illustrates the effect of the original crossing on salinity in the upstream surface water, which was much less variable than the surface water downstream except during rain storms. This may be explained by a combination of factors including impoundment of high salinity water upstream, stratification of water in the impoundment, and the fact that at low tide, enough groundwater was seeping into the channel to temporarily affect salinity levels in the shallow remnant pool. Fig. 12 illustrates that the new structure at 9079 has resulted in a similar level of variability in surface water salinity upstream and downstream of the crossing. [Note: manufacturer recommendations for salinity sensor calibration every three weeks were not performed in order to maintain continuous water level monitoring. Both data sets appear to show drift downward in salinity over the deployment].

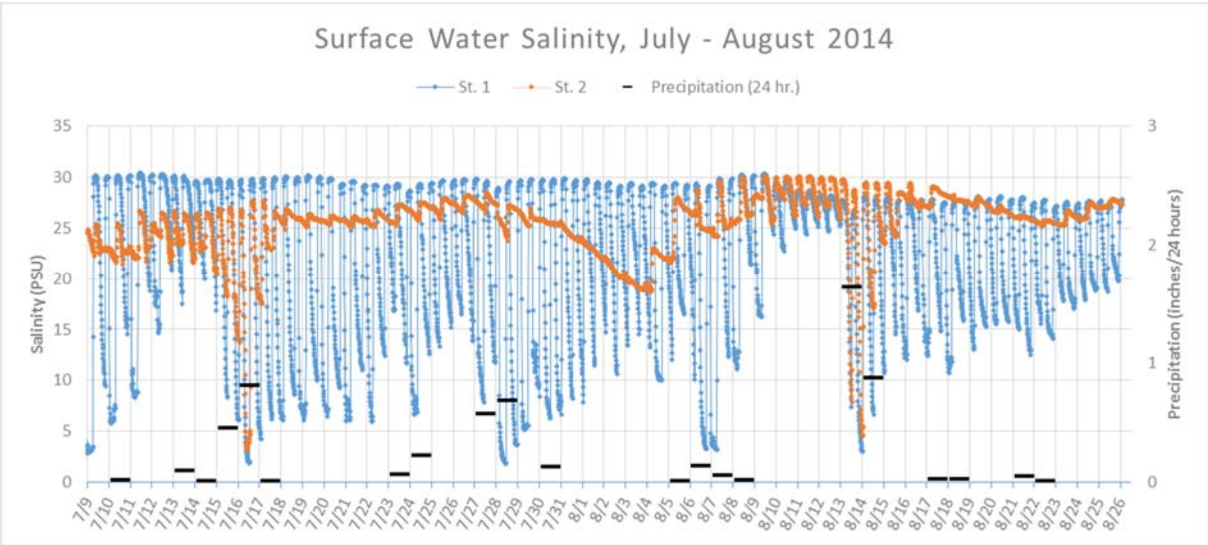


*Figure 11. Pre-project surface water salinity, 2014.*

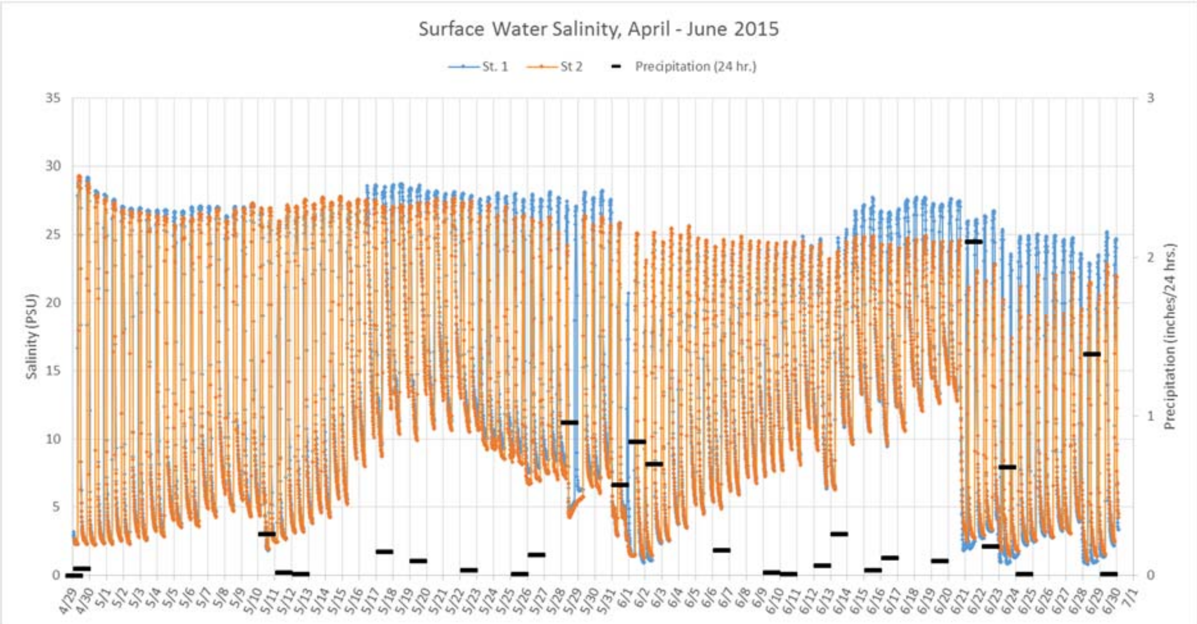


*Figure 12. Post-project surface water salinity, 2015.*

Tables 9 and 10 summarize the mean, minimum, and maximum salinity levels for surface water at Stations 1 and 2, and groundwater at Station 10. Mean salinity levels were higher at Stations 1 and 2 in 2014 (Table 9) than at the same locations in 2015 (Table 10). In 2014, salinity levels at Station 10 were near zero for the deployment period, but in 2015, salinity levels reached a high of 10.1 PSU (standard salinity units), despite the fact that overall site salinity was lower downstream, and there was a much lower documented HOW in 2015 than in 2014 (see Section 3.8.3). Figure 13 plots pre- and post- project salinity at Station 10 with water levels at Station 2 to illustrate the effect of high water levels on salinity upstream. Spring tides did not affect salinity levels at Station 10 in 2014, but did in 2015, indicating that tidal water moved upstream of 9078.

*Table 9. Pre-project summary statistics for salinity (2014).*

| Location | MIN | MAX | MEAN |
|---|---|---|---|
| **St. 1** | 1.9 | 30.4 | 21.4 |
| **St. 2** | 3.1 | 30.0 | 25.4 |
| **St. 10** | 0.0 | 0.7 | 0.2 |

*Table 10. Post-project summary statistics for salinity (2015).*

| Location | MIN | MAX | MEAN |
|---|---|---|---|
| **St. 1** | 0.8 | 29.2 | 13.7 |
| **St. 2** | 1.1 | 29.3 | 12.5 |
| **St. 10** | 0.0 | 10.1 | 4.2 |

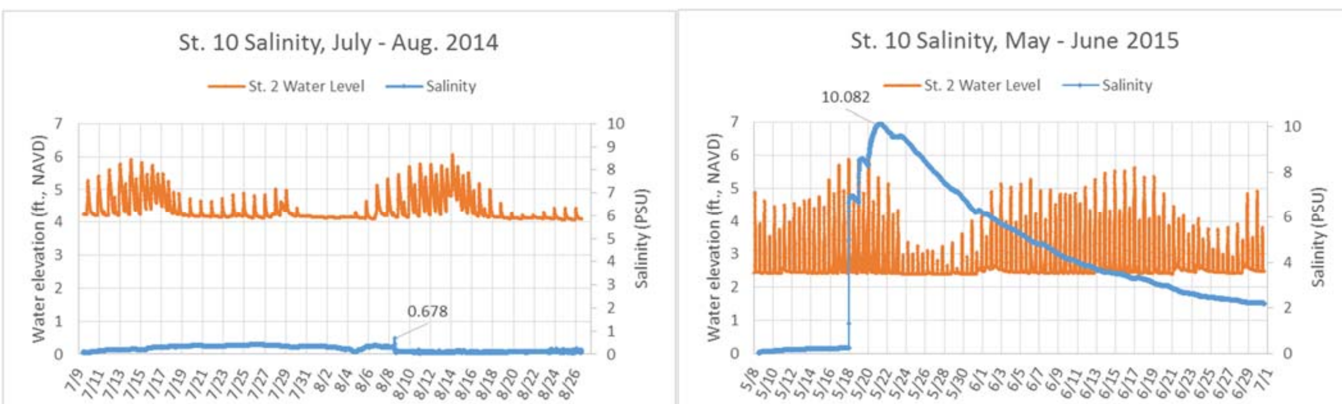


*Figure 13. Comparison of pre- and post- project salinity levels at St. 10 with water levels at St. 2.*

### 3.9.2 Pore water salinity

CBEP collected pre- and post-project pore water salinity samples from using wells constructed with PVC piping consistent with specifications provided in the *Restoration Work Plan*, which allow for samples in the root zone of salt marsh vegetation of 15-25 cm below the marsh surface. Sampling protocols call for samples to be collected at least once per month during the growing season (April – October), with samples collected using a catheter and surgical tubing, and measurements made using a calibrated hand-held refractometer. At Stations 3, 4, 6, 8, and 9, multiple wells were installed along the vegetation transect to document pore water salinity levels at various distances from the creek channel and upland edge, with lower alphabetical order (e.g., 3a, 3b) generally associated with closer proximity to the channel.

Graphed results (Fig. 14) illustrate that 2015 pore water salinity levels were consistent with 2014 at wells located nearer to the bay (1, 3a, 3b, 3c), and generally higher in 2015 at wells further from the bay (7, 8a, 8b, 9a, 9b, 9c), which will be interesting to track for vegetation community shifts. Fig. 15 illustrates mean, minimum, and maximum pore water salinity levels at each well in 2014 and 2015. Maximum observed pore water salinity was higher at every station in 2015 than in 2014, and means were generally higher. Minimum salinity levels were comparable or lower in 2015, consistent with increased flushing and improved drainage following removal of the impoundment created at crossing 9079. The influence of groundwater seepages from upslope is clearly evident at 6b and 8b, which lie at the foot of a steep hill, and at St. 10, which drains an area that includes several houses upslope.

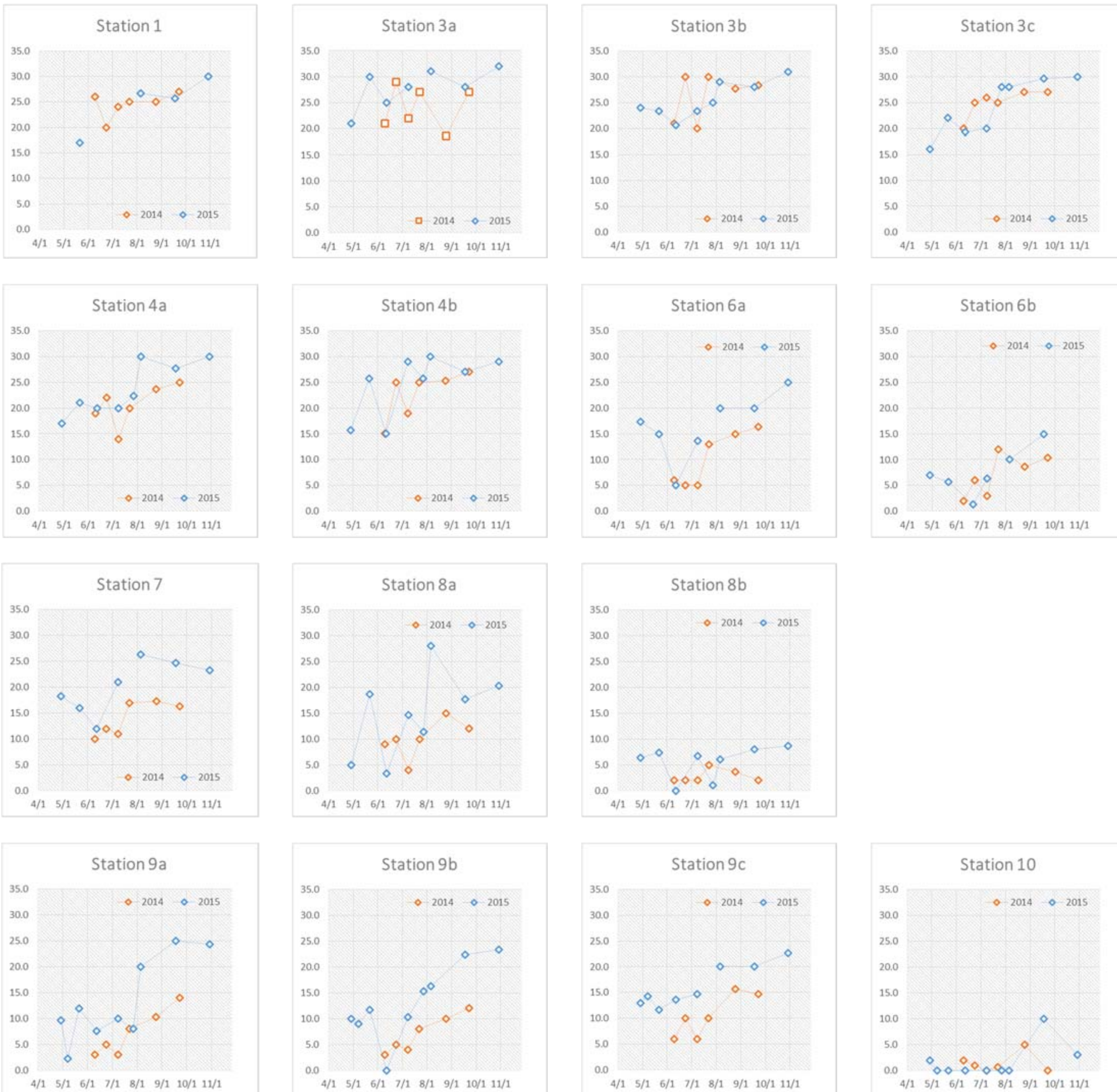


*Figure 14. Graphs of pre- and post- project pore water salinity levels at individual wells.*

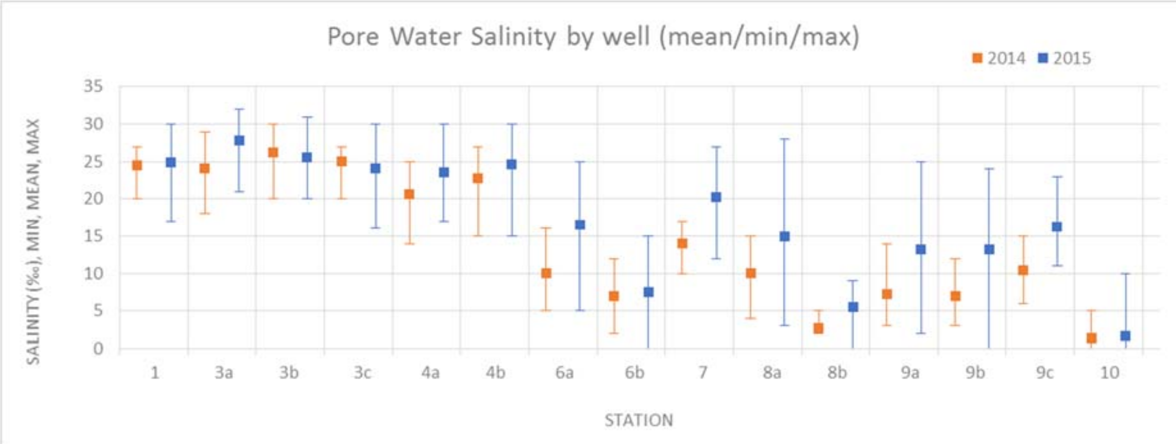


*Figure 15. Box and whisker illustration of mean, minimum, and maximum pore water salinity levels pre- and post-project.*

## 3.10 Channel Morphology

CBEP staff surveyed channel cross sections at Stations 1-9, as well as longitudinal profile through the construction areas, pre-project and again in 2015. Data were entered into the *Reference Reach Spreadsheet*[1] for comparison. Fig. 16 plots the longitudinal profile of 9079 based on data collected in 2012. The profile illustrates the perched crossing (9079) at 200 feet, with accumulated sediment 50 feet upstream of the culvert outlet functioning as a grade control that impounded surface water upstream. Fig. 17 plots the profile of the channel approaching 9078 from downstream.

The 2015 longitudinal profile of the tidal creek from the bay through both project areas (9079 and 9078) is shown in Fig. 18, with elevations in feet, NAVD based on benchmark data provided by Wright Pierce. Mean high water (MHW, 4.12' NAVD) for the Portland datum is shown for context.

The channel bottom at 9079 is consistent with the channel grade upstream and downstream, and the accumulated sediment upstream is no longer evident. A series of shallow pools remains immediately downstream of 9079, and has formed immediately upstream in response to gradual movement of sediment. A small head cut was observed a little more than 400' upstream from the bay, with the channel bottom relatively flat until getting shallower between Station 8 and 9. The channel bottom at 800' (Fig. 18) has dropped by approximately 1' from the 2012 survey (50', Fig. 17). Further upstream, the channel becomes extremely shallow approaching 9078, where the slug of coarse-grained sediments (evident in both Fig. 17 and 18) sits on the marsh surface, resulting in a very shallow braided channel below the outlet of 9078. The sand is believed to have been deposited in this location during a culvert blow-out prior to any discussions about a restoration project. Local residents described a portion of the road bed washing onto the downstream marsh along with the culvert. Immediately upstream of the slug, and immediately downstream of the culvert outlet, is the area excavated during culvert installation. Here, water is pooled behind this grade control through the culvert into the excavated area upstream, above which a defined channel is no longer visible. This issue is discussed further in Section 4.2.

The profile ends at the next culvert upstream (9076) beneath Shore Road.

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[1] Mecklenburg, D. 2006. *The Reference Reach Spreadsheet*. Ohio Department of Natural Resources. http://water.ohiodnr.gov/portals/soilwater/data/xls/Example_of_Reference_Reach_Survey_4_0_T.xls

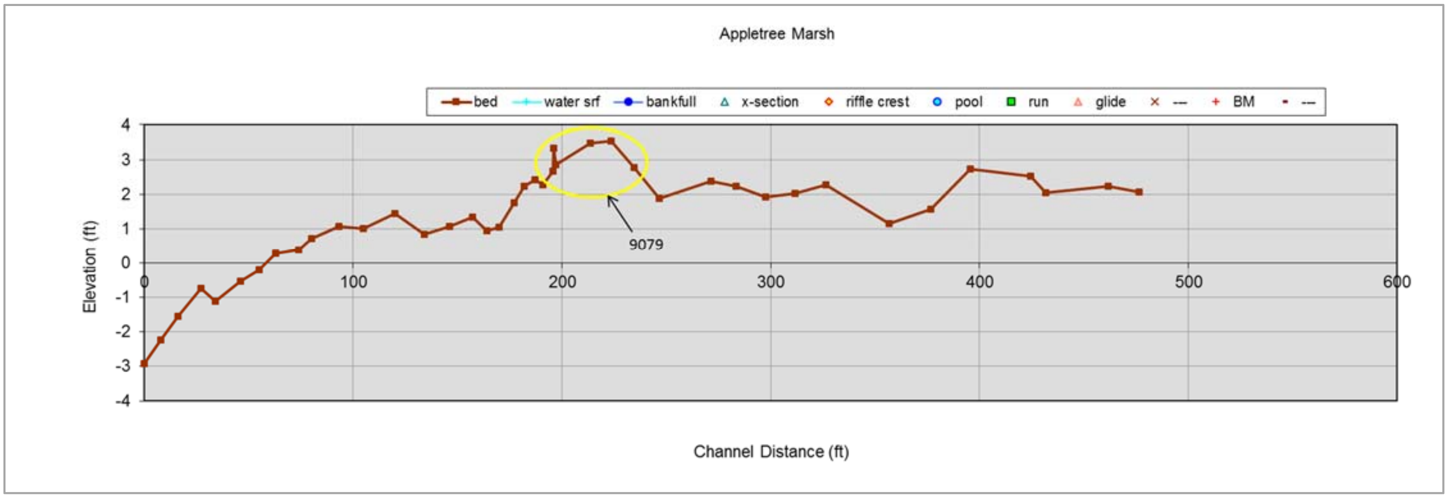


*Figure 16. Pre-project longitudinal profile of 9079 (2012). Mecklenburg 2006.*

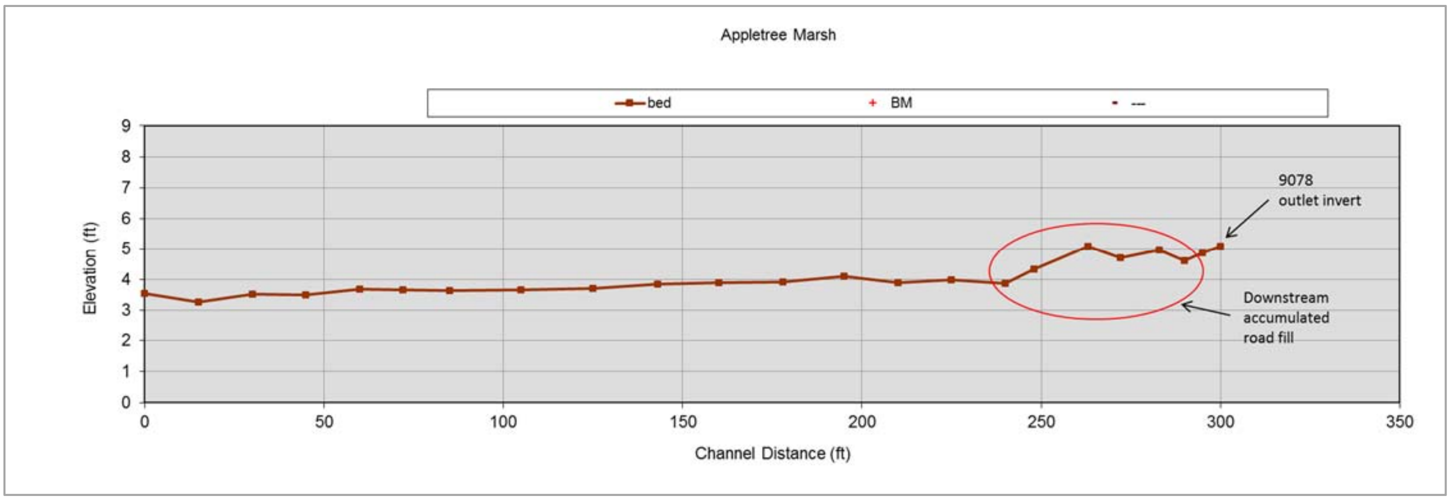


*Figure 17. Pre-project longitudinal profile of 9078 (2012, downstream only). Mecklenburg 2006.*

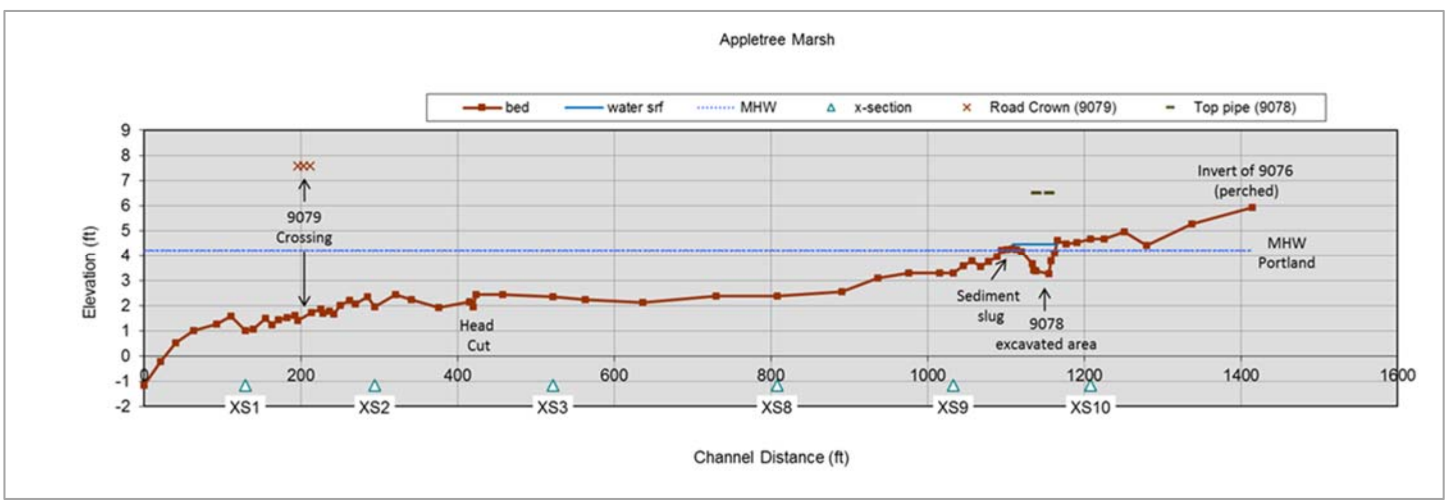


*Figure 18. Post-project longitudinal profile of the tidal creek (2015). Mecklenburg 2006.*

Fig. 19 plots channel cross section profiles for 2014 and 2015 side by side using the *Reference Reach Spreadsheet.* Cross sections for St. 1, 9 and 10 are not shown.

Bankfull width was approximated using channel characteristics (elevation breaks, observations/notes) to calculate channel dimensions and cross sectional area, allowing for a roughly standardized year over year comparison of change in channel characteristics, which is useful for considering channel evolution in relation to increased inundation of the marsh surface. At each station, the direction of the cross section is shown on the top of the graph. Elevations are in feet relative to NAVD.

- At Station 2, the middle and south side of the channel has deepened, with the base of the south bank more angular, suggesting active scour and sediment mobility.
- At Station 3, the channel is becoming V-shaped and angular in general, particularly at the thalweg, suggesting active scour. Unconsolidated sediment appears to have moved out of the channel outside the thalweg as well.
- At Station 4, which is upstream of the bifurcation of the main channel into two channels, the channel is similarly narrow, but deeper.
- At Station 5, a v-shaped angular channel shape is emerging, indicative of active scour.
- Station 6 shows little change from pre-project to post-project other than an angular shape to the west bank, which appears to be lower.
- At Station 7, near the southern tip of the marsh and fed by groundwater seep, the channel appears unchanged,
- At Station 8, on the northern lobe of the marsh, the channel appears slightly wider, but generally similar.

By percentage, the greatest increase in channel cross sectional area from pre-project to 2015 occurred at Station 4 (57.6%; Fig. 20). By volume, the greatest increase was measured at Station 3 (6.9 $ft.^2$).

Selected photographs from the cross section surveys are included in the appendices. At most Stations, photographs were taken looking upstream, downstream, and from each channel bank, providing a visual record. At some Stations, additional photos were taken showing views to the upland edge.

Additional photos and cross section graphs for Stations 1, 2, and 10 are available upon request to CBEP.

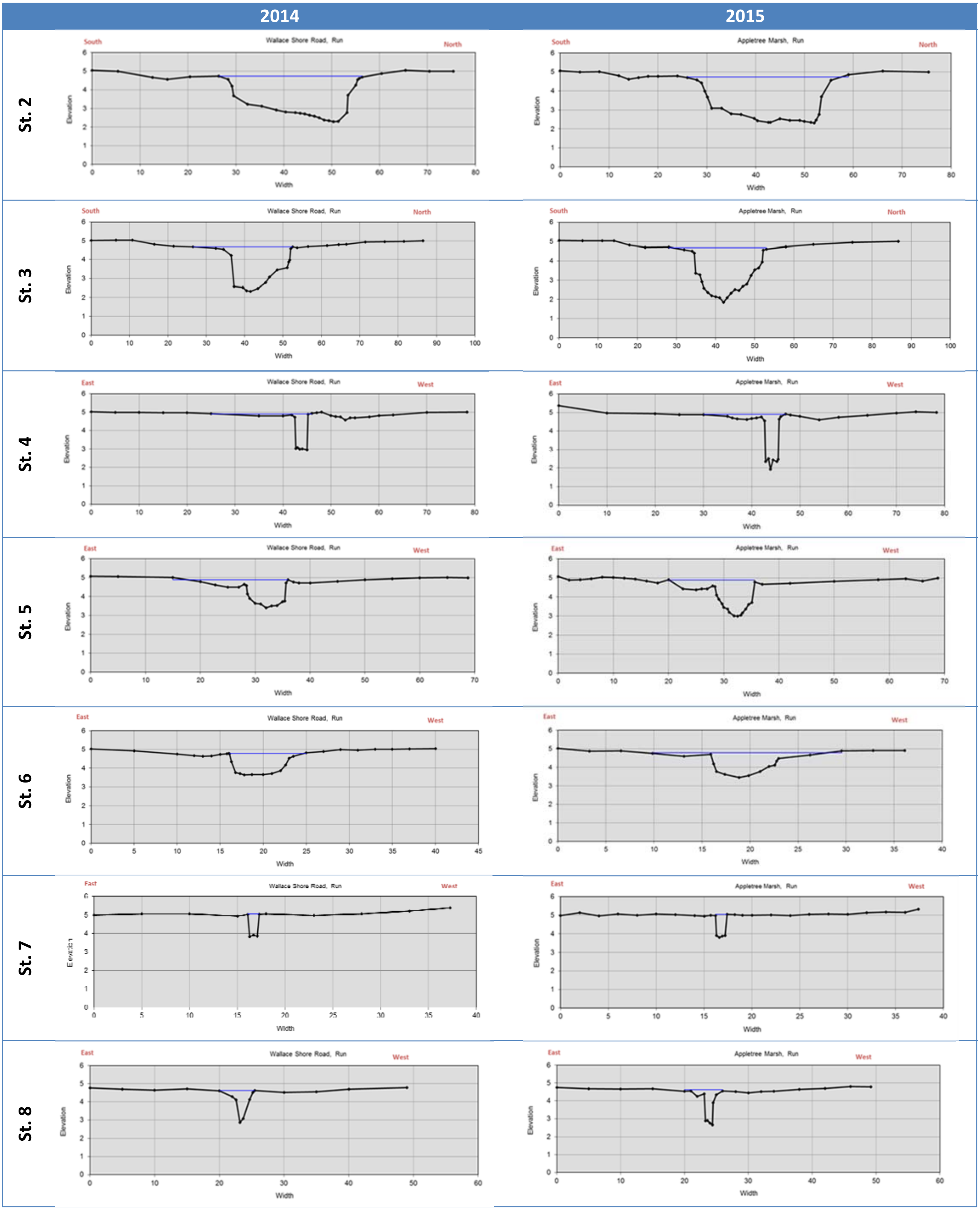


*Figure 19. Comparison of pre- and year 1 post- project cross section profiles at Stations 2 - 8. Mecklenburg 2006.*

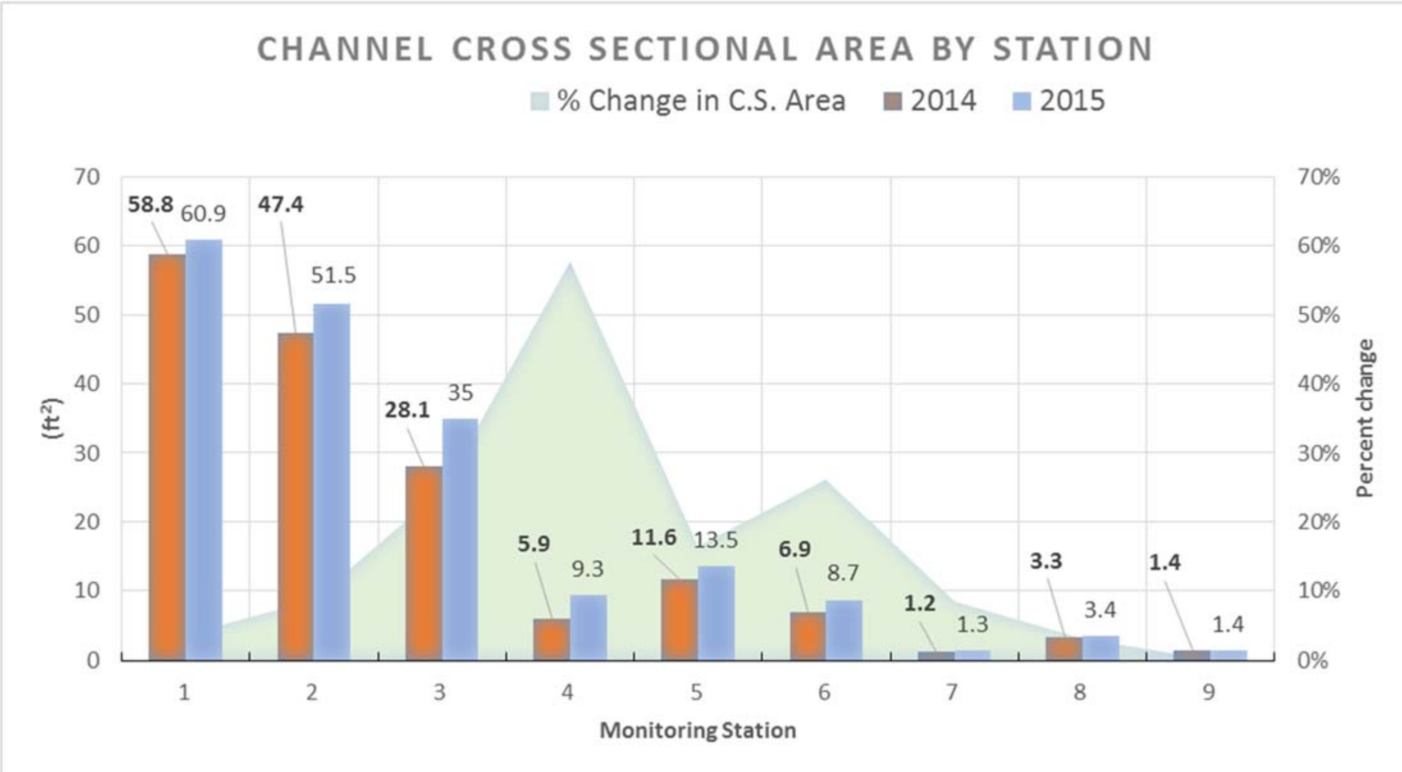


*Figure 20. Comparison of channel cross sectional area pre- and year 1 post-project.*

## 3.11 Plant Species of Concern

Plant species of concern are included in the monitoring plan. Observations were recorded during invasive species meander surveys of the marsh and its perimeter, during vegetation monitoring, and during incidental observations. CBEP did not document the presence of invasive plants in the forested area upslope of the upland edge, but they appear to be abundant under the forest canopy in some places. Neither did the surveys cover adjacent freshwater wetlands to the north and south of the wetland area influenced by the tidal restoration project.

The primary species of interest for performance standard monitoring, *Phragmites australis*, remains absent from the site. In 2015, the only invasive plant observed in the wetland footprint was Purple Loosestrife (*Lythrum salicaria*), which was found in several locations, typically in clusters of a few plants, along the perimeter (St. 2, St. 8, St. 10). Primarily, loosestrife was observed on or immediately adjacent to the road bank, and secondarily, in areas with obvious freshwater inputs (seeps or surface water). A large Japanese Barberry (*Berberis thunbergii*) was also observed on the road bank to the west of 9078 in 2014 and 2015 (Fig. 21), right at the wetland's delineated edge. CBEP staff manually cut back the Barberry to the ground in 2015 in order to promote native vegetation and limit the potential for expansion, and will monitor future growth and repeat manual cuts until the plant is dead.

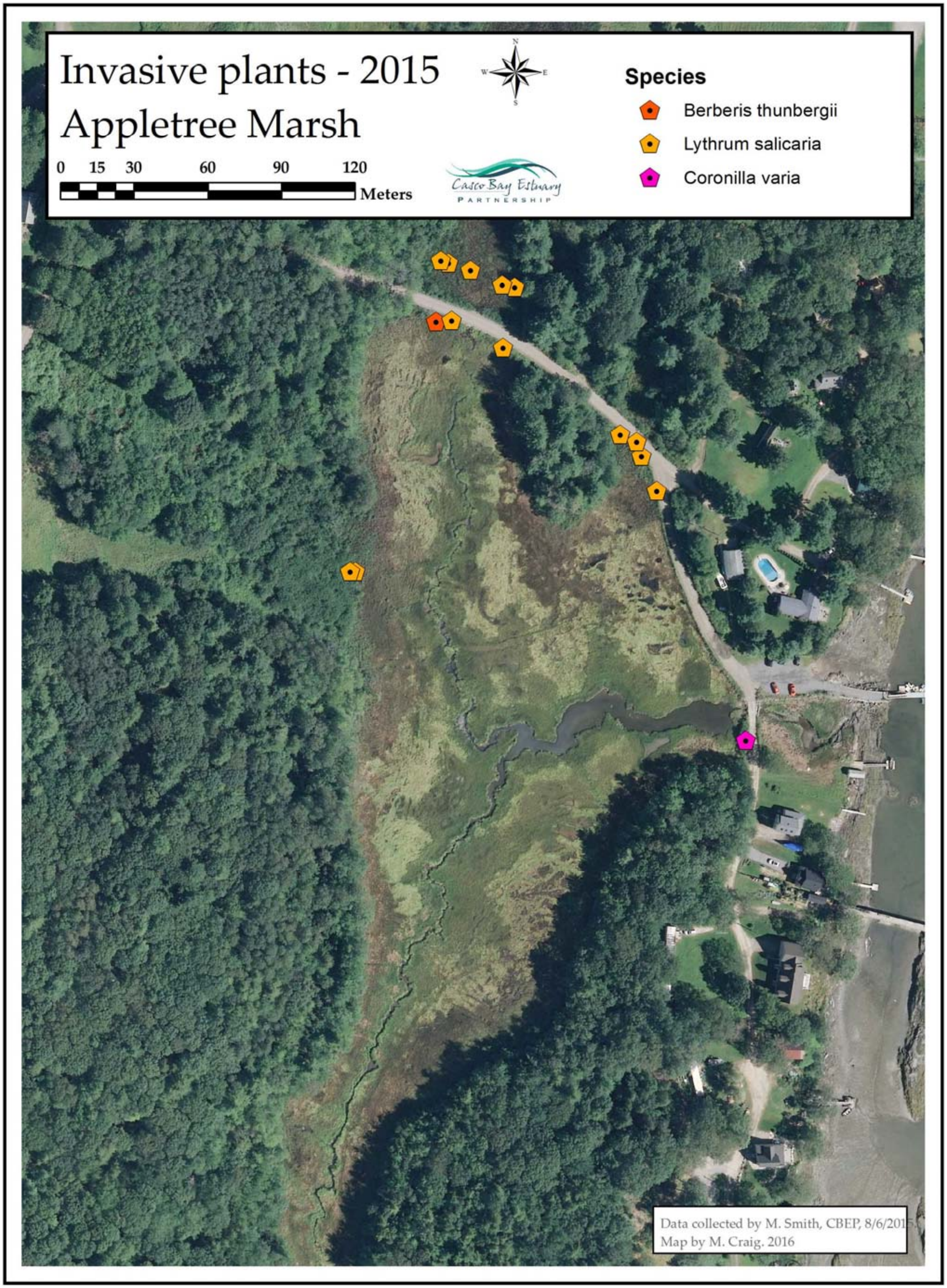


*Figure 21. 2015 observations of plant species of concern.*

# 4. Summary and Conclusions

## 4.1 General Site Conditions

The project successfully replaced road/stream crossing infrastructure at two locations on Wallace Shore Road (site 9079 and 9078) with the goal, as stated in the *Restoration Work Plan*, of restoring tidal exchange and increasing freshwater drainage, thereby improving overall hydrology, at the adjacent E2EM1P estuarine and marine wetland.

General site conditions are on track with the performance standards defined by the *Restoration Work Plan*:

- All the constructed features such as slopes, soils, and substrates within the mitigation site are stable and free from erosion during the monitoring period.
- Invasive *Phragmites australis* has not been introduced to the site.
- The tidal restriction at the primary crossing, defined as the difference between highest observed water (HOW) downstream and upstream, is less than or equal to .3' based on 2015 monitoring.

Based on review of hydrology data (Section 3.8), the overarching project goal has been achieved. Data collected through monitoring of other ecological parameters, including vegetation, channel morphology, and pore water salinity, indicates that the wetland has begun to adjust to the abrupt change in hydrology (Sections 3.5, 3.9, 3.10), which is presumed to be an ongoing process. Indications of improved bidirectional flow include channel scour, lower water levels, and higher pore water salinity levels. While some parameters, such as tidal hydrology and pore water salinity, show a short-term/immediate response to the new culverts, other parameters, particularly vegetation communities and channel morphology, are responding gradually and less abruptly. The ecological response to the new hydrology is an ongoing process that will be monitoring and reported for Years 2 – 5.

## 4.2 Recommendations for Adaptive Management

As noted in Section 3.4, and described further in Section 3.10 (and illustrated in the 2015 longitudinal profile in Fig. 18), over the course of several monitoring visits, CBEP observed that surface water is pooling in the excavated channel outlet of crossing 9078 due to a lack of channel development/scour. Water flowing into the excavated area from upstream (north side of culvert) is impounded at the edge of the area excavated during installation, and backs up through the pipe into the excavated area upstream of the inlet, creating a standing pool of water that discharges in a braided network of channels before it reaches the downstream channel. Closer examination revealed that a sediment slug from a historic culvert failure is controlling the grade just downstream of the 9078 outlet. This may be maintaining water levels that allow for persistence of glycophytic species and slow the process of conversion to brackish and halophytic communities at Station 10. The issue is most obvious during low flow conditions that co-occur with a neap tide phase when the flow out of this pool becomes a trickle (Fig. 22). Shallow exploratory probing of the channel suggests that coarse-grained sediments are present on the marsh surface along the edge of the excavated area, and are not mobilizing, presumably due to a lack of velocity/volume combined with volume of sediments present. As previously mentioned, anecdotes from abutters confirm that several years ago (preceding the project), the culvert blew out at this location, washing road fill onto the downstream marsh. The pool, and the sediment slug, may be contributing to the presence of cattails immediately downstream (Fig. 22).

Although water levels in the cattail stand upstream (Station 10) have dropped following installation of the new culvert, and hydrology and pore water salinity data confirms that salt water is now accessing this area post-project, the sediments appear to be maintaining water levels higher than would be expected upstream, and further benefits to tidal exchange (bidirectional flow) could be achieved by removing sediments to assist channel evolution.

Three conceptual management responses could be considered to addressing the issue and enhancing flow at and downstream of 9078:

1. No action. In this approach, CBEP would continue to survey the channel, then re-evaluate the situation in the next report based on Year 2 data. This would allow for additional time to determine whether a direct remediation measure is warranted or whether the channel is slowly responding on its own. No additional cost would be associated with this option, which would occur within pre-determined monitoring and reporting tasks.

2. Remove sediments from the channel. Use hand tools (shovel, hoe) to carefully hand dig coarse-grained sand out of the narrow channel without damaging adjacent vegetation, and transport sediments offsite using a few five gallon buckets. Prior to implementation, additional sediment probes in the channel could be used to determine the extent and depth of coarse grained road fill in the channel. A simple plan could be drawn up in advance to determine channel elevations and width, based on the 2015 longitudinal profile, and survey equipment would be used to check elevations during field implementation. Implementation could be conducted in the summer of 2016. No cost is anticipated with this approach, which could be completed by two people in a couple hours. This is the preferred approach and is recommended out of the three options presented, provided that no additional permitting and approvals is required.

3. Remove sediments from the marsh and channel. Another approach would be to bring heavy equipment back to the site to excavate sediments from both the marsh surface and the channel. The purpose would be to not only improve flow out of the excavated area, and relieve the impoundment, but also to lower marsh surface elevations. A detailed topographic survey downstream of the 9078 outlet may be warranted, as well as a more expansive survey of sediments, to determine the extent and depth of coarse grain sediments downstream of 9078. Simple drawings may be warranted to guide excavation of sediments working with large equipment (presumably, a back hoe or excavator and a dump truck). This option is least preferred. Although this approach could realize additional benefits by removing fill from the marsh surface, use of an heavy equipment brings an inherent risk of doing more harm than good (damage to vegetation, digging out a larger or deeper channel than is suitable, etc.). For this reason, the approach is not recommended. Work could be conducted in late summer/early fall 2016 if funding was obtained, and permits were secured if necessary, but these are unknown considerations at this time.


*Figure 22. Pooled water at the outlet of crossing 9078 (2015).*

# Appendix A – Photographs

*Representative photos are required to support the findings and recommendations, for each restoration/enhancement site. Photos should be taken from the same locations for each monitoring event and must be dated and clearly labeled. A map, or maps, showing photo locations must be included and clearly labeled with the direction from which the photo was taken. Photos may be included in this appendix or in the body of the report.*

CBEP staff photo-documented conditions on the marsh and at the two project areas (crossing #9079 & #9078) on multiple occasions pre-project, and at least once during year 1 post-project. A subset of these photos are organized in a set of three tables, which also include the subject, direction and date of each photo, within Appendix A. Maps showing the location of the photo stations, which include the project areas (sites 9079 and 9078), and the cross section and vegetation monitoring stations (Stations 1 – 10) are provided in the main body of the report.

Tables 11 and 12 compare pre-project and 2015 comparisons of conditions at the two project locations, 9079 and 9078. Additional photos (for example of the road approach, or certain details) are available upon request.

Table 13 presents pre/post photos at cross sections survey locations (Stations 1 – 9). Additional photos showing alternate views of the cross section surveys may be available. Photographs for Station 10 are presented in Table 14, for the vegetation surveys.

Table 14 presents pre/post photos along the transects at vegetation monitoring stations (Stations 1 – 10). Additional photos showing photos in the opposite direction (e.g., from the upland toward the channel) are available for each Station.

*Table 11. Photos of project area, crossing #9079 (crossing nearest to bay).*

<table>
<tr><th>SITE 9079, PRE-PROJECT</th><th>SITE 9079, POST-PROJECT (YEAR 1)</th></tr>
<tr><td colspan="2">View Downstream (Est). Dates (L to R): 7/31/2012; 8/18/2015.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">View to Outlet (West). Dates (L to R): 7/31/2012; 8/18/2015</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">View to Inlet (East). Dates (L to R): 7/31/2012; 8/18/2015</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">View Upstream (West). Dates (L to R): 7/31/2012; 8/18/2015</td></tr>
<tr><td></td><td></td></tr>
</table>

*Table 12. Photos of project area, crossing #9078 (crossing nearest to upland).*

| **SITE 9078, PRE-PROJECT** | **SITE 9078, POST-PROJECT (YEAR 1)** |
|---|---|
| View Downstream (South). Dates (L to R): 7/23/2012; 8/18/2015 | |
|  |  |
| View to Outlet (North). Dates (L to R): 7/28/2014; 5/26/2015 | |
|  |  |
| View to Inlet (South). Dates (L to R): 7/28/2014; 5/26/2015 | |
|  |  |
| View Upstream (North). Dates (L to R): 7/23/2012; 8/18/2015 | |
|  |  |

*Table 13. Photos from cross section surveys.*

<table>
<tr><th>PRE-PROJECT</th><th>POST-PROJECT (YEAR 1)</th></tr>
<tr><td colspan="2">Station 1 (L – 7/31/2012; R – 8/4/2015); view to E/SE. Outlet to bay in the background.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 2 (L - 7/25/2014; R – 8/4/2015); view to E. Inlet of 9079 in background.</td></tr>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">Station 3 (L – 7/9/2014; R – 8/4/2015); view to W, looking upstream from 9079.</td></tr>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">Station 4 (L – 7/9/2014; R – 7/28/2015); view to S, toward St. 5, 6, and 7.</td></tr>
<tr><td>
</td><td></td></tr>
</table>

<table>
<tr><th>PRE-PROJECT</th><th>POST-PROJECT (YEAR 1)</th></tr>
<tr><td colspan="2">Station 5 (L – 7/9/2014; R – 7/28/2015); view to N, toward St. 4.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 6 (L – 7/9/2014; R – 8/18/2015); view to N, toward St. 4 & 5.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 7 (L – 7/9/2014; R – 7/28/2015); view to S. Channel obscured by vegetation.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 8 (L – 7/25/2014; R – 7/28/2015); view to S toward St. 4, 5.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 9 (L – 7/25/2014; R – 7/30/2015); view to S toward St. 8. Channel obscured by S. alterniflora.</td></tr>
<tr><td></td><td></td></tr>
</table>

*Table 14. Photos from vegetation surveys.*

| **PRE-PROJECT** | **POST-PROJECT (YEAR 1)** |
|---|---|
| Transcect 1a. (L – 7/15/2014; R - 7/14/2015); view S/SW from channel to upland. | |
|  |  |
| Station 1b. (L – 7/15/2014; R – 7/14/2015); view N from channel to upland/gravel parking lot. | |
|  |  |
| Station 2. (L – 7/15/2014; R – 7/14/2015); view N from channel toward upland. | |
|  |  |
| Station 3. (L – 7/15/2014; R – 7/16/2015); view N from channel to upland. | |
|  |  |

<table>
<tr><th>Pre-Project</th><th>Post-Project (Year 1)</th></tr>
<tr><td colspan="2">Transect 4. (L – 7/17/2014; 7/14/2015); view E from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 5. (L – 7/17/2014; R – 7/14/2015); view E from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 6. (L – 7/17/2014; R – 7/14/2015); view E from channel to upland.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Station 7. (L – 7/17/2014; R – 7/14/2015); view E from W end of transect.</td></tr>
<tr><td></td><td></td></tr>
</table>

| **PRE-PROJECT** | **POST-PROJECT (YEAR 1)** |
|---|---|
| Transect 8. (L – 7/15/2014; 7/16/2015). L - view E from upland to channel; R - view W from channel to upland. | |
|  |  |
| Station 9. (L – 7/15/2014; R – 7/16/2015). View W from channel to upland. | |
|  |  |
| Station 10. (L – 7/15/2014; R – 7/16/2015). View E from W end of transect. | |
|  |  |

## Appendix B – Maps

*A map or maps should be attached to each monitoring report showing the boundaries of the restoration/enhancement area(s) relative to other landscape features on the site, habitat types, locations of photographic reference points, transects, sampling data points, and/or other features pertinent to the restoration/enhancement plan and monitoring events. Geographic coordinates are helpful in locating the site(s) for inspection purposes.*

All maps are included within the main body of the report. Monitoring stations are georeferenced and GPS coordinates are available upon request to CBEP.

## Appendix C – Plans

*If alterations were made to the approved restoration/enhancement plan due to conditions found in the field, as-built plans showing appropriate topography for type of restoration, structures including any inlet/outlet structures, grading, etc. must be submitted. These need only be submitted once and may be included in future monitoring reports by reference. If plantings were part of the plan, location and extent of the designed plant community types (e.g., shrub swamp) should be included. Within each community type the plan shall show the species planted—but it is not necessary to illustrate the precise location of each individual plant. There should also be a soil profile description and the actual measured organic content of the topsoil. This should be included in the first monitoring report unless there is grading or soil modifications or additional plantings of different species in subsequent years.*

No modifications were necessary due to unforeseen conditions in the field, so the project was constructed within the parameters of the final engineering designs as presented in the *Wallace Shore Road Restoration Work Plan.*

## Appendix D – Plant List

*As applicable, a vegetative species list of volunteers in each plant community type. The volunteer species list should, at a minimum, include those that cover at least 5% of their vegetative layer.*

A comprehensive list of vegetation identified during vegetation surveys is provided in the main body of the report, and a list of invasive plant species observed is provided in Section 3.11. Since this project did not involve planting vegetation, and the community type is already present on the site, the monitoring plan was not designed to document volunteers species within each community type.