UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

Memorandum

Date: December 6, 2021

Subject: New Bedford Harbor Superfund Site; New Bedford, Acushnet, Fairhaven and Dartmouth, Massachusetts

Final Remedial Action Report for West Zone 1 Intertidal Area, OU I (RA-8)

From: Natalie Burgo, Remedial Project Manager, New Bedford Harbor Superfund Site, Massachusetts Superfund Section

Through: Matthew Audet, Section Chief
Massachusetts Superfund Section

To: Bob Cianciarulo, Chief
Remediation & Restoration Branch I

The December 2021 *Final West Zone 1 Remedial Action Report* for the New Bedford Harbor Superfund Site in New Bedford, Dartmouth, Acushnet and Fairhaven, MA is available in SEMS. The report was prepared by the United States Environmental Protection Agency.

The RA Report provides: a site history; a description of the remedial design; a description of the West Zone 1 remedy implementation; a description of construction quality control measures; and the documentation, findings and analyses which were utilized to demonstrate that the construction of the West Zone 1 remedy is complete.

In summary, the West Zone 1 intertidal/shoreline remedy involved the data-driven excavation of PCB-contaminated sediment and soil to meet the 1998 ROD's Target Cleanup Levels (TCLs). Approximately 1.07 acres and 4,491 cubic yards of soil and/or sediment was excavated to meet these TCLs. Compliance and construction quality were measured by compliance land surveying to demonstrate that the proposed horizontal and vertical design limits of excavation had been achieved.

A pre-final inspection occurred on June 10, 2021, resulting in a "punch list" of final tasks to be completed. These included completion of saltmarsh/restoration plantings, expansion of a rip-rap

swale, re-seeding, repair of minor erosional issues, and monitoring grass seed growth. All of these punch list tasks were completed in summer and fall of 2021, and a final inspection occurred on September 15, 2021 to confirm that all punch list items were completed.

This memo does not pertain to the following actions at the NBH Site, which still need to be completed and or continued: completion of remaining intertidal cleanup zones in the Upper Harbor, capping of the Lower Harbor CAD Cell, capping of the pilot shoreline CDF at Sawyer Street, removal of the TSCA/RCRA material stored in Cell 1 at Sawyer Street, maintenance of seafood consumption advisories and associated signage, and final determination for the remedy required at the various sediment caps installed at the site.

EPA has determined that the remedial action of the West Zone 1 intertidal area at the New Bedford Harbor Superfund Site is complete and complies with all federal and state regulatory requirements. I recommend that you sign this memorandum to indicate EPA's acceptance of this as documentation of West Zone 1 intertidal area Remedial Action completion.

ROBERT CIANCIARULO

Digitally signed by ROBERT CIANCIARULO
Date: 2021.12.07 12:04:49 -05'00'

Robert Cianciarulo, Chief
Remediation I Branch

New Bedford Harbor Superfund Site
Final Intertidal West Zone 1 Remedial Action Report

December 2021

Prepared by:

U.S. Environmental Protection Agency, Region 1
Boston, Massachusetts

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Acronyms and Abbreviations

bgs	below ground surface
cy	cubic yards
CDE	Cornell Dubilier Electronics, Inc.
CSO	combined sewer overflow
DDA	Debris Disposal Area
EPA	U.S. Environmental Protection Agency
ft	feet
GPS	global positioning system
IA	Immunoassay
Jacobs	Jacobs Engineering Group, Inc.
LH	Lower Harbor
mg/kg	milligrams per kilogram
MHHW	mean higher high water
NAE	U.S. Army Corps of Engineers – New England District
NBHSS	New Bedford Harbor Superfund Site
OH	Outer Harbor
PCB	polychlorinated biphenyl
PCPT	pre-excavation confirmatory pilot test
PECC	pre-excavation congener confirmation
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAC	Remedial Action Contract
RBG	risk-based goals
ROD	Record of Decision
RTK	real-time kinematic
SES	Sevenson Environmental Services, Inc.
TCL	target cleanup level
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
UH	Upper Harbor
WZ	West Zone

1. Introduction

Remediation and restoration of the West Zone 1 (WZ1) intertidal zone was conducted by Jacobs Engineering Group, Inc. (Jacobs) under U.S. Army Corps of Engineers – New England District (NAE) Remediation Action Contract (RAC) No. W912WJ-15-D-0001 between July 2020 – October 2021. The primary objective of the remedial action at WZ1 was to remove soil and sediment with polychlorinated biphenyl (PCB) concentrations greater than the site-specific target cleanup levels (TCL) as established in the 1998 Record of Decision (ROD) for the New Bedford Harbor Superfund Site and to restore the site to baseline or comparable conditions (U.S. EPA, 1998). TCLs established for the intertidal shorelines in WZ1 are 25 milligrams per kilogram (mg/kg) for the top one foot (95% upper confidence limit [UCL] of the mean concentrations), and 50 mg/kg below one foot landward of the mudflats (not-to-exceed value). The TCL for the Upper Harbor mudflats and subtidal zones is 10 mg/kg, which must be attained as an average on an Upper Harbor-wide basis. Collectively, WZ1 includes five tax parcels of land: 116-132, 116-86, 116-100, 116-94 and 112-65. These five parcels encompass the shoreline north of the former Aerovox property up to Wood Street (Figure 1-1) on the west side of the Acushnet River. A total of 4,491 cubic yards (cy) of PCB-contaminated soil and sediment was excavated, which encompassed an area of 46,552 square feet (1.07 acres).[1] The excavation areas are presented on Figure 1-1.

The purpose of this Remedial Action Report is to document the remediation activity and final disposition of the restored WZ1. PCB-contaminated soils and sediments were removed and disposed off-site at a PCB-licensed landfill, and the zone was then restored in accordance with the *Draft Final Intertidal Work Plan for West Zone 1* (Jacobs Engineering Group, Inc., 2019b). Final planting plans deviated slightly from the WZ1 work plan based on as-built conditions, landowner preferences and recommendations from the New Bedford Harbor Superfund Site (NBHSS) team wetlands subcontractor .

1.1 Site History

New Bedford Harbor (the Site) was proposed for the Superfund National Priorities List (NPL) in 1982 and finalized on the NPL in 1983. Pursuant to 40 CFR 300.425 (c)(2), the Commonwealth of Massachusetts nominated the harbor as its priority site for listing on the NPL. The Site is located approximately 55 miles south of Boston, in Bristol County, Massachusetts and is bounded to the east by the Town of Acushnet and Town of Fairhaven and bounded to the west by the City of New Bedford and the Town of Dartmouth. The Site covers approximately 18,000 acres, extending from the shallow northern reaches of the Acushnet River Estuary, southward through the commercial harbor of New Bedford and into the adjacent section of Buzzards Bay. Based on the different geographic, environmental, and man-made features in the harbor, it has been subdivided into three sections identified as the Upper Harbor (UH), Lower Harbor (LH), and the Outer Harbor (OH).

[1] The total volume of 4,491 cy includes 244.4 cy of soil/sediment containing PCBs below the TCL that were removed to achieve the restoration design elevations.

The subtidal zone and impacted intertidal zones in the UH comprise approximately 236 acres and are bounded to the north by the Main Street Bridge and to the south by the Coggeshall Street Bridge (Figure 1-1). The LH comprises approximately 750 acres and is bounded to the north by the Coggeshall Street Bridge and to the south by the New Bedford Harbor Hurricane Barrier. The OH (approximately 17,000 acres) begins at the Hurricane Barrier and extends southward into Buzzards Bay to an imaginary line extending from Rocky Point (the southern tip of West Island in Fairhaven) southwesterly to a New Bedford Harbor navigational buoy (Buoy C3) and then southwesterly to Mishaum Point in Dartmouth.

PCB contamination of the sediments and seafood in and around New Bedford Harbor was first identified in the mid-1970s. Site-specific investigations by the EPA began in 1983 and 1984 and included pilot dredging and disposal studies and extensive physical and chemical computer modeling. These early studies are summarized in the 1990 Feasibility Study for the Site (Ebasco Services, Inc., 1990) and in the 1998 ROD.

Based on the results of these investigations and knowledge of the operations at the former Aerovox Site at 740 Belleville Avenue in New Bedford, the Aerovox site was identified as the principal source of PCB contamination in the UH. During operations at this facility (1940s – 1970s), PCB wastes were discharges directly to the UH through open trenches, spills, direct dumping and indirectly via the City of New Bedford's sewerage system. During the same general time period, inputs of PCBs were also contributed to the Site by operations at the Cornell Dubilier Electronics, Inc. (CDE) facility, located just south of the New Bedford Hurricane Barrier in the OH.

Operations at the Aerovox Site resulted in significantly elevated PCB concentrations in UH sediments that generally decreased from north to south across the Site. Prior to the completion of remedial efforts, UH sediments contained PCB concentrations that ranged from below detection to more than 100,000 parts per million (ppm) in localized areas. As a tidal embayment with diurnal four-foot tides, intertidal mudflats and vegetated saltmarshes became contaminated with PCBs in the UH and in certain localized shoreline areas of the LH. This report documents the WZ1 Remedial Action that occurred during 2020 and 2021 in New Bedford, Massachusetts located north of the former Aerovox mill.

2. Remedial Actions

The methods used to complete the remedial actions at WZ1 are presented below. All WZ1 actions were conducted in accordance with the *Draft Final Intertidal Work Plan for West Zone 1* and final planting plans were developed by CR Environmental as documented in Attachment A (CR Environmental, 2021).

2.1 Site Preparation

Sampling of sediment and soil from the subtidal, intertidal, and upland areas around WZ1 was conducted in 1999, 2001, 2002, 2010, 2015 and 2018 allowing for the estimation of the horizontal and vertical boundaries requiring remediation. Figures 2-1a through 2-1d and table

2-1 present all characterization sample locations used to determine the final remedial boundaries.

Pre-existing conditions at WZ1 were documented prior to the initiation of remedial actions to establish baseline conditions for backfill, contouring, and re-establishment of native vegetation. This included a pre-excavation elevation survey and mapping of wetland cover types within the intertidal zone (Figures 2-2a through 2-2d). Pre-existing vegetative characteristics including the type and extent of vegetative cover were outlined in the *Draft Final Intertidal Work Plan for West Zone 1*. Other pre-excavation preparation actions included site clearing, construction of an access road, and mobilization of equipment.

2.2 Removal of Contaminated Sediments

Removal of contaminated shoreline soil and mudflat sediment was conducted by Sevenson Environmental Services, Inc (SES) with a track-mounted excavator operated in the intertidal zone and guided by real-time kinematic global positioning system (RTK GPS). Excavated material was temporarily piled and staged in the intertidal zone near the mean higher high water (MHHW) mark to allow for water to drain from the sediment prior to loading into roll-off containers. The roll-off containers were then transported to the NBHSS support facility at 103 Sawyer Street in New Bedford for further stabilization (i.e., addition of Portland cement) and final load out to the designated offsite disposal facility (see Section 3 below).

A total of 4,491 cubic yards (cy) of contaminated sediment was removed from the WZ1 intertidal zone. This value is based on estimates derived from the pre-excavation and post-excavation survey data. The as-built limits of excavation are presented on Figure 2-3.

2.3 Environmental Sampling

The TCL compliance for the WZ1 intertidal zone was confirmed with collection of post-excavation land survey data to demonstrate that the excavation achieved the target horizontal and vertical design limits (Jacobs Engineering Group, Inc., 2020b). Collection of multiple lines of evidence (chemistry and elevation data) during the East Zone 1 remediation formed the basis of the site-specific Pre-Excavation Confirmatory Pilot Test (PCPT), which demonstrated that elevation could be used as the basis for establishing compliance with the TCL. The collection of elevation data is quickly completed and allows for rapid evaluation of compliance. The PCPT concluded that a dense pre-excavation congener-based sampling grid, combined with post-excavation compliance land surveying, is a successful compliance verification approach for the NBH intertidal excavation zones (Jacobs Engineering Group, Inc., 2020b). The pre-and post-excavation land survey data are shown in Table 2-2.[2] Land survey compliance locations were co-located with pre-excavation characterization sample locations (Figure 2-4).

[2] A PCPT precautionary practice for pre-excavation congener confirmation (PECC) locations near large outfalls (e.g. storm drains, industrial outfalls) is to review all related characterization data and consider additional sampling and excavation if deemed appropriate. One location (WS157) near a combined sewer overflow (CSO) was excavated one foot deeper than the design elevation after a post-excavation floor sample analysis indicated PCB contamination above the TCL.

Ambient air monitoring was conducted at fixed monitoring locations during the WZ1 remedial action in accordance with the *Draft Final Ambient Air Monitoring Plan for Remediation Activities* (Jacobs Engineering Group, Inc., 2020a). No exceedances to the risk-based goals (RBGs) were identified during the WZ1 remedial action.

2.4 Site Restoration

The backfill of excavated areas was performed by Sevenson using clean material as specified in the *Draft Final Generic Upper Harbor Intertidal Work Plan* (Jacobs Engineering Group, Inc., 2019a). Gravel was used to backfill deeper excavations, with topsoil placed within the top foot of the excavations. Proposed and as-built restoration elevations are listed in Table 2-2. All topsoil was tested for quality requirements identified in the *Draft Final Topsoil Acceptance Plan* (Jacobs Engineering Group, Inc., 2019c). A summary of the topsoil analysis results by vendor batch is provided in Attachment A.

Site restoration was completed following the removal of contaminated sediments according to the methods defined in the *Draft Final Intertidal Work Plan for West Zone 1* (Jacobs Engineering Group, Inc., 2019b) and in the supplemental planting plans developed by CR Environmental as illustrated in Attachment B (CR Environmental, 2021). Restoration included backfilling, installing erosion protections (e.g., coir logs, gravel, and large stones), planting of native species (e.g., shrubs, trees, and saltmarsh grasses) and the broadcasting of conservation seed mix and/or salt-tolerant grass mix where appropriate. The planting summary is presented in Table 2-3. The pre-final inspection of the restored parcels was performed by Jacobs and NAE, accompanied by EPA and SES, on June 10, 2021; the final inspection was performed on September 15, 2021 to confirm that all punch list items were completed.

The WZ1 ecological habitat was restored on an approximate 1:1 basis between the pre-excavation and post-excavation wetland distribution as illustrated in the Figure 2-1 series and 2-5 series respectively. The exception to the 1:1 restoration is the mudflat areas; areas seaward of the low marsh/mudflat boundary (i.e., seaward of the coir logs) were backfilled only as necessary to provide slope stability and erosion control. Typically this involved backfilling to pre-excavation elevations to approximately 10 feet seaward of the low marsh/mudflat boundary, then sloping downward to meet the existing harbor bottom. A post-excavation drone survey was conducted by Green Seal Environmental, LLC on April 27, 2021 to document post-restoration topography for the entirety of WZ1.

Site monitoring and maintenance will continue through the first five full growing seasons (Fall 2026) and will serve as documentation for the progress towards the WZ1 wetland and upland restoration goals. The respective monitoring and maintenance protocols are described in the *Draft Final Generic Harbor Intertidal Plan* (Jacobs Engineering Group, Inc., 2019a).

3. Waste Management

Sediment generated from the WZ1 intertidal remediation was disposed of in accordance with the Toxic Substance Control Act (TSCA). Approximately 6,357 tons of stabilized sediment generated during the WZ1 remediation were transported from the WZ1 site or the Sawyer Street facility to a transload facility Worcester, Massachusetts. At the transload facility the stablized sediment was transferred from trucks to rail cars and then sent via rail to the Wayne Disposal, Inc. Site #2 Landfill (operated by US Ecology, Inc.) in Belleville, MI for final disposal.

4. References

CR Environmental. (2021). *WZ-1 Planting Plan, New Bedford Harbor Superfund Site.* Retrieved from https://semspub.epa.gov/work/01/100019100.pdf

Ebasco Services, Inc. (1990, August). Draft Final Feasibility Study of Remedial Alternatives for the Estuary and Lower Harbor/Bay. (Volume I, II and III). New Bedford, Massachusetts, USA. Retrieved from https://semspub.epa.gov/work/01/63937.pdf

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Jacobs Engineering Group, Inc. (2019b). *Draft Final Intertidal Work Plan for West Zone 1 Revision 1. ACE-J23-35BG2000-M1-0119.* New Bedford: U.S. Army Corps of Engineers New England District. Retrieved from https://semspub.epa.gov/work/01/100014732.pdf

Jacobs Engineering Group, Inc. (2019c). *Draft Final Topsoil Acceptance Plan. ACE-J23-35BG2000-M1-0076|0.* Retrieved from https://semspub.epa.gov/work/01/100019049.pdf

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Jacobs Engineering Group, Inc. (2020b). *Final Pre-Excavation Confirmatory Pilot Test Technical Memorandum. ACE-J23-35BG2000-M17-0079.* New Bedford: U.S. Army Corps of Engineers New England District. Retrieved from https://semspub.epa.gov/work/01/100019052.pdf

U.S. EPA. (1998). *Record of Decision for the Upper and Lower Harbor Operable Unit New Bedford Harbor Superfund Site.* Boston: U.S. EPA. Retrieved from https://semspub.epa.gov/work/01/38206.pdf

Figures

Legend

- MLLW (-1.97 ft. Pre-Excavation)
- MHHW (1.99 ft. Pre-Excavation)
- Proposed Limits of Excavation

0 150 300 Feet

Basemap Data Source: MassGIS, ESRI

August 2021

West Zone 1 Pre-Excavation Site Location and Features

New Bedford Harbor Superfund Site

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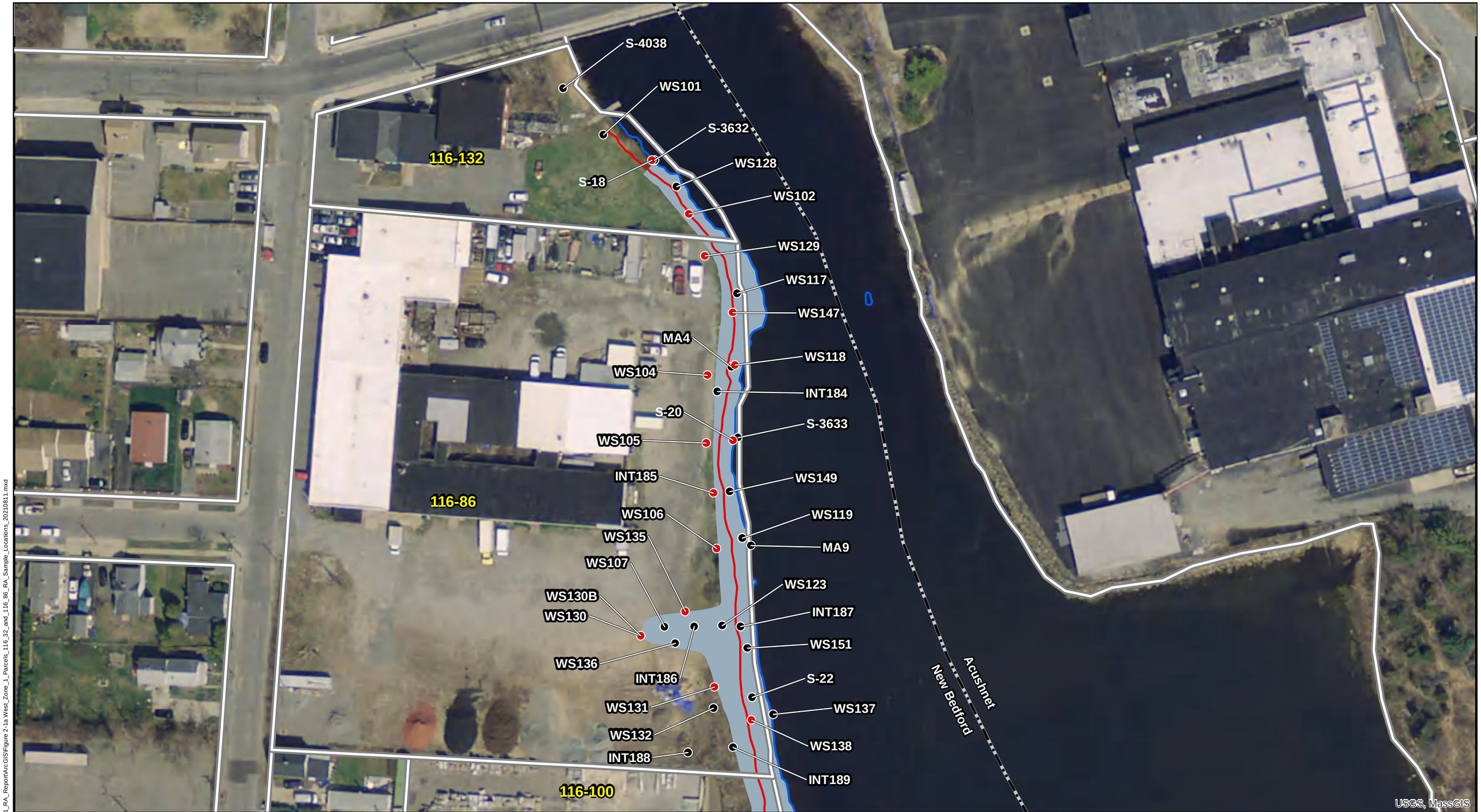
Figure 1-1

Path: Y:\NBH\Projects\35BG1001\20210809_WZ1_RA_Report\ArcGIS\Figure 1-1 West_Zone_1_RA_Site_Location_20210811.mxd



Legend

- PCB Characterization and Survey Compliance Location
- PCB Characterization Sample Location
- Proposed Limits of Excavation
- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- Parcel Boundary

0 70 140 Feet

Basemap Data Source: MassGIS, ESRI

August 2021

West Zone 1 Parcel 116-132 and 116-86 Proposed Excavation Boundaries and PCB Sample Locations

New Bedford Harbor Superfund Site

JACOBS

Figure 2-1a

Path: Y:\NBH\Projects\35BG10011\20210809_WZ1_RA_Report\ArcGIS\Figure 2-1a West_Zone_1_Parcels_116_32_and_116_86_RA_Sample_Locations_20210811.mxd

Legend

- PCB Characterization and Survey Compliance Location
- PCB Characterization Sample Location
- Proposed Limits of Excavation
- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- Parcel Boundary

0 40 80 Feet

Basemap Data Source:
MassGIS, ESRI

August 2021

West Zone 1 Parcel 116-100 Proposed Excavation Boundaries and PCB Sample Locations

New Bedford Harbor Superfund Site

JACOBS

Figure 2-1b

Path: Y:\NBH\Projects\35BG10031\20210809_WZ1_RA_Report\ArcGIS\Figure 2-1b West_Zone_1_Parcel_116_100_RA_Sample_Locations_20210811.mxd

Legend

- PCB Characterization and Survey Compliance Location
- PCB Characterization Sample Location
- Proposed Limits of Excavation
- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- Parcel Boundary

0 40 80 Feet

Basemap Data Source:
MassGIS, ESRI

August 2021

West Zone 1 Parcel 116-94
Proposed Excavation Boundaries and PCB Sample Locations

New Bedford Harbor Superfund Site

JACOBS

Figure 2-1c

Path: Y:\NBH\Projects\35BG10012021\20210809_WZ1_RA_Report\ArcGIS\Figure 2-1c West_Zone_1_Parcel_116_94_RA_Sample_Locations_20210811.mxd

Legend

- PCB Characterization and Survey Compliance Location
- PCB Characterization Sample Location
- Proposed Limits of Excavation
- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- Parcel Boundary
- Aerovox Interim Cap Zone 1
- Aerovox Interim Cap Zone 3

0 40 80 Feet

Basemap Data Source: MassGIS, ESRI

August 2021

West Zone 1 Parcel 112-65 Proposed Excavation Boundaries and PCB Sample Locations

New Bedford Harbor Superfund Site

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Figure 2-1d

Path: Y:\NBH\Projects\35BG100120210809_W21_RA_Report\ArcGIS\Figure 2-1d West_Zone_1_Parcel_112_65_RA_Sample_Locations_20210811.mxd

Notes:

Existing vegetative cover was surveyed by Nearview, LLC (October 2017).

116-132

116-86

116-100

USGS, MassGIS

Legend

- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- 1-foot Contour
- Parcel Boundary
- 0-1' Excavation Depth
- 1-2' Excavation Depth
- 2-3' Excavation Depth
- 3-4' Excavation Depth
- 4-5' Excavation Depth
- 5-6' Excavation Depth
- Low Marsh
- Mudflat
- Phragmites
- Upland
- Unvegetated Fill

0 50 100 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

West Zone 1 Parcel 116-32 and 116-86 Pre-Excavation Wetland Cover and Topography in Excavation Areas

New Bedford Harbor Superfund Site

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Figure 2-2a

Path: Y:\NBH\Projects\35BG100120210809_WZ1_RA_Report\ArcGIS\Figure 2-2a West_Zone_1_Parcels_116_32_and_116_86_RA_Wetland_Cover_20210811.mxd

Notes:

Existing vegetative cover was surveyed by Nearview, LLC (October 2017).

Legend

- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- 1-foot Contour
- Parcel Boundary
- 0-1' Excavation Depth
- 1-2' Excavation Depth
- 2-3' Excavation Depth
- 3-4' Excavation Depth
- Low Marsh
- Mudflat
- Phragmites
- Upland

0 50 100 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

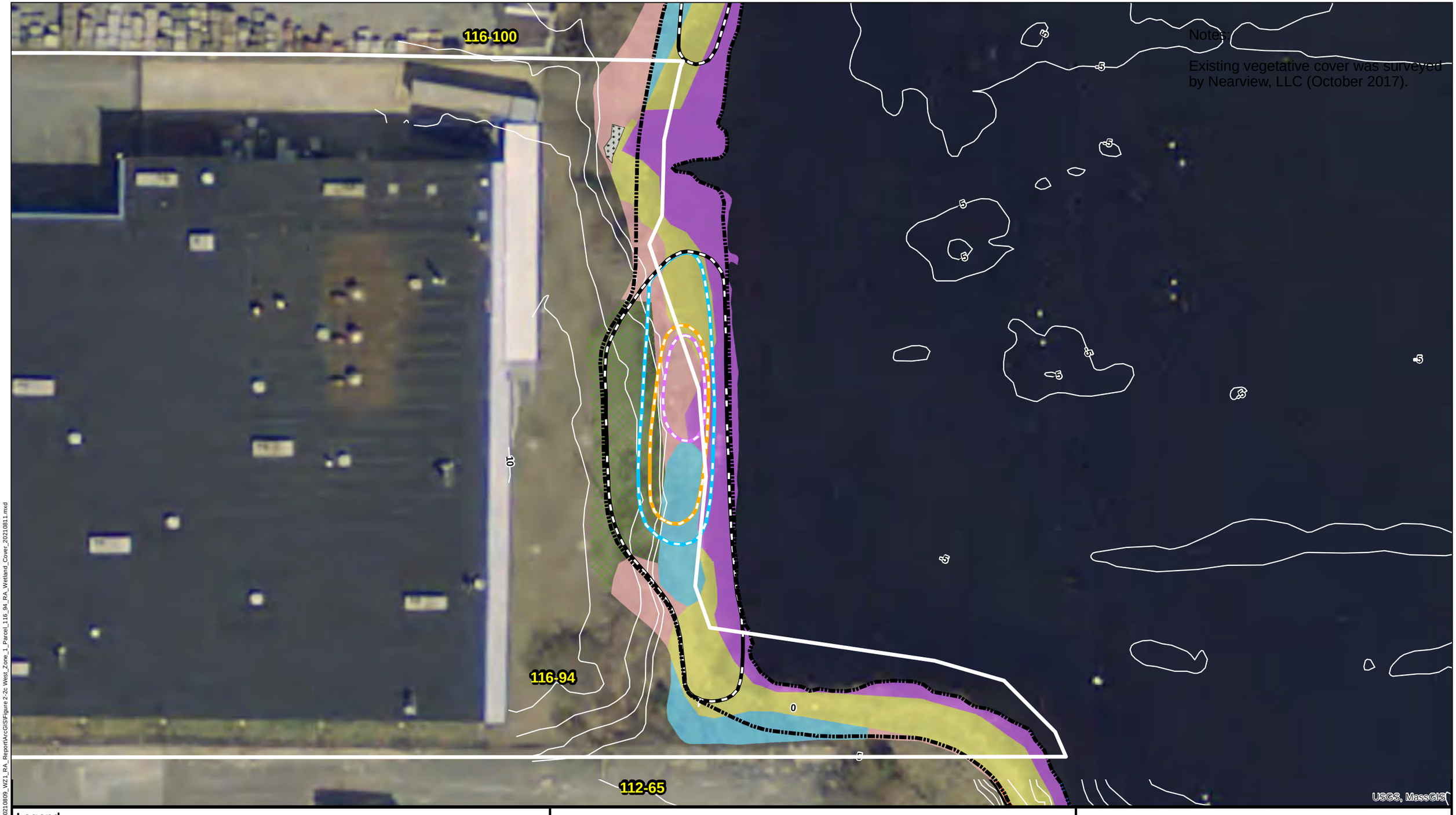
West Zone 1 Parcel 116-100 Pre-Excavation Wetland Cover and Topography in Excavation Areas

New Bedford Harbor Superfund Site

JACOBS

Figure 2-2b

Path: Y:\NBH\Projects\35BG100\120210809_WZ1_RA_Report\ArcGIS\Figure 2-2b West_Zone_1_Parcel_116_100_RA_Wetland_Cover_20210811.mxd



Notes:

Existing vegetative cover was surveyed by Nearview, LLC (October 2017).

Legend

- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- 1-foot Contour
- Parcel Boundary
- 0-1' Excavation Depth
- 1-2' Excavation Depth
- 2-3' Excavation Depth
- 3-4' Excavation Depth
- 4-5' Excavation Depth
- 5-6' Excavation Depth
- Low Marsh
- Mudflat
- Phragmites
- Unvegetated Fill
- Upland
- Upland/Lawn

0 50 100 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

West Zone 1 Parcel 116-94 Pre-Excavation Wetland Cover and Topography in Excavation Areas

New Bedford Harbor Superfund Site

JACOBS

Figure 2-2c

Path: Y:\NBH\Projects\35BG1001\20210809_WZ1_RA_Report\ArcGIS\Figure 2-2c West_Zone_1_Parcel_116_94_RA_Wetland_Cover_20210811.mxd

Notes:

Existing vegetative cover was surveyed by Nearview, LLC (October 2017).

Legend

- MHHW (1.99 ft. Pre-Excavation)
- MLLW (-1.97 ft. Pre-Excavation)
- 1-foot Contour
- Parcel Boundary
- Aerovox Interim Cap Zone 1
- Aerovox Interim Cap Zone 3
- 0-1' Excavation Depth
- 1-2' Excavation Depth
- Low Marsh
- Mudflat
- Phragmites
- Upland

0 50 100 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

Intertidal West Zone 1
Parcel 112-65
Existing Vegetation, Topography, and Excavation Area

New Bedford Harbor Superfund Site

JACOBS

Figure 2-2d

Path: Y:\NBH\Projects\35BG10012\20210809_WZ1_RA_Report\ArcGIS\Figure 2-2d West_Zone_1_Parcel_112_65_RA_Wetland_Cover_20210811.mxd

Legend

- MLLW (-1.97 ft. Post-Restoration)
- MHHW (1.99 ft. Post-Restoration)
- As-built Limits of Excavation

0 75 150 Feet

Basemap Data Source: MassGIS, ESRI

August 2021

West Zone 1
Post-Excavation Limits

New Bedford Harbor Superfund Site

JACOBS

Figure 2-3

Path: Y:\NBH\Projects\35BG1001\20210809_WZ1_RA_Report\ArcGIS\Figure 2-3 West_Zone_1_RA_Post_Excavation_Limits_20210811.mxd

S-18
WS158
WS102
WS129
WS147
WS104
WS118
WS105
S-20
NT185
WS119
WS106
WS135
WS130
WS131
WS161
WS152
WS133
WS156
WS121
WS110
WS157
WS155
WS112
WS140
WS162
WS163
INT198
WS141
WS164
WS143
116-132
116-100
116-94
112-65

Legend

- MHHW (1.99 ft. Post-Restoration)
- MLLW (-1.97 ft. Post-Restoration)
- Parcel Boundary
- As-built Limits of Excavation

Compliance Location

- Sidewall Survey Compliance Location
- Floor Survey Compliance Location
- PCB Compliance Location

Post-Excavation MHHW and MLLW Elevations NAVD88 ft. (Meridian, May, 2021)

N

Basemap Data Source: MassGIS, ESRI

0 50 100 Feet

1:1,250

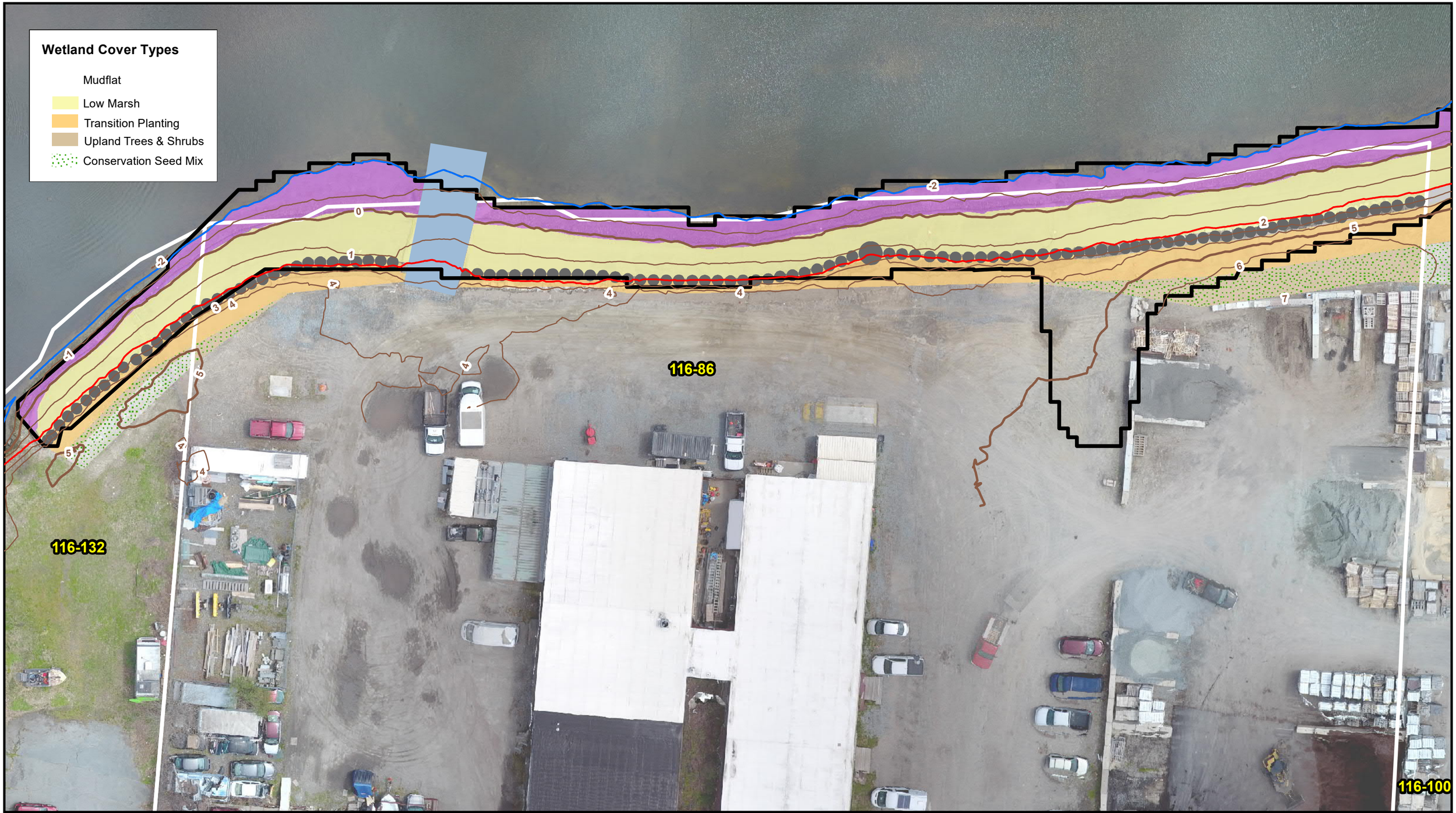
JACOBS

West Zone 1 Compliance Locations

New Bedford Harbor Superfund Site

August 2021 | Figure 2-4

Path: Y:\NBH\Projects\35BG1001\20210809_WZ1_RA_Report\ArcGIS\Figure 2-4 West_Zone_1_RA_Compliance_Locations_20210811.mxd



Legend

- Post-Restoration 1-foot Contours
- Post-Restoration 5-foot Contours
- MHHW (1.99 ft. Post-Restoration)
- MLLW (-1.97 ft. Post-Restoration)
- Boulders
- Boat Ramp
- As-built Limits of Excavation
- Parcel Boundary

Restoration Aerial: Meridian May 2021

0 40 80 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

West Zone 1 Parcel 116-32 and 116-86
Post-Excavation and Restoration Record Drawing

New Bedford Harbor Superfund Site

JACOBS

Figure 2-5a

Legend

- Post-Restoration 1-foot Contours
- Post-Restoration 5-foot Contours
- MHHW (1.99 ft. Post-Restoration)
- MLLW (-1.97 ft. Post-Restoration)
- Boulders
- Gravel Wedge
- Rip-rap/Swale
- As-built Limits of Excavation
- Parcel Boundary

Restoration Aerial: Meridian May 2021

0 30 60 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

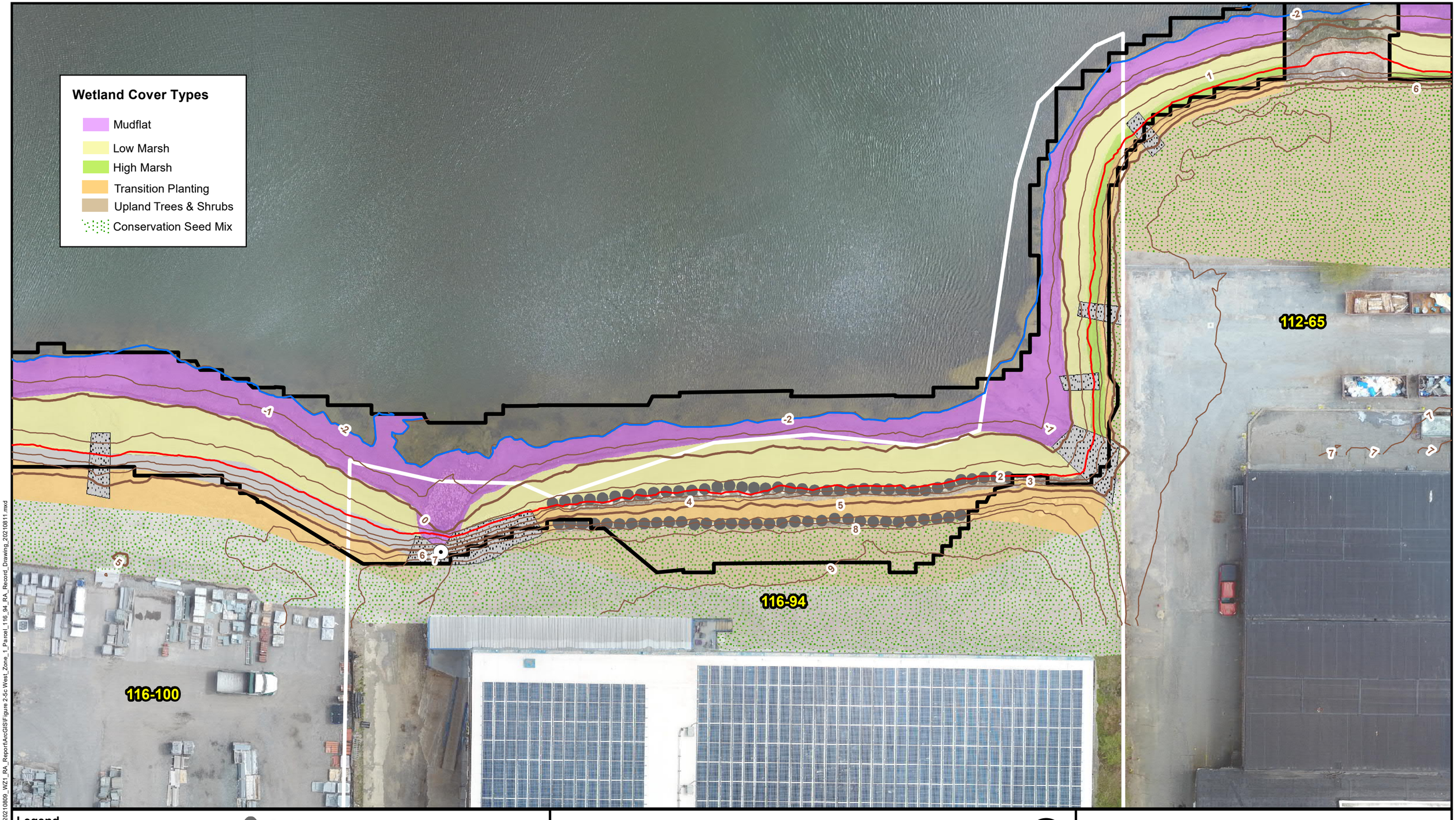
West Zone 1 Parcel 116-100
Post-Excavation and Restoration Record Drawing

New Bedford Harbor Superfund Site

JACOBS

Figure 2-5b

Path: Y:\NBH\Projects\35BG10012\20210809_WZ1_RA_Report\ArcGIS\Figure 2-5b West_Zone_1_Parcel_116_100_RA_Record_Drawing_20210811.mxd



Legend

- Post-Restoration 1-foot Contours
- Post-Restoration 5-foot Contours
- MHHW (1.99 ft. Post-Restoration)
- MLLW (-1.97 ft. Post-Restoration)
- Boulders
- Gravel Wedge
- Rip-rap/Swale
- As-built Limits of Excavation
- Parcel Boundary
- CSO

Restoration Aerial: Meridian May 2021

0 40 80 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

West Zone 1 Parcel 116-94
Post-Excavation and Restoration Record Drawing

New Bedford Harbor Superfund Site

JACOBS

Figure 2-5c

Path: Y:\NBH\Projects\35BG100\20210809_WZ1_RA_Report\ArcGIS\Figure 2-5c West_Zone_1_Parcel_116_94_RA_Record_Drawing_20210811.mxd

Path: Y:\NBH\Projects\35BG100\120210809_WZ1_RA_Report\ArcGIS\Figure 2-5d West_Zone_1_Parcel_112_65_RA_Record_Drawing_20210811.mxd

Legend

- Post-Restoration 1-foot Contours
- Post-Restoration 5-foot Contours
- MHHW (1.99 ft. Post-Restoration)
- MLLW (-1.97 ft. Post-Restoration)
- Rip-rap/Swale
- As-built Limits of Excavation
- Parcel Boundary
- Aerovox Interim Cap Zone 1
- Aerovox Interim Cap Zone 3

Restoration Aerial: Meridian May 2021

0 40 80 Feet

August 2021

Basemap Data Source: MassGIS

Vertical Datum: NAVD88

West Zone 1 Parcel 112-65
Post-Excavation and Restoration Record Drawing

New Bedford Harbor Superfund Site

JACOBS

Figure 2-5d

Tables

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcels 116-132 and 116-86

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
116-132	Low Marsh	S-0018-1	S-18	0.0	1.0	9/7/1999	Total PCB Congeners (sum CONG x factor)	1.2	
116-132	Low Marsh	S-0018-2	S-18	1.0	2.0	9/7/1999	Total PCB Congeners (sum CONG x factor)	45.0	
116-132	Low Marsh	S-3632-.5-1.0	S-3632	0.5	1.0	8/21/2001	Total 18 NOAA PCB cong (excl non-detects)	2.2	
116-132	Low Marsh	S-3632-1.0-1.5	S-3632	1.0	1.5	8/21/2001	Total 18 NOAA PCB cong (excl non-detects)	13.5	
116-132	Low Marsh	S-3632-1.5-2.0	S-3632	1.5	2.0	8/21/2001	Total 18 NOAA PCB cong (excl non-detects)	7.0	
116-132	Low Marsh	S-3632-2.0-2.5	S-3632	2.0	2.5	8/21/2001	Total 18 NOAA PCB cong (excl non-detects)	1.8	
116-132	Upland	S-4038-0.0-1.0	S-4038	0.0	1.0	7/9/2002	Total 18 NOAA PCB cong (excl non-detects)	2.4	
116-132	Upland	S-4038-0.0-1.0REP	S-4038	0.0	1.0	7/9/2002	Total 18 NOAA PCB cong (excl non-detects)	1.8	
116-132	Upland	S-4038-1.0-2.0	S-4038	1.0	2.0	7/9/2002	Total 18 NOAA PCB cong (excl non-detects)	1.4	
116-132	Upland	S-4038-2.0-2.5	S-4038	2.0	2.5	7/9/2002	Total 18 NOAA PCB cong (excl non-detects)	1.1	
116-132	Upland	S-WS101-18FSP10-00-10	WS101	0.0	1.0	5/9/2018	Total 209 PCB cong (excl non-detects)	12.1	
116-132	Upland	S-WS101-18FSP10-10-20	WS101	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	6.9	J
116-132	Upland	S-WS102-18FSP10-00-10	WS102	0.0	1.0	5/9/2018	Total 209 PCB cong (excl non-detects)	35.9	
116-132	Upland	S-WS102-18FSP10-10-20	WS102	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	77.0	JD
116-132	Upland	S-WS102-18FSP10-20-30	WS102	2.0	3.0	8/8/2018	Total 209 PCB cong (excl non-detects)	8.2	
116-132	Low Marsh	S-WS128-18FSP10-00-10	WS128	0.0	1.0	8/24/2018	Total 209 PCB cong (excl non-detects)	608	
116-132	Low Marsh	S-WS128-18FSP10-10-20	WS128	1.0	2.0	8/24/2018	Aroclor 1254 - Immunoassay	90.0	JD
116-86	Upland	S-15L-INT184-00-10	INT184	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	534	D
116-86	Upland	S-15L-INT184-10-20	INT184	1.0	2.0	7/7/2015	Aroclor 1254 - Immunoassay	44.3	D
116-86	Upland	S-15L-INT184-20-24	INT184	2.0	2.4	7/7/2015	Aroclor 1254 - Immunoassay	8.2	
116-86	Upland	S-15L-INT185-00-10	INT185	0.0	1.0	7/7/2015	Total 139 PCB cong (excl non-detects)	5.6	
116-86	Upland	S-15L-INT185-10-17	INT185	1.0	1.8	7/7/2015	Aroclor 1254 - Immunoassay	9.1	
116-86	Upland	S-15L-INT186-00-10	INT186	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	118	D
116-86	Upland	S-15L-INT186-10-20	INT186	1.0	2.0	7/7/2015	Total 139 PCB cong (excl non-detects)	13.0	
116-86	Upland	S-15L-INT186-20-30	INT186	2.0	3.0	7/7/2015	Aroclor 1254 - Immunoassay	692	D
116-86	Low Marsh	S-15L-INT187-00-10	INT187	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	0.90	
116-86	Low Marsh	S-15L-INT187-10-20	INT187	1.0	2.0	7/7/2015	Aroclor 1254 - Immunoassay	120	D
116-86	Low Marsh	S-15L-INT187-20-30	INT187	2.0	3.0	7/7/2015	Total 139 PCB cong (excl non-detects)	56.0	
116-86	Upland	S-15L-INT188-00-10	INT188	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	0.60	
116-86	Upland	S-15L-INT188-10-20	INT188	1.0	2.0	7/7/2015	Aroclor 1254 - Immunoassay	1.1	
116-86	Upland	S-15L-INT189-00-10	INT189	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	2.2	
116-86	Upland	S-15L-INT189-10-20	INT189	1.0	2.0	7/7/2015	Aroclor 1254 - Immunoassay	4.7	
116-86	Low Marsh	S-10O-C039-0-0.5	MA4	0.0	0.5	10/21/2010	Total 18 NOAA PCB cong (excl non-detects)	36.4	
116-86	Low Marsh	S-10O-C043-0-0.5	MA9	0.0	0.5	10/21/2010	Total 18 NOAA PCB cong (excl non-detects)	572	
116-86	Low Marsh	S-0020-1	S-20	0.0	1.0	9/7/1999	Total PCB Congeners (sum CONG x factor)	1700	
116-86	Low Marsh	S-0020-2	S-20	1.0	2.0	9/7/1999	Total PCB Congeners (sum CONG x factor)	4.0	
116-86	Low Marsh	S-0020-3	S-20	2.0	3.0	9/7/1999	Total PCB Congeners (sum CONG x factor)	12.0	
116-86	Low Marsh	S-0022-1	S-22	0.0	1.0	9/8/1999	Total PCB Congeners (sum CONG x factor)	300	
116-86	Low Marsh	S-0022-2	S-22	1.0	2.0	9/8/1999	Total PCB Congeners (sum CONG x factor)	6.0	
116-86	Low Marsh	S-3633-.3-.8	S-3633	0.3	0.8	8/22/2001	Total 18 NOAA PCB cong (excl non-detects)	133	

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcels 116-132 and 116-86

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
116-86	Low Marsh	S-3633-.8-1.3	S-3633	0.8	1.3	8/21/2001	Total 18 NOAA PCB cong (excl non-detects)	187	
116-86	Upland	S-WS104-18FSP10-00-09	WS104	0.0	0.9	5/9/2018	Total 209 PCB cong (excl non-detects)	0.73	
116-86	Upland	S-WS105-18FSP10-00-10	WS105	0.0	1.0	5/4/2018	Total 209 PCB cong (excl non-detects)	0.94	
116-86	Upland	S-WS105-18FSP10-10-20	WS105	1.0	2.0	5/4/2018	Aroclor 1254 - Immunoassay	6.2	J
116-86	Upland	S-WS106-18FSP10-00-10	WS106	0.0	1.0	4/30/2018	Total 209 PCB cong (excl non-detects)	0.66	
116-86	Upland	S-WS106-18FSP10-10-20	WS106	1.0	2.0	4/30/2018	Aroclor 1254 - Immunoassay	3.7	J
116-86	Upland	S-WS107-18FSP10-00-10	WS107	0.0	1.0	4/30/2018	Total 209 PCB cong (excl non-detects)	2.7	
116-86	Upland	S-WS107-18FSP10-10-20	WS107	1.0	2.0	4/30/2018	Aroclor 1254 - Immunoassay	3400	JD
116-86	Upland	S-WS107-18FSP10-20-30	WS107	2.0	3.0	4/30/2018	Total 209 PCB cong (excl non-detects)	133	
116-86	Mudflat	S-WS117-18FSP10-00-10	WS117	0.0	1.0	5/4/2018	Aroclor 1254 - Immunoassay	2.0	JB
116-86	Mudflat	S-WS117-18FSP10-10-20	WS117	1.0	2.0	5/4/2018	Aroclor 1254 - Immunoassay	140	JD
116-86	Mudflat	S-WS117-18FSP10-20-29	WS117	2.0	2.9	5/4/2018	Aroclor 1254 - Immunoassay	120	J
116-86	Low Marsh	S-WS118-18FSP10-00-10	WS118	0.0	1.0	5/4/2018	Aroclor 1254 - Immunoassay	56.0	JD
116-86	Low Marsh	S-WS118-18FSP10-10-20	WS118	1.0	2.0	5/4/2018	Aroclor 1254 - Immunoassay	260	JD
116-86	Low Marsh	S-WS118-18FSP10-20-30	WS118	2.0	3.0	5/4/2018	Total 209 PCB cong (excl non-detects)	22.2	
116-86	Low Marsh	S-WS119-18FSP10-00-10	WS119	0.0	1.0	5/4/2018	Aroclor 1254 - Immunoassay	5.2	JD
116-86	Low Marsh	S-WS119-18FSP10-10-20	WS119	1.0	2.0	5/4/2018	Aroclor 1254 - Immunoassay	240	JD
116-86	Low Marsh	S-WS119-18FSP10-20-30	WS119	2.0	3.0	5/4/2018	Aroclor 1254 - Immunoassay	19.0	JD
116-86	Low Marsh	S-WS119-18FSP10-30-40	WS119	3.0	4.0	5/4/2018	Aroclor 1254 - Immunoassay	320	JD
116-86	Low Marsh	S-WS119-18FSP10-40-50	WS119	4.0	5.0	9/18/2018	Aroclor 1254 - Immunoassay	99.0	JD
116-86	Low Marsh	S-WS119-18FSP10-50-58	WS119	5.0	5.8	9/18/2018	Total 209 PCB cong (excl non-detects)	62.3	
116-86	Upland	S-WS123-18FSP10-00-10	WS123	0.0	1.0	4/30/2018	Aroclor 1254 - Immunoassay	56.0	JD
116-86	Upland	S-WS123-18FSP10-10-20	WS123	1.0	2.0	4/30/2018	Aroclor 1254 - Immunoassay	17.0	JD
116-86	Upland	S-WS123-18FSP10-20-30	WS123	2.0	3.0	4/30/2018	Aroclor 1254 - Immunoassay	23.0	JD
116-86	Upland	S-WS123-18FSP10-30-40	WS123	3.0	4.0	4/30/2018	Aroclor 1254 - Immunoassay	17.0	JD
116-86	Upland	S-WS123-18FSP10-40-50	WS123	4.0	5.0	4/30/2018	Aroclor 1254 - Immunoassay	4.1	J
116-86	Upland	S-WS129-18FSP10-00-10	WS129	0.0	1.0	8/1/2018	Total 209 PCB cong (excl non-detects)	1.6	
116-86	Upland	S-WS129-18FSP10-10-12	WS129	1.0	1.2	8/1/2018	Aroclor 1254 - Immunoassay	1.8	JD
116-86	Upland	S-WS130-18FSP10-00-10	WS130	0.0	1.0	7/31/2018	Total 209 PCB cong (excl non-detects)	0.15	
116-86	Upland	S-WS130-18FSP10-10-20	WS130	1.0	2.0	7/31/2018	Aroclor 1254 - Immunoassay	8.8	J
116-86	Upland	S-WS130-18FSP10-20-23	WS130	2.0	2.3	7/31/2018	Aroclor 1254 - Immunoassay	13.0	JD
116-86	Upland	S-WS130B-18FSP10-00-10	WS130	0.0	1.0	8/3/2018	Total 209 PCB cong (excl non-detects)	0.42	
116-86	Upland	S-WS130B-18FSP10-10-20	WS130	1.0	2.0	8/3/2018	Aroclor 1254 - Immunoassay	7.0	J
116-86	Upland	S-WS130B-18FSP10-20-25	WS130	2.0	2.5	8/3/2018	Aroclor 1254 - Immunoassay	6.0	JD
116-86	Upland	S-WS131-18FSP10-00-10	WS131	0.0	1.0	8/15/2018	Total 209 PCB cong (excl non-detects)	3.7	
116-86	Upland	S-WS131-18FSP10-10-13	WS131	1.0	1.3	8/15/2018	Aroclor 1254 - Immunoassay	15.0	JD
116-86	Upland	S-WS132-18FSP10-00-10	WS132	0.0	1.0	8/8/2018	Total 209 PCB cong (excl non-detects)	2.5	
116-86	Upland	S-WS132-18FSP10-10-19	WS132	1.0	1.9	8/8/2018	Aroclor 1254 - Immunoassay	9.1	J
116-86	Upland	S-WS135-18FSP10-00-10	WS135	0.0	1.0	8/3/2018	Total 209 PCB cong (excl non-detects)	2.1	
116-86	Upland	S-WS135-18FSP10-10-20	WS135	1.0	2.0	8/3/2018	Aroclor 1254 - Immunoassay	8.1	J

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcels 116-132 and 116-86

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
116-86	Upland	S-WS136-18FSP10-00-10	WS136	0.0	1.0	8/1/2018	Total 209 PCB cong (excl non-detects)	7.1	
116-86	Upland	S-WS136-18FSP10-10-20	WS136	1.0	2.0	8/1/2018	Aroclor 1254 - Immunoassay	4.0	JD
116-86	Upland	S-WS136-18FSP10-20-29	WS136	2.0	2.9	8/1/2018	Aroclor 1254 - Immunoassay	100	JD
116-86	Low Marsh	S-WS137-18FSP10-10-20	WS137	1.0	2.0	8/6/2018	Aroclor 1254 - Immunoassay	2.4	JD
116-86	Low Marsh	S-WS137-18FSP10-20-24	WS137	2.0	2.4	8/6/2018	Aroclor 1254 - Immunoassay	2.4	J
116-86	Low Marsh	S-WS138-18FSP10-10-20	WS138	1.0	2.0	8/6/2018	Total 209 PCB cong (excl non-detects)	125	
116-86	Low Marsh	S-WS138-18FSP10-20-30	WS138	2.0	3.0	8/6/2018	Total 209 PCB cong (excl non-detects)	85.5	
116-86	Low Marsh	S-WS138-18FSP10-30-40	WS138	3.0	4.0	8/6/2018	Total 209 PCB cong (excl non-detects)	35.9	
116-86	Low Marsh	S-WS147-18FSP10-30-40	WS147	3.0	4.0	8/8/2018	Total 209 PCB cong (excl non-detects)	71.4	
116-86	Low Marsh	S-WS147-18FSP10-40-49	WS147	4.0	4.9	8/8/2018	Total 209 PCB cong (excl non-detects)	15.5	
116-86	Low Marsh	S-WS149-18FSP10-30-40	WS149	3.0	4.0	8/8/2018	Aroclor 1254 - Immunoassay	17.0	JD
116-86	Low Marsh	S-WS149-18FSP10-40-50	WS149	4.0	5.0	8/8/2018	Aroclor 1254 - Immunoassay	8.7	J
116-86	Low Marsh	S-WS151-18FSP10-30-40	WS151	3.0	4.0	9/4/2018	Total 209 PCB cong (excl non-detects)	68.4	
116-86	Low Marsh	S-WS151-18FSP10-40-50	WS151	4.0	5.0	9/4/2018	Total 209 PCB cong (excl non-detects)	555	

Notes:
Pre-excavation confirmatory congener samples are shaded green.
D - reported value is from a dilution; U - not detected; J - estimated value.
Total 18 NOAA PCB congeners multiplied by a factor of 2.6.

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcel 116-100

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
116-100	Upland	S-15L-INT190-00-10-REP	INT190	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	2.0	
116-100	Upland	S-15L-INT190-00-10	INT190	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	1.2	
116-100	Upland	S-15L-INT190-10-20	INT190	1.0	2.0	7/7/2015	Aroclor 1254 - Immunoassay	2.3	
116-100	Upland	S-15L-INT190-10-20-REP	INT190	1.0	2.0	7/7/2015	Aroclor 1254 - Immunoassay	1.6	
116-100	Low Marsh	S-15L-INT191-00-10	INT191	0.0	1.0	7/7/2015	Aroclor 1254 - Immunoassay	691	D
116-100	Low Marsh	S-15L-INT191-10-20	INT191	1.0	2.0	7/7/2015	Aroclor 1254 - Immunoassay	1499	D
116-100	Low Marsh	S-15L-INT191-20-30	INT191	2.0	3.0	7/7/2015	Aroclor 1254 - Immunoassay	192	D
116-100	Low Marsh	S-15L-INT191-30-38	INT191	3.0	3.8	7/7/2015	Total 139 PCB cong (excl non-detects)	63.0	
116-100	Mudflat	S-15G-INT192-00-10	INT192	0.0	1.0	8/4/2015	Aroclor 1254 - Immunoassay	298	D
116-100	Mudflat	S-15G-INT192-10-20	INT192	1.0	2.0	8/4/2015	Aroclor 1254 - Immunoassay	0.50	U
116-100	Upland	S-WS108-18FSP10-00-10	WS108	0.0	1.0	5/9/2018	Total 209 PCB cong (excl non-detects)	1.9	
116-100	Upland	S-WS108-18FSP10-10-20	WS108	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	6.1	J
116-100	Upland	S-WS109-18FSP10-00-10	WS109	0.0	1.0	5/4/2018	Total 209 PCB cong (excl non-detects)	1.3	
116-100	Upland	S-WS109-18FSP10-10-20	WS109	1.0	2.0	5/4/2018	Aroclor 1254 - Immunoassay	4.3	J
116-100	Low Marsh	S-WS120-18FSP10-00-10	WS120	0.0	1.0	4/30/2018	Aroclor 1254 - Immunoassay	19.0	JD
116-100	Low Marsh	S-WS120-18FSP10-10-20	WS120	1.0	2.0	4/30/2018	Aroclor 1254 - Immunoassay	33.0	JD
116-100	Low Marsh	S-WS120-18FSP10-20-30	WS120	2.0	3.0	4/30/2018	Aroclor 1254 - Immunoassay	140	J
116-100	Low Marsh	S-WS121R-18FSP10-00-10-REP	WS121	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	410	JD
116-100	Low Marsh	S-WS121-18FSP10-00-10	WS121	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	350	JD
116-100	Low Marsh	S-WS121-18FSP10-10-20	WS121	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	93.0	JD
116-100	Low Marsh	S-WS121R-18FSP10-10-20-REP	WS121	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	93.0	JD
116-100	Low Marsh	S-WS121-18FSP10-20-30	WS121	2.0	3.0	5/9/2018	Total 209 PCB cong (excl non-detects)	102	
116-100	Low Marsh	S-WS121-18FSP10-30-40	WS121	3.0	4.0	9/18/2018	Total 209 PCB cong (excl non-detects)	4.82	
116-100	Low Marsh	S-WS124-18FSP10-00-10	WS124	0.0	1.0	5/4/2018	Aroclor 1254 - Immunoassay	8.2	J
116-100	Low Marsh	S-WS124-18FSP10-10-20	WS124	1.0	2.0	5/4/2018	Aroclor 1254 - Immunoassay	49.0	JD
116-100	Low Marsh	S-WS124-18FSP10-20-30	WS124	2.0	3.0	5/4/2018	Aroclor 1254 - Immunoassay	270	JD
116-100	Low Marsh	S-WS124-18FSP10-30-40	WS124	3.0	4.0	5/4/2018	Total 209 PCB cong (excl non-detects)	93.4	
116-100	Upland	S-WS125-18FSP10-00-10	WS125	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	270	JD
116-100	Upland	S-WS125-18FSP10-10-20	WS125	1.0	2.0	5/9/2018	Total 209 PCB cong (excl non-detects)	366	
116-100	Upland	S-WS125-18FSP10-20-30	WS125	2.0	3.0	5/9/2018	Total 209 PCB cong (excl non-detects)	158	
116-100	Upland	S-WS125-18FSP10-30-40	WS125	3.0	4.0	5/9/2018	Aroclor 1254 - Immunoassay	15.0	JD
116-100	Upland	S-WS127-18FSP10-00-10	WS127	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	8.4	J
116-100	Upland	S-WS127-18FSP10-10-20	WS127	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	4.7	J
116-100	Upland	S-WS127-18FSP10-20-30	WS127	2.0	3.0	5/9/2018	Aroclor 1254 - Immunoassay	2.3	J
116-100	Upland	S-WS127-18FSP10-30-38	WS127	3.0	3.8	5/9/2018	Aroclor 1254 - Immunoassay	2.6	J
116-100	Upland	S-WS133-18FSP10-00-10	WS133	0.0	1.0	8/14/2018	Total 209 PCB cong (excl non-detects)	3.5	
116-100	Upland	S-WS133-18FSP10-10-20	WS133	1.0	2.0	8/14/2018	Aroclor 1254 - Immunoassay	17.0	JD
116-100	Low Marsh	S-WS152-18FSP10-30-40	WS152	3.0	4.0	8/9/2018	Total 209 PCB cong (excl non-detects)	172	
116-100	Low Marsh	S-WS152-18FSP10-40-50	WS152	4.0	5.0	8/9/2018	Total 209 PCB cong (excl non-detects)	12.8	
116-100	Upland	S-WS153-18FSP10-40-50	WS153	4.0	5.0	8/14/2018	Total 209 PCB cong (excl non-detects)	17.7	

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcel 116-100

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
116-100	Upland	S-WS156-18FSP10-00-10	WS156	0.0	1.0	8/14/2018	Total 209 PCB cong (excl non-detects)	3.8	
116-100	Upland	S-WS156-18FSP10-10-20	WS156	1.0	2.0	8/14/2018	Total 209 PCB cong (excl non-detects)	26.8	
116-100	Upland	S-WS156-18FSP10-20-30	WS156	2.0	3.0	8/14/2018	Aroclor 1254 - Immunoassay	6.0	J

Notes:
Pre-excavation confirmatory congener samples are shaded green.
D - reported value is from a dilution; U - not detected; J - estimated value.
Total 18 NOAA PCB congeners multiplied by a factor of 2.6.

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcel 116-94

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
116-94	Mudflat	S-15G-INT193-00-10	INT193	0.0	1.0	8/4/2015	Total 139 PCB cong (excl non-detects)	2300	
116-94	Mudflat	S-15G-INT193-10-12	INT193	1.0	1.2	8/4/2015	Aroclor 1254 - Immunoassay	1426	D
116-94	Mudflat	S-15G-INT193-12-22	INT193	1.2	2.2	8/4/2015	Aroclor 1254 - Immunoassay	1.3	
116-94	Upland	S-15L-INT194-00-10	INT194	0.0	1.0	7/15/2015	Aroclor 1254 - Immunoassay	1.4	
116-94	Upland	S-15L-INT194-10-21	INT194	1.0	2.1	7/15/2015	Aroclor 1254 - Immunoassay	4.9	
116-94	Upland	S-15L-INT195-00-10	INT195	0.0	1.0	7/15/2015	Aroclor 1254 - Immunoassay	662	D
116-94	Upland	S-15L-INT195-10-20	INT195	1.0	2.0	7/15/2015	Aroclor 1254 - Immunoassay	1637	D
116-94	Upland	S-15L-INT195-20-30	INT195	2.0	3.0	7/15/2015	Aroclor 1254 - Immunoassay	1174	D
116-94	Mudflat	S-15G-INT196-00-10	INT196	0.0	1.0	8/4/2015	Aroclor 1254 - Immunoassay	65.2	D
116-94	Mudflat	S-15G-INT196-10-20	INT196	1.0	2.0	8/4/2015	Aroclor 1254 - Immunoassay	1.0	
116-94	Upland	S-15G-INT197-00-10	INT197	0.0	1.0	8/5/2015	Aroclor 1254 - Immunoassay	5.3	D
116-94	Upland	S-15G-INT197-10-20	INT197	1.0	2.0	8/5/2015	Aroclor 1254 - Immunoassay	2.0	
116-94	Mudflat	S-0032-1	S-32	0.0	1.0	9/9/1999	Total PCB Congeners (sum CONG x factor)	720	
116-94	Mudflat	S-0032-2	S-32	1.0	2.0	9/9/1999	Total PCB Congeners (sum CONG x factor)	650	
116-94	Low Marsh	S-ar1	S-ar1	0.0	1.0	pre-ROD	Total PCB Congeners (sum CONG x factor)[1]	200	
116-94	Upland	S-WS110-18FSP10-00-10	WS110	0.0	1.0	5/4/2018	Total 209 PCB cong (excl non-detects)	0.54	
116-94	Upland	S-WS110-18FSP10-10-20	WS110	1.0	2.0	5/4/2018	Aroclor 1254 - Immunoassay	2.1	B
116-94	Upland	S-WS111-18FSP10-00-10	WS111	0.0	1.0	5/9/2018	Total 209 PCB cong (excl non-detects)	9.2	
116-94	Upland	S-WS111-18FSP10-10-20	WS111	1.0	2.0	5/9/2018	Total 209 PCB cong (excl non-detects)	179	
116-94	Upland	S-WS111-18FSP10-20-30	WS111	2.0	3.0	5/9/2018	Total 209 PCB cong (excl non-detects)	134	
116-94	Upland	S-WS112-18FSP10-00-10	WS112	0.0	1.0	5/9/2018	Total 209 PCB cong (excl non-detects)	0.56	
116-94	Low Marsh	S-WS113-18FSP10-00-10	WS113	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	140	JD
116-94	Low Marsh	S-WS113R-18FSP10-00-10-REP	WS113	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	68.0	JD
116-94	Low Marsh	S-WS113R-18FSP10-10-20-REP	WS113	1.0	2.0	5/9/2018	Total 209 PCB cong (excl non-detects)	215	
116-94	Low Marsh	S-WS113-18FSP10-10-20	WS113	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	8.6	J
116-94	Low Marsh	S-WS113R-18FSP10-20-30-REP	WS113	2.0	3.0	5/9/2018	Aroclor 1254 - Immunoassay	21.0	JD
116-94	Low Marsh	S-WS113-18FSP10-20-30	WS113	2.0	3.0	5/9/2018	Aroclor 1254 - Immunoassay	8.6	J
116-94	Low Marsh	S-WS113R-18FSP10-30-40-REP	WS113	3.0	4.0	5/9/2018	Aroclor 1254 - Immunoassay	18.0	JD
116-94	Low Marsh	S-WS113-18FSP10-30-40	WS113	3.0	4.0	5/9/2018	Aroclor 1254 - Immunoassay	8.6	J
116-94	Low Marsh	S-WS122-18FSP10-00-10	WS122	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	74.0	JD
116-94	Low Marsh	S-WS122-18FSP10-10-20	WS122	1.0	2.0	5/9/2018	Total 209 PCB cong (excl non-detects)	292	
116-94	Low Marsh	S-WS122-18FSP10-20-30	WS122	2.0	3.0	5/9/2018	Aroclor 1254 - Immunoassay	7.4	J
116-94	Low Marsh	S-WS122-18FSP10-30-40	WS122	3.0	4.0	5/9/2018	Total 209 PCB cong (excl non-detects)	295	
116-94	Upland	S-WS126-18FSP10-00-10	WS126	0.0	1.0	5/9/2018	Aroclor 1254 - Immunoassay	36.0	JD
116-94	Upland	S-WS126-18FSP10-10-20	WS126	1.0	2.0	5/9/2018	Aroclor 1254 - Immunoassay	180	JD
116-94	Upland	S-WS126-18FSP10-20-30	WS126	2.0	3.0	5/9/2018	Aroclor 1254 - Immunoassay	98.0	JD
116-94	Upland	S-WS126-18FSP10-30-40	WS126	3.0	4.0	5/9/2018	Aroclor 1254 - Immunoassay	140	JD
116-94	Upland	S-WS126-18FSP10-40-50	WS126	4.0	5.0	5/9/2018	Aroclor 1254 - Immunoassay	150	JD
116-94	Upland	S-WS134-18FSP10-00-10	WS134	0.0	1.0	8/3/2018	Total 209 PCB cong (excl non-detects)	6.0	
116-94	Upland	S-WS134-18FSP10-10-16	WS134	1.0	1.6	8/3/2018	Aroclor 1254 - Immunoassay	10.0	JD

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcel 116-94

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
116-94	Low Marsh	S-WS139-18FSP10-10-20	WS139	1.0	2.0	8/1/2018	Aroclor 1254 - Immunoassay	19.0	JD
116-94	Low Marsh	S-WS139-18FSP10-20-30	WS139	2.0	3.0	8/1/2018	Total 209 PCB cong (excl non-detects)	87.1	
116-94	Low Marsh	S-WS139-18FSP10-30-40	WS139	3.0	4.0	8/1/2018	Total 209 PCB cong (excl non-detects)	13.7	
116-94	Low Marsh	S-WS140-18FSP10-00-10	WS140	0.0	1.0	8/6/2018	Aroclor 1254 - Immunoassay	76.0	JD
116-94	Low Marsh	S-WS140-18FSP10-10-20	WS140	1.0	2.0	8/6/2018	Total 209 PCB cong (excl non-detects)	62.3	
116-94	Low Marsh	S-WS140-18FSP10-20-30	WS140	2.0	3.0	8/6/2018	Aroclor 1254 - Immunoassay	10.0	J
116-94	Low Marsh	S-WS140-18FSP10-30-40	WS140	3.0	4.0	8/6/2018	Aroclor 1254 - Immunoassay	9.6	JD
116-94	Upland	S-WS154-18FSP10-40-50	WS154	4.0	5.0	8/9/2018	Aroclor 1254 - Immunoassay	100	JD
116-94	Upland	S-WS154-18FSP10-50-60	WS154	5.0	6.0	8/9/2018	Total 209 PCB cong (excl non-detects)	110	
116-94	Mudflat	S-WS155-18FSP10-30-40	WS155	3.0	4.0	8/9/2018	Total 209 PCB cong (excl non-detects)	41.5	
116-94	Mudflat	S-WS155-18FSP10-40-50	WS155	4.0	5.0	8/9/2018	Aroclor 1254 - Immunoassay	21.0	JD
116-94	Mudflat	S-WS157-18FSP10-20-30	WS157	2.0	3.0	7/31/2018	Total 209 PCB cong (excl non-detects)	0.20	
116-94	Mudflat	S-WS157-18FSP10-30-40	WS157	3.0	4.0	7/31/2018	Aroclor 1254 - Immunoassay	7.1	JD
116-94	Upland	S-WS158-18FSP10-10-20	WS158	1.0	2.0	8/6/2018	Aroclor 1254 - Immunoassay	2.2	JD
116-94	Upland	S-WS158-18FSP10-20-30	WS158	2.0	3.0	8/6/2018	Aroclor 1254 - Immunoassay	3.4	JD
116-94	Upland	S-WS158-18FSP10-30-40	WS158	3.0	4.0	8/6/2018	Aroclor 1254 - Immunoassay	3.6	JD

Notes:
Pre-excavation confirmatory congener samples are shaded green.
D - reported value is from a dilution; U - not detected; J - estimated value.
Total 18 NOAA PCB congeners multiplied by a factor of 2.6.
1. Pre-ROD sample result is most likely a total Aroclor value although it is reported in the project database as Sum 18 NOAA PCB congeners X factor.

Table 2-1
West Zone 1 Pre-Excavation PCB Characterization Sample Results for Parcel 112-65

Parcel	Type	Sample ID	Station ID	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Sample Date	Description	Total PCB (mg/kg)	Final Qualifier
112-65	Upland	S-15L-INT198-00-10	INT198	0.0	1.0	7/8/2015	Total 139 PCB cong (excl non-detects)	8.7	
112-65	Upland	S-15L-INT198-10-20	INT198	1.0	2.0	7/8/2015	Aroclor 1254 - Immunoassay	5.4	
112-65	Upland	S-15L-INT198-20-24	INT198	2.0	2.4	7/8/2015	Aroclor 1254 - Immunoassay	4.9	
112-65	Upland	S-15L-INT199-00-10	INT199	0.0	1.0	7/8/2015	Aroclor 1254 - Immunoassay	0.50	U
112-65	Upland	S-15L-INT199-10-20	INT199	1.0	2.0	7/8/2015	Aroclor 1254 - Immunoassay	0.50	U
112-65	Upland	S-15L-INT200-00-10	INT200	0.0	1.0	7/8/2015	Aroclor 1254 - Immunoassay	1.3	
112-65	Upland	S-15L-INT200-10-20	INT200	1.0	2.0	7/8/2015	Aroclor 1254 - Immunoassay	0.50	U
112-65	Low Marsh	S-15L-INT202-00-10	INT202	0.0	1.0	7/8/2015	Aroclor 1254 - Immunoassay	64.5	D
112-65	Low Marsh	S-15L-INT202-10-20	INT202	1.0	2.0	7/8/2015	Aroclor 1254 - Immunoassay	9.9	
112-65	Low Marsh	S-15L-INT202-20-30	INT202	2.0	3.0	7/8/2015	Aroclor 1254 - Immunoassay	2.9	
112-65	Upland	S-WS114-18FSP10-00-10	WS114	0.0	1.0	4/30/2018	Total 209 PCB cong (excl non-detects)	0.98	
112-65	Upland	S-WS114-18FSP10-10-20	WS114	1.0	2.0	4/30/2018	Aroclor 1254 - Immunoassay	3.1	JB
112-65	Upland	S-WS115-18FSP10-00-10	WS115	0.0	1.0	4/30/2018	Total 209 PCB cong (excl non-detects)	7.4	
112-65	Upland	S-WS115-18FSP10-10-20	WS115	1.0	2.0	4/30/2018	Aroclor 1254 - Immunoassay	4.0	J
112-65	Upland	S-WS116-18FSP10-00-10	WS116	0.0	1.0	4/30/2018	Total 209 PCB cong (excl non-detects)	2.9	
112-65	Upland	S-WS116-18FSP10-10-20	WS116	1.0	2.0	4/30/2018	Aroclor 1254 - Immunoassay	170	JD
112-65	Upland	S-WS116-18FSP10-20-30	WS116	2.0	3.0	4/30/2018	Aroclor 1254 - Immunoassay	210	J
112-65	Upland	S-WS141-18FSP10-00-10	WS141	0.0	1.0	8/3/2018	Aroclor 1254 - Immunoassay	160	JD
112-65	Upland	S-WS141-18FSP10-10-20	WS141	1.0	2.0	8/3/2018	Total 209 PCB cong (excl non-detects)	158	
112-65	Upland	S-WS141-18FSP10-20-30	WS141	2.0	3.0	8/3/2018	Total 209 PCB cong (excl non-detects)	34.1	
112-65	Upland	S-WS141-18FSP10-30-40	WS141	3.0	4.0	8/3/2018	Aroclor 1254 - Immunoassay	13.0	JD
112-65	Mudflat	S-WS142-18FSP10-00-10	WS142	0.0	1.0	7/31/2018	Aroclor 1254 - Immunoassay	1.8	JD
112-65	Mudflat	S-WS142-18FSP10-10-20	WS142	1.0	2.0	7/31/2018	Aroclor 1254 - Immunoassay	10.0	J
112-65	Mudflat	S-WS142-18FSP10-20-30	WS142	2.0	3.0	7/31/2018	Aroclor 1254 - Immunoassay	3.5	JD
112-65	Mudflat	S-WS142-18FSP10-30-40	WS142	3.0	4.0	7/31/2018	Aroclor 1254 - Immunoassay	5.6	JD
112-65	Low Marsh	S-WS143-18FSP10-00-10	WS143	0.0	1.0	8/3/2018	Aroclor 1254 - Immunoassay	240	JD
112-65	Low Marsh	S-WS143-18FSP10-10-20	WS143	1.0	2.0	8/3/2018	Aroclor 1254 - Immunoassay	71.0	JD
112-65	Low Marsh	S-WS143-18FSP10-20-30	WS143	2.0	3.0	8/3/2018	Aroclor 1254 - Immunoassay	55.0	JD
112-65	Low Marsh	S-WS143-18FSP10-30-40	WS143	3.0	4.0	8/3/2018	Aroclor 1254 - Immunoassay	79.0	JD
112-65	Low Marsh	S-WS143-18FSP10-40-50	WS143	4.0	5.0	8/3/2018	Aroclor 1254 - Immunoassay	88.0	JD
112-65	Mudflat	S-WS145-18FSP10-00-10	WS145	0.0	1.0	8/30/2018	Aroclor 1254 - Immunoassay	95.0	JD
112-65	Mudflat	S-WS145-18FSP10-10-20	WS145	1.0	2.0	8/30/2018	Aroclor 1254 - Immunoassay	95.0	JD
112-65	Mudflat	S-WS145-18FSP10-20-29	WS145	2.0	2.9	8/30/2018	Total 209 PCB cong (excl non-detects)	25.1	
112-65	Mudflat	S-WS146-18FSP10-00-10	WS146	0.0	1.0	8/16/2018	Aroclor 1254 - Immunoassay	95.0	JD
112-65	Mudflat	S-WS146-18FSP10-10-14	WS146	1.0	1.4	8/16/2018	Aroclor 1254 - Immunoassay	96.0	JD
112-65	Upland	S-WS146B-18FSP10-00-10	WS146B	0.0	1.0	8/28/2018	Aroclor 1254 - Immunoassay	94.0	JD
112-65	Upland	S-WS146B-18FSP10-10-20	WS146B	1.0	2.0	8/28/2018	Aroclor 1254 - Immunoassay	94.0	JD
112-65	Upland	S-WS146B-18FSP10-20-30	WS146B	2.0	3.0	8/28/2018	Aroclor 1254 - Immunoassay	10.0	JD
112-65	Upland	S-WS146B-18FSP10-30-31	WS146B	3.0	3.1	8/28/2018	Aroclor 1254 - Immunoassay	19.0	JD

Notes:
Pre-excavation confirmatory congener samples are shaded green.
D - reported value is from a dilution; U - not detected; J - estimated value.
Total 18 NOAA PCB congeners multiplied by a factor of 2.6.

Table 2-2
West Zone 1 Compliance Survey Control Table

Parcel	Station ID	Location	Design Excavation Elevation	Post-Excavation Elevation	Δ (ft)	Design Restoration Elevation	Post-Restoration Elevation	Δ (ft)
			NAVD88 ft			NAVD88 ft		
116-132	S-18	Sidewall	-2.8	-3.2	-0.4	0.20	0.46	0.26
116-132	WS158	Sidewall	3.1	2.9	-0.2	4.00	4.15	0.15
116-132	WS165	Sidewall	-4.0	-4.4	-0.4	0.20	0.37	0.17
116-132	WS102	Floor	-0.3	-0.3	0.0	1.40	1.62	0.22
116-86	WS159	Sidewall	1.2	0.9	-0.3	2.00	2.12	0.12
116-86	WS160	Sidewall	2.1	1.7	-0.5	1.90	2.19	0.29
116-86	INT185	Sidewall	2.2	2.2	-0.1	3.70	3.89	0.19
116-86	WS106	Sidewall	2.7	2.3	-0.4	3.20	3.44	0.24
116-86	WS130	Sidewall	4.3	4.0	-0.3	5.50	5.7	0.20
116-86	WS131	Sidewall	5.4	4.7	-0.7	6.10	6.33	0.23
116-86	WS135	Sidewall	3.0	2.7	-0.3	4.90	4.97	0.07
116-86	WS161	Sidewall	4.0	3.5	-0.5	5.00	5.24	0.24
116-86	WS166	Sidewall	-4.1	-4.3	-0.2	-1.00	-0.82	0.18
116-86	WS167	Sidewall	-2.9	-3.0	-0.1	0.00	0.19	0.19
116-86	WS168	Sidewall	-6.9	-8.0	-1.1	-0.90	-0.71	0.19
116-86	WS169	Sidewall	-4.0	-4.7	-0.7	-1.30	-1.12	0.18
116-86	S-20	Floor	-1.9	-2.3	-0.4	-0.62	-0.45	0.17
116-86	WS118	Floor	-1.5	-2.7	-1.2	0.50	0.6	0.10
116-86	WS119	Floor	-5.7	-6.7	-1.0	0.20	0.26	0.06
116-86	WS123	Floor	3.0	2.6	-0.5	3.30	3.59	0.29
116-86	WS138	Floor	-1.7	-2.2	-0.5	0.90	1.25	0.35
116-86	WS147	Floor	-1.7	-2.1	-0.4	0.90	0.95	0.05
116-100	WS133	Sidewall	3.8	3.4	-0.4	4.60	4.96	0.36
116-100	WS156	Sidewall	3.4	2.6	-0.8	4.00	4.26	0.26
116-100	WS170	Sidewall	-3.1	-3.2	-0.1	-1.96	-1.90	0.06
116-100	WS171	Sidewall	-3.9	-4.7	-0.8	-1.96	-1.86	0.10
116-100	WS121	Floor	-2.6	-2.9	-0.3	0.20	0.25	0.05
116-100	WS152	Floor	-3.5	-3.5	0.0	0.49	0.76	0.27
116-100	WS153	Floor	-1.7	-1.8	-0.1	0.80	0.96	0.16
116-94	WS110	Sidewall	5.3	4.6	-0.7	6.90	7.15	0.25
116-94	WS112	Sidewall	8.0	7.6	-0.4	9.00	9.18	0.18
116-94	WS134	Sidewall	7.6	7.4	-0.2	8.69	8.77	0.08
116-94	WS162	Sidewall	2.3	2.1	-0.2	3.30	3.64	0.34
116-94	WS172	Sidewall	-4.1	-4.2	-0.1	-2.15	-2.03	0.12
116-94	WS173	Sidewall	-2.9	-3.4	-0.5	-2.15	-2.08	0.07
116-94	WS174	Sidewall	-3.2	-3.5	-0.3	-1.30	-1.05	0.25
116-94	WS111	Floor	5.0	4.8	-0.2	7.69	7.86	0.17
116-94	WS139	Floor	-3.7	-4.3	-0.6	0.20	0.35	0.15
116-94	WS140	Floor	-2.6	-2.9	-0.3	0.20	0.21	0.01
116-94	WS155	Floor	-4.0	-4.4	-0.4	-1.30	-1.23	0.07
116-94	WS157	Floor	-3.9	-4.0	-0.1	-2.00	-1.72	0.28
112-65	WS163	Sidewall	0.6	0.3	-0.3	3.00	3.38	0.38
112-65	WS164	Sidewall	2.1	1.2	-0.9	3.30	3.51	0.21
112-65	WS175	Sidewall	-4.2	-4.5	-0.3	-1.96	-1.90	0.06
112-65	WS176	Sidewall	-2.9	-3.2	-0.3	-1.80	-1.25	0.55
112-65	WS141	Floor	-1.7	-1.9	-0.2	0.20	0.31	0.11
112-65	WS143	Floor	-0.2	-0.9	-0.7	0.73	0.83	0.10

Notes:
Elevation measurements at sidewall locations will be taken at the base of the sidewall (bottom of the excavation).
Locations WS158 through WS176 are compliance survey locations only (no associated PCB sample data).
MA - Massachusetts; NAD83 - North American Datum 1983; NAVD88 - North American Vertical Datum 1988; ft - feet; TBD - to be determined.
Δ - difference between post-excavation elevation and design elevation.

Table 2-4
West Zone 1 Planting Summary

COMPLETED ACTIVITIES	
5/18/21-5/25/21	WZ1 Saltmarsh plugs completed. Low Marsh (Spartina alterniflora) 2" plugs, High Marsh (Spartina patens and Distichlis spicata)
7/7/21-7/9/21	Herbivory deterrent fencing installed in WZ-1
5/19/21-5/24/21	SWCA installs upland plantings (1 gallon containers and plugs) at WZ-1
5/24/2021	SWCA performs seeding and mulching of disturbed upland areas
6/15/21	SWCA installs remaining trees and shrubs (1 gallon containers) at WZ1 (previously out of stock)
10/21/21	Re-seed and mulch any bare upland areas at WZ-1 (Parcel 116-100)
PLANNED ACTIVITIES	
Planned for Spring 2022	Replace any dead warrantied dead trees or shrubs

Attachment A

West Zone 1 Topsoil Summary

		Acceptable Nutrient Ranges										Geotech (Method D7928)			MCP S-1 Soil Cleanup Standards									
Batch #	Supplier	pH 6 - 7	CEC >20 meq/100g	Base Saturation >35%	Avail Plant Moisture 50 - 70%	Organic Matter Content 5 - 8%	Mg 50 - 120 ppm	Ca 1000 - 1500 ppm	K 100 - 160 ppm	N >25 ppm	P >15 ppm	Sand 45 - 85%	Silt 0 - 50%	Clay 0 - 20%	Metals	Petroleum Hydrocarbons	Target VOCs	Target SVOCs	EDB	1,4-Dioxane	Cyanide	PCBs	Backfill Location	Approved Vol (CY)
033	Read Custom	6.6	8.9	77.6	NA	5.9	154.0	945	349	42.5	101	76.5	15.5	8	√	√	√	√	√	√	√	√	WZ1	500
034	Read Custom	6.7	8.2	75.8	NA	5.6	132.0	870	307	32.4	94	76.1	15.4	8.6	√	√	√	√	√	√	√	√	WZ1	1000
035	Read Custom	6.7	8	75.2	NA	5.9	129.0	841	297	38.4	90	76.9	14.4	8.7	√	√	√	√	√	√	√	√	WZ1	1500
	Averages	6.7	8.4	76.2		5.8	138.3	885.3	317.7	37.8	95.0	76.5	15.1	8.4										

Notes

NA= Not analyzed

Attachment B

West Zone 1 Final Planting Plans

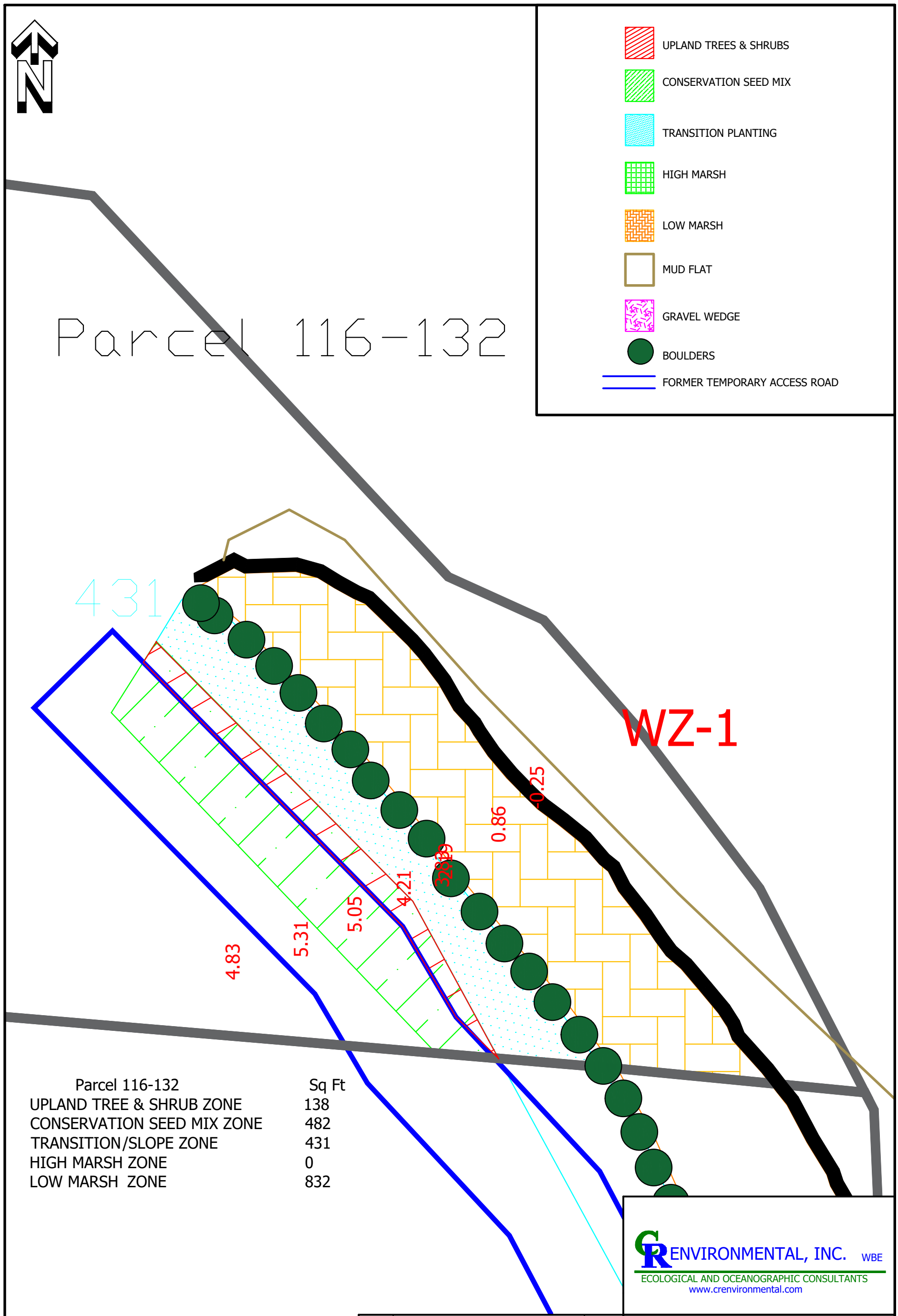
WZ-1 PLANTING PLAN

New Bedford Harbor Superfund Site

March 2021

0

Path: Y:\Special Assignments\New Bedford\WZ1\Basemap for CR\Figure 2-3 West Zone 1 RA Post Excavation Limits 20200302CR.mxd



Parcel 116-132	Sq Ft
UPLAND TREE & SHRUB ZONE	138
CONSERVATION SEED MIX ZONE	482
TRANSITION/SLOPE ZONE	431
HIGH MARSH ZONE	0
LOW MARSH ZONE	832

0 10' 20'

REVISIONS		
DATE	DESCRIPTION	DRAWN
2-5-21	REV1	kjt
3-10-21	Update details	kjt

Notes
1) Scale 1"/10'
2) Cross section points collected 1/7/2021.

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Parcel 116-132

UPPER HARBOR WEST ZONE-1, PARCEL 116-132

PROPOSED PLANTINGS (Spring 2021) Shrubs and trees all 1 gallon containers, and number for each plant species is in parentheses. Herbaceous plugs of salt marsh grasses, seaside goldenrod, switchgrass, and coastal panic grass should be 2" diameter. Slow release fertilizer such as Osmocote for plugs and 1 gallon containers for establishment. Seed mixes are New England/ Wildlife Seed Mix and Coastal Salt Tolerant Grass Mix (Reference Figure for Parcel 116-132 for planting zones, and Table 1 for a tally of Plant Materials). Treat *Phragmites australis* just N and adjacent to the remediated area at Parcel 116-132.

- **Provide temporary fencing at the upland extent to protect plantings during establishment**

UPLAND Tree and Shrub Zone (5 ft o.c. triangular spacing)
(~138 sq ft)

Juniperus virginiana **(3)** Eastern red cedar
Clethra alnifolia **(3)** sweet pepperbush

Plant just landward of the transition zone alternating in a row (seaward of access road).
Overseed with **NE Conservation/Wildlife seed mix**

CONSERVATION SEED (Application rate: 25lbs/acre or 1750 sq ft/lb)
(478 sq ft)
Seed entire zone with NE Conservation/Wildlife seed mix **~0.3 lbs**

TRANSITION Zone (shrubs 3 ft o.c. and herbs* 1.5 ft o.c. triangular spacing)
(431 sq ft)

Bayberry subZONE
Myrica pensylvanica **(10)** northern bayberry
Rosa virginiana **(10)** Virginia rose
Panicum virgatum **(33)** switchgrass*

Plant above High Tide Bush subzone. Plant in sets of 3 plants of the same species. Alternate the *M. pensylvanica* and *R. virginiana* with *P. virgatum*

High Tide Bush subZONE
Iva frutescens **(10)** high tide bush
Panicum amarum var *amarula* **(33)** coastal panic grass or substitute *P. virgatum**
Solidago sempervirens **(33)** seaside goldenrod*

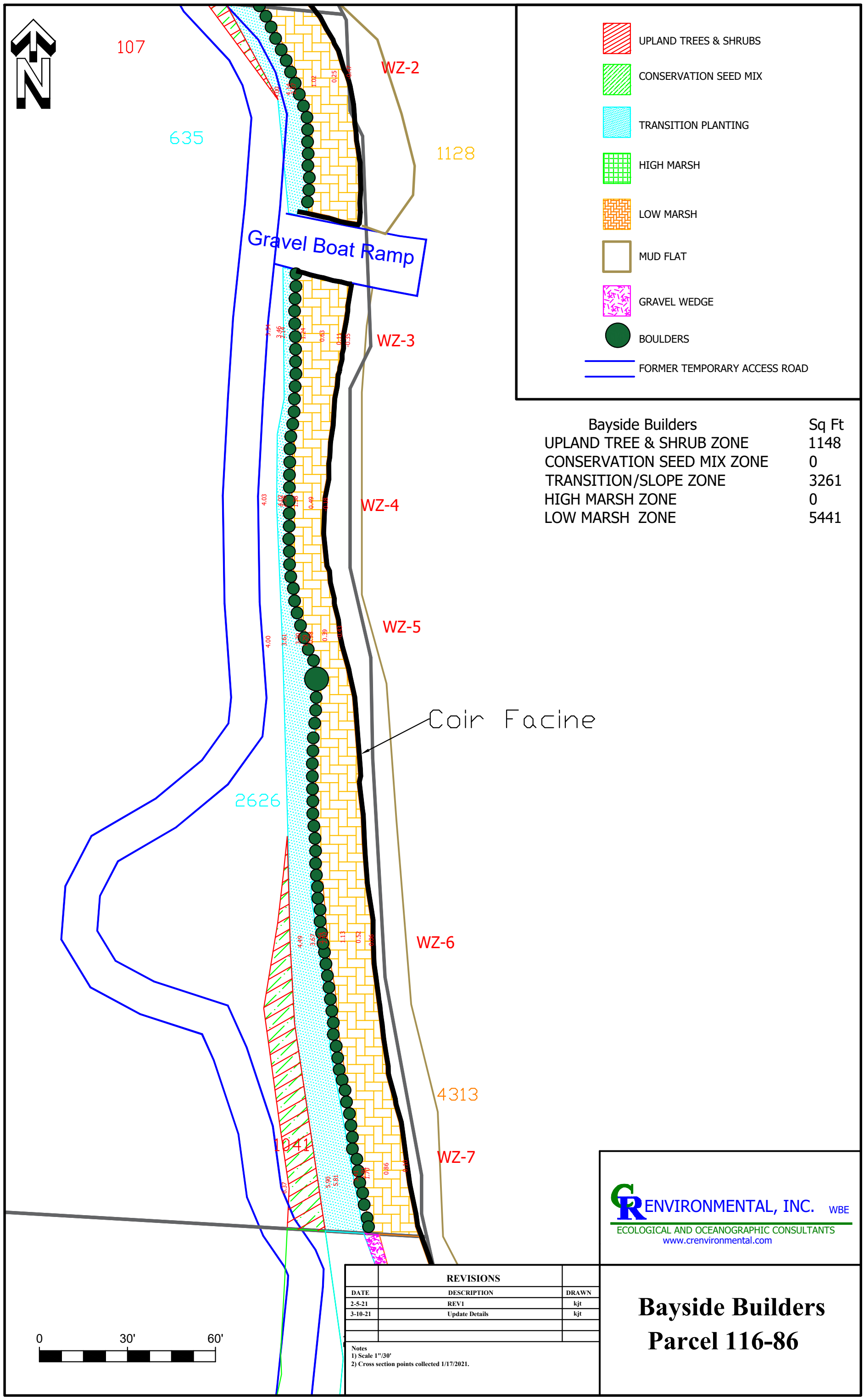
Plant above 2-man stone where soil appears stable and seaward of the bayberry and Virginia rose
Plant in sets of 3 plants of the same species.

Overseed entire transition zone with **Coastal Salt Tolerant Grass seed mix at rate of 1 lb/1250 sq ft** or **~0.35 lbs.** See attached specification sheet.

LOW MARSH (1.5 ft o.c. square spacing)
(832 sq ft)

Spartina alterniflora **(370)**

Plant plugs with slow release fertilizer



Bayside Builders	Sq Ft
UPLAND TREE & SHRUB ZONE	1148
CONSERVATION SEED MIX ZONE	0
TRANSITION/SLOPE ZONE	3261
HIGH MARSH ZONE	0
LOW MARSH ZONE	5441

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REVISIONS		
DATE	DESCRIPTION	DRAWN
2-5-21	REV1	kjt
3-10-21	Update Details	kjt

Notes
1) Scale 1"/30'
2) Cross section points collected 1/17/2021.

Bayside Builders
Parcel 116-86

UPPER HARBOR WEST ZONE-1, PARCEL 116-86 Bayside Builders

PROPOSED PLANTINGS (Spring 2021) Shrubs and trees all 1 gallon containers, and number for each plant species is in parentheses. Herbaceous plugs of salt marsh grasses, seaside goldenrod, switchgrass, and/or coastal panic grass should be 2" diameter. Slow release fertilizer such as Osmocote for plugs and 1 gallon containers for establishment. Seed mixes are New England/ Wildlife Seed Mix and Coastal Salt Tolerant Grass Mix (Reference Figure for Parcel 116-86 for planting zones, and Table 1 for a tally of Plant Materials).

- **Provide temporary fencing at the upland extent to protect plantings during establishment**

UPLAND Tree and Shrub Zone (10 ft o.c. triangular spacing)

(107 sq ft)

Clethra alnifolia **(2)** sweet pepperbush

(1,041 sq ft)

Juniperus virginiana **(6)** Eastern red cedar

Clethra alnifolia **(6)** sweet pepperbush

Plant landward of the transition zone in a triangular pattern. **Overseed** entire zone with **NE Conservation/Wildlife seed mix** 1 lb per 1750 sq ft or **~0.7 lbs**

TRANSITION Zone (shrubs 3 ft o.c. and herbs* 1.5 ft o.c. triangular spacing)

(635 sq ft N of gravel boat ramp) (1,041 sq ft S of boat ramp)

Bayberry subZONE *Myrica pensylvanica* **(60)** northern bayberry

Rosa virginiana **(30)** Virginia rose

Panicum virgatum **(136)** switchgrass*

Plant above High Tide Bush subzone in sets of 3 plants of the same species. Alternate switchgrass with the bayberry and rose.

High Tide Bush subZONE

Iva frutescens **(30)** high tide bush

Panicum amarum var. amarula coastal panic grass **(136)** or if not available *P. virgatum* grass*

Solidago sempervirens **(106)** seaside goldenrod*

Plant above 2-man stone where soil appears stable and seaward of the bayberry and Virginia rose. Plant in sets of 3 plants of the same species. Alternate coastal panic grass with high tide bush and seaside goldenrod.

Overseed entire transition zone with **Coastal Salt Tolerant Grass seed mix** at rate of 1 lb/1250 sq ft or **~1.4 lbs**.

LOW MARSH (1.5 ft o.c. square spacing)

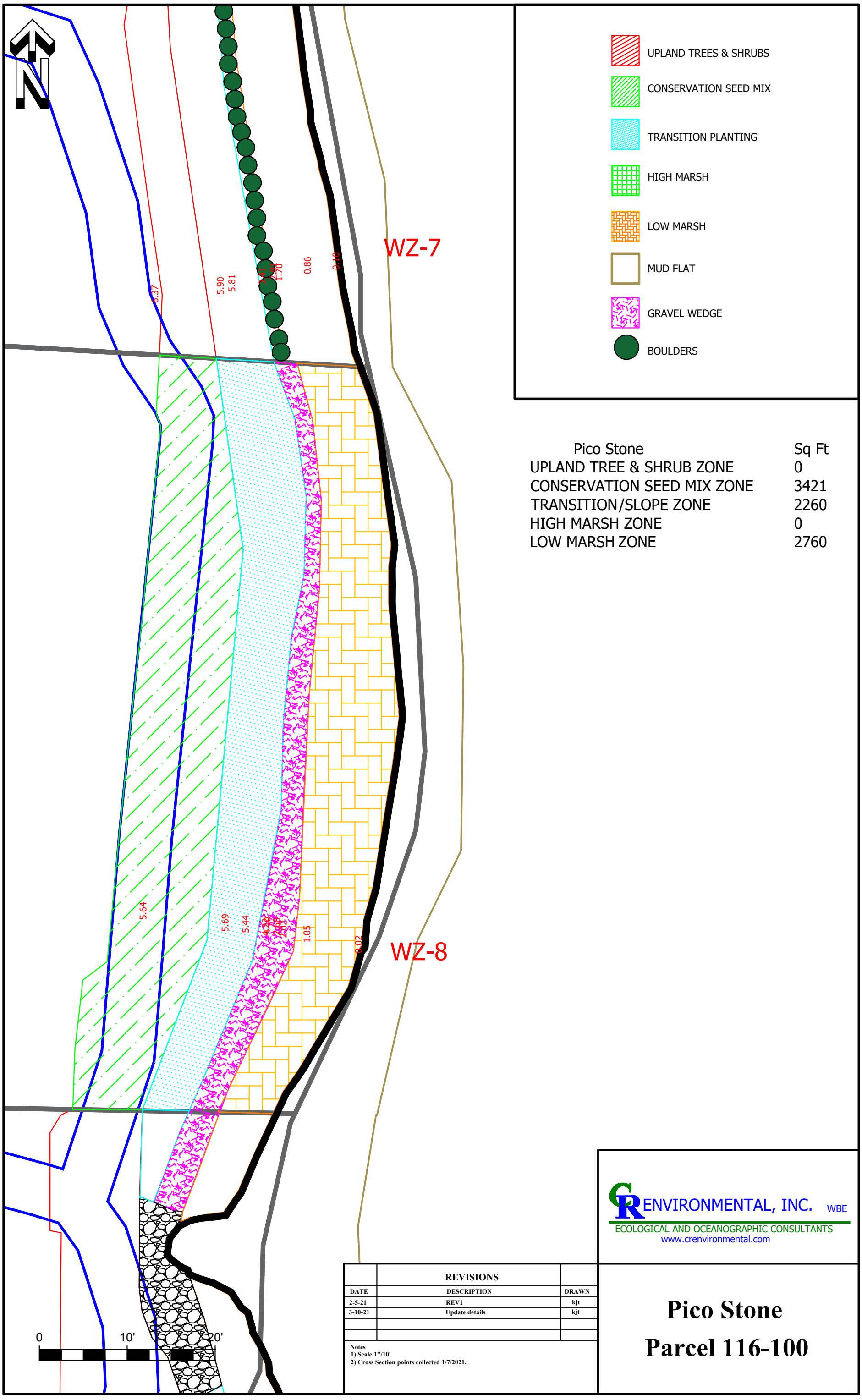
(1,128 sq ft N of boat ramp)

Spartina alterniflora **(500)**

(4,313 sq ft S of boat ramp)

Spartina alterniflora **(1,917)**

Plant 2" plugs with slow release fertilizer



Pico Stone	Sq Ft
UPLAND TREE & SHRUB ZONE	0
CONSERVATION SEED MIX ZONE	3421
TRANSITION/SLOPE ZONE	2260
HIGH MARSH ZONE	0
LOW MARSH ZONE	2760

REVISIONS		
DATE	DESCRIPTION	DRAWN
2-5-21	REV1	kjt
3-10-21	Update details	kjt

Notes
1) Scale 1"/10'
2) Cross Section points collected 1/7/2021.

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Pico Stone
Parcel 116-100

UPPER HARBOR WEST ZONE-1, PARCEL 116-100 PICO Stone

PROPOSED PLANTINGS (Spring 2021) Shrubs and trees all 1 gallon containers, and number for each plant species is in parentheses. Herbaceous plugs of salt marsh grasses, seaside goldenrod, switchgrass, and/or coastal panic grass should be 2" diameter. Slow release fertilizer for establishment. Seed mixes are New England/ Wildlife Seed Mix and Coastal Salt Tolerant Grass Mix (Reference Figure for Parcel 116-100 for planting zones, and Table 1 for a tally of Plant Materials). Provide temporary fencing at the upland extent to protect plantings during establishment

CONSERVATION SEED MIX Zone

(3,421 sq ft)

Landward of the transition zone **seed** entire zone with **NE Conservation/Wildlife seed mix** 1 lb per 1750 sq ft or **~2.0 lbs**

TRANSITION Zone (3 ft o.c. triangular spacing for shrubs, 1.5 ft for herbs*)

(2,260 sq ft)

Bayberry subZONE

Myrica pensylvanica **(45)** northern bayberry

Rosa virginiana **(45)** Virginia rose

Panicum virgatum **(230)** switchgrass*

Plant above High Tide Bush subzone in sets of 3 plants of the same species. Alternate switchgrass at 1.5 ft o.c. with bayberry and rose spaced at 3 ft o.c.

High Tide Bush subZONE

Iva frutescens **(27)** high tide bush

P. amarum var. amarula coastal panic grass **(230**) if not available *Panicum virgatum* switchgrass*

Solidago sempervirens **(230)** seaside goldenrod*

Plant above gravel wedge where soil appears stable and seaward of the bayberry and Virginia rose. Plant in sets of 3 plants of the same species.

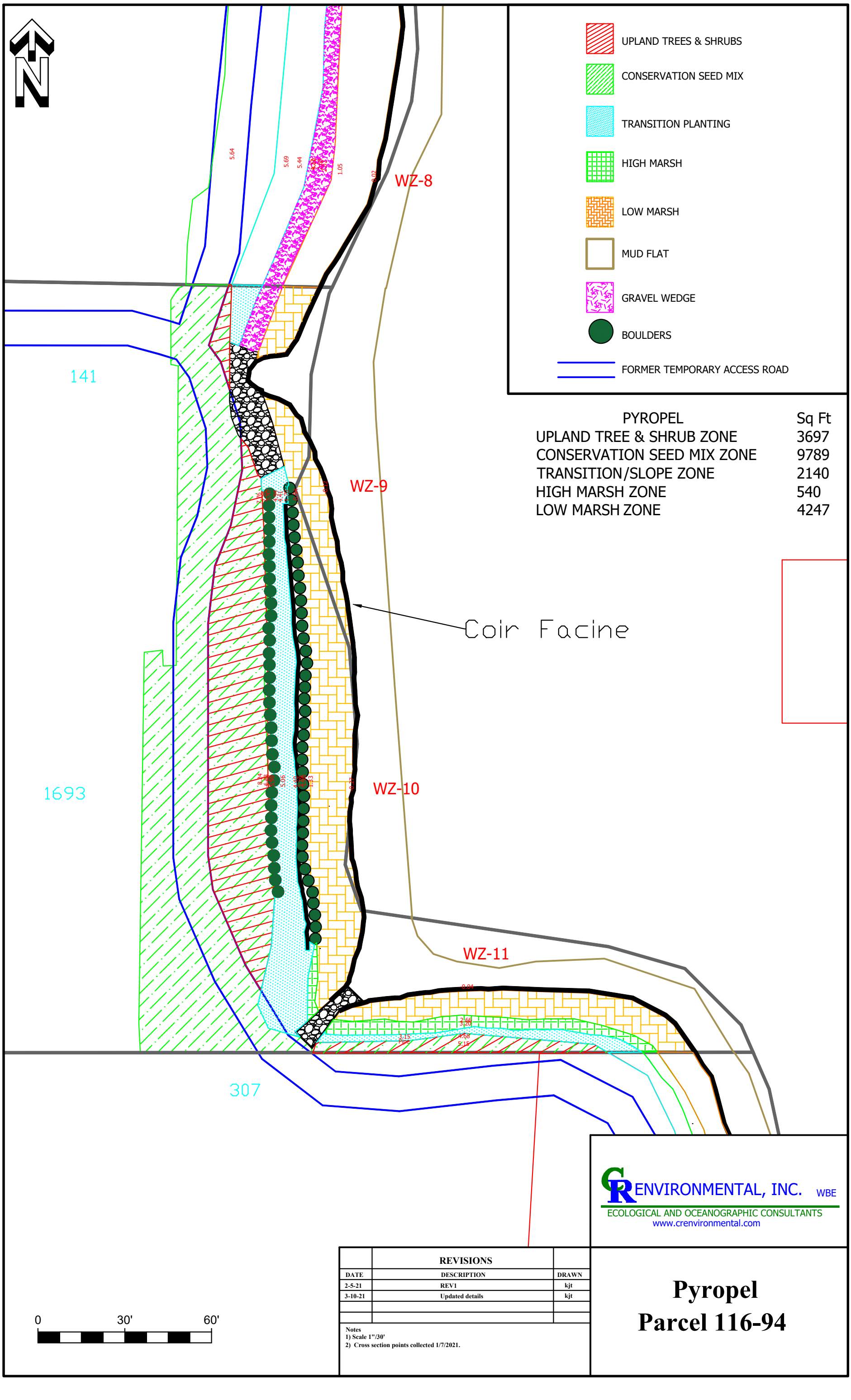
Overseed entire transition zone with **Coastal Salt Tolerant Grass seed mix** at rate of 1 lb/1250 sq ft or **~1.8 lbs.**

LOW MARSH (1.5 ft o.c. square spacing)

(2760 sq ft)

Spartina alterniflora **(1227)** salt marsh cordgrass

Plant 2" plugs with slow release fertilizer



PYROPEL	Sq Ft
UPLAND TREE & SHRUB ZONE	3697
CONSERVATION SEED MIX ZONE	9789
TRANSITION/SLOPE ZONE	2140
HIGH MARSH ZONE	540
LOW MARSH ZONE	4247

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REVISIONS		
DATE	DESCRIPTION	DRAWN
2-5-21	REV1	kjt
3-10-21	Updated details	kjt

Notes
1) Scale 1"/30'
2) Cross section points collected 1/7/2021.

Pyropel
Parcel 116-94

UPPER HARBOR WEST ZONE-1, PARCEL 116-94 Pyropel

PROPOSED PLANTINGS (Spring 2021) Shrubs and trees all 1 gallon containers, and number for each plant species is in parentheses. Herbaceous plugs of salt marsh grasses, seaside goldenrod, switchgrass, and/or coastal panic grass should be 2" diameter. Slow release fertilizer such as Osmocote for plugs and 1 gallon containers for establishment. Seed mixes are New England/ Wildlife Seed Mix and Coastal Salt Tolerant Grass Mix (Reference Figure for Parcel 116-86 for planting zones, and Table 1 for a tally of Plant Materials).

- **Provide temporary fencing at the upland extent to protect plantings during establishment**

UPLAND Tree and Shrub Zone (~8 ft o.c. square spacing) planting a ~3,125 sq ft area up-gradient of the 2 man stones and seaward of the former access road. The remaining upland zone to be seeded with NE Conservation seed mix.
(total area is 9,788 sq ft/ planting 3,125 sq ft)

Juniperus virginiana **(7)** Eastern red cedar
Salix sericea **(3)** silky willow
Rhus aromatica **(12)** fragrant sumac
Rosa virginiana **(21)** Virginia rose

Plant landward of the transition zone. Plant rose and red cedar at the seaward edge of the upland. Then fragrant sumac and silky willow landward up to the area of the former access road. Remaining zone to receive only NE Conservation seed mix.
Overseed entire zone with **NE Conservation/Wildlife seed mix** 1 lb per 1750 sq ft or **~5.6 lbs**

TRANSITION Zone (3 ft o.c. for shrubs and 1.5 ft o.c. for herbs* square spacing)
(2,140 sq ft)

Bayberry subZONE *Myrica pensylvanica* **(60)** northern bayberry
Rosa virginiana **(30)** Virginia rose
Panicum virgatum **(184)** switchgrass*

Plant on shelf between the two rows of 2-man stone in sets of 3 plants of the same species; and above the high tide bush zone at southern extent of the parcel. Plant bayberry and rose at **3 ft o.c**. and switchgrass at **1.5 ft o.c**.

High Tide Bush subZONE
Iva frutescens **(18)** high tide bush
Panicum amarum var. amarula coastal panic grass **(184)** or if not available *P. virgatum* grass*
Solidago sempervirens **(184)** seaside goldenrod 2" plugs*

Plant above the high marsh zone at the southern end of the parcel. High tide bush and seaside goldenrod should be planted at the upper limit of the wrack line. High tide bush should be planted approximately **6 feet apart**. Plant seaside goldenrod between the high tide bush and the coastal panic grass landward with a spacing of **~1.5 ft o.c.**

Overseed entire transition zone with **Coastal Salt Tolerant Grass seed mix** at rate of 1 lb/1250 sq ft or **~ 1.7 lbs**.

UPPER HARBOR WEST ZONE-1, PARCEL 116-94 Pyropel

HIGH MARSH Zone (1 ft o.c. square spacing)

(540 sq ft)

Distichlis spicata **(270)** spike grass

Spartina patens **(270)** salt meadow grass

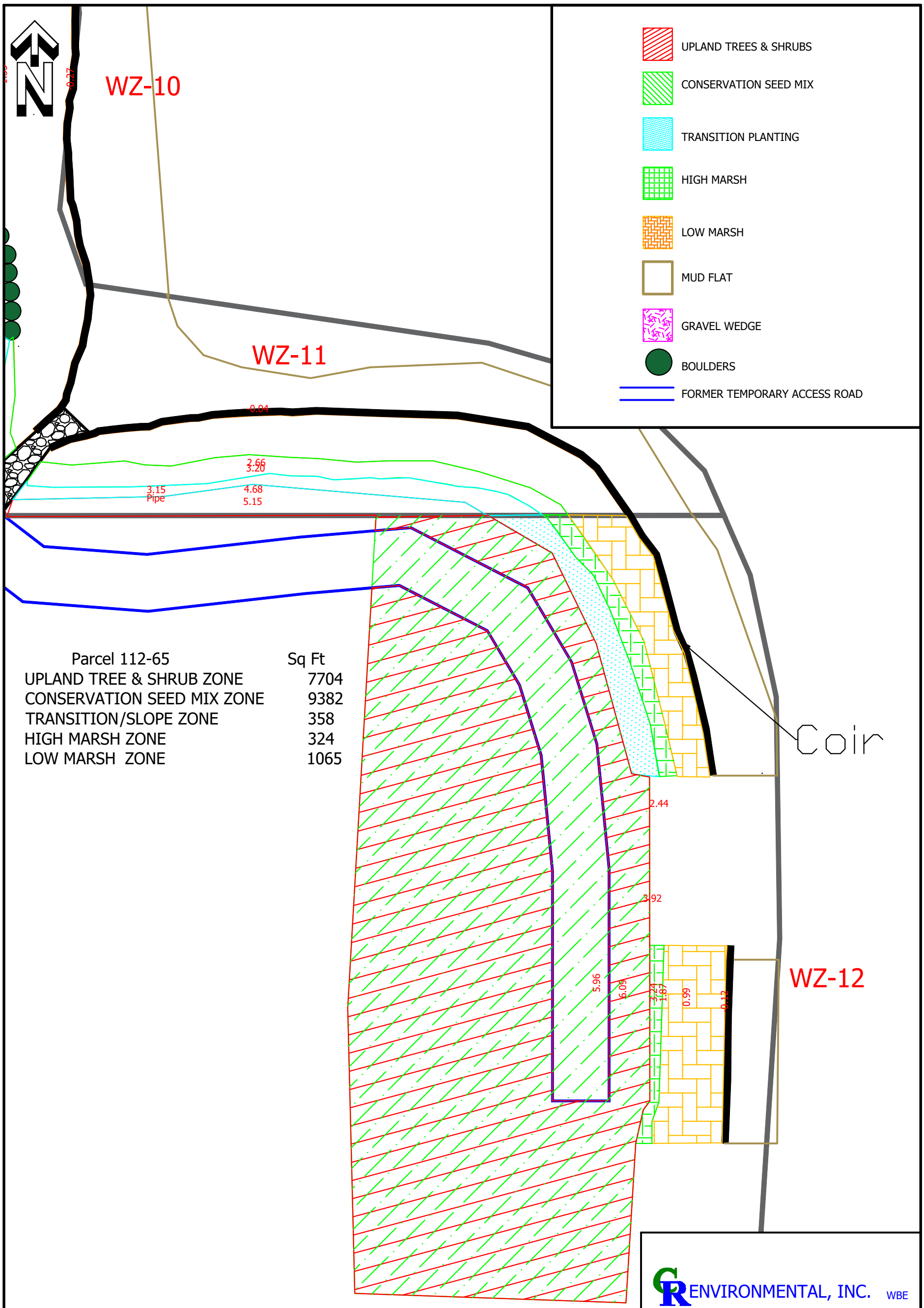
Plant 50/50 mix southern end of parcel.

LOW MARSH Zone (1.5 ft o.c. square spacing)

(4,247 sq ft)

Spartina alterniflora **(1,888)** salt marsh cordgrass

Plant 2" plugs with slow release fertilizer



Parcel 112-65	Sq Ft
UPLAND TREE & SHRUB ZONE	7704
CONSERVATION SEED MIX ZONE	9382
TRANSITION/SLOPE ZONE	358
HIGH MARSH ZONE	324
LOW MARSH ZONE	1065

Parcel 112-65

0 20' 40'

REVISIONS		
DATE	DESCRIPTION	DRAWN
2-5-21	REV1	kjt
3-10-21	Update details	kjt

Notes
1) Scale 1"/20'
2) Cross section points collected 1/7/2021.

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Precix
Parcel 112-65

UPPER HARBOR WEST ZONE-1, PARCEL 116-65 Precix

PROPOSED PLANTINGS (Spring 2021) Shrubs and trees all 1 gallon containers, and number for each plant species is in parentheses. Herbaceous plugs of salt marsh grasses, seaside goldenrod, switchgrass, and/or coastal panic grass should be 2" diameter. Slow release fertilizer such as Osmocote for plugs and 1 gallon containers for establishment. Seed mixes are New England/ Wildlife Seed Mix and Coastal Salt Tolerant Grass Mix (Reference Figure for Parcel 116-86 for planting zones, and Table 1 for a tally of Plant Materials).

***Provide temporary fencing at the upland extent to protect plantings during establishment**

UPLAND Tree and Shrub Zone (~12 ft o.c. triangular spacing)

(9,382 sq ft total) about 8,812 sq ft for shrubs and trees

Quercus alba **(1)** white oak

Betula populifolia **(3)** gray birch

Juniperus virginiana **(7)** Eastern red cedar

Salix sericea **(2)** silky willow

Myrica pensylvanica **(33)** northern bayberry

Rhus aromatic **(11)** aromatic sumac

Plant landward of the transition zone . Plant bayberry, aromatic sumac and red cedar closer to the shore, and other species gray birch, sweet pepperbush, silky willow and oak landward of the access road footprint. Do not plant woody vegetation in the footprint of the access road.

Overseed entire zone with **NE Conservation/Wildlife seed mix** 1 lb per 1750 sq ft or **~5.4 lbs**

TRANSITION Zone (358 sq ft) **(~1.5 ft o.c. square spacing)**

Panicum amarum var. amarula coastal panic grass **(102)** or if not available *P. virgatum* switchgrass*

Iva frutescens **(8)** high tide bush

Solidago sempervirens **(48)** seaside goldenrod*

Plant above high marsh zone. Alternate sets of 3 coastal panic grass plugs with high tide bush and seaside goldenrod.

Overseed entire transition zone with **Coastal Salt Tolerant Grass seed mix** at rate of 1 lb/1250 sq ft **~ 0.3 lbs**.

HIGH MARSH Zone (1 ft o.c. square spacing)

(540 sq ft)

Distichlis spicata **(162)** spike grass

Spartina patens **(162)** salt meadow grass

Plant 50/50 mix above low marsh zone

LOW MARSH Zone (1.5 ft o.c. square spacing)

(1055 sq ft)

Spartina alterniflora **(469)** salt marsh cordgrass

Plant 2" plugs with slow release fertilizer

TABLE 1a

PLANTS FOR WZ-1 BY PARCEL
Original and Currently Proposed Numbers

		Bayside Builders			PICO Stone		Pyropel		Precix		Original	Current
			116-132	116-86	116-100		116-94		112-65		TOTALS	TOTALS
Shrub Species	(1 gallon)	Original	Proposed	Proposed	Original	Proposed	Original	Proposed	Original	Proposed		
Iva frutescens	High tide bush	47	10	30		27	32	18	13	8	92	93
Clethra alnifolia	Sweet pepperbush	49	3	8	7		48		7		111	11
Rosa virginiana	Virginia rose	190	10	30		45	61	30			251	136
								21				
Myrica pensylvanica	Northern bayberry	21	10	60		45		60	7	33	28	208
Salix sericea	Silky willow							3	2	2	2	5
Rhus aromatica	Fragrant sumac							12		11	0	17
Tree Species												
Acer rubrum	Red Maple						2		2		4	0
Juniperus virginiana	Red Cedar	28	3	6				7	7	7	35	23
Quercus alba	White Oak									1	1	1
Betula populifolia	Gray Birch								1	3	1	3
	TOTAL	335	36	134	7	117	143	151	39	65	525	**497**

TABLE 1a

PLANTS FOR WZ-1 BY PARCEL
Original and Currently Proposed Numbers

	Bayside Builders		PICO Stone		Pyropel		Precix			
Herbaceous Species (Grasses and Forbs)										
Panicum virgatum										
Panicum amarum var. amarula										
Solidago sempervirens										
Spartina alterniflora										
Spartina patens										
Distichlis spicata										
New England Conservation/Wildlife seed mix (lbs) (total for Upland shrub & tree zone and Conservation seed zone) APPLICATION RATE: 25lbs/acre | 1750 sq ft/lb	0.3	0.7		2		5.6		5.4		14
Coastal Salt Tolerant Grass seed mix (lbs) APPLICATION RATE: 35 lbs/acre | 1250 sq ft/lb										

KEY

- Upland Shrub & Tree Zone
- Transition Zone
- High Marsh Zone
- Low Marsh Zone

Reference Jacobs Figure WZ-1 Post Excavation Limits, Parcel Figures, and Planting Directions

TABLE 1b

PLANTS FOR WZ-1 BY PARCEL

		Bayside Builders		Pico Stone	Pyropel	Precix	**Current**
		116-132	**116-86**	**116-100**	**116-94**	**112-65**	**TOTALS**
Shrub Species	(1 gallon)	Proposed	Proposed	Proposed	Proposed	Proposed	
Iva frutescens	High tide bush	10	30	27	18	8	93
Clethra alnifolia	Sweet pepperbush	3	8				11
Rosa virginiana	Virginia rose	10	30	45	30		136
					21		
Myrica pensylvanica	Northern bayberry	10	60	45	60	33	208
Salix sericea	Silky willow				3	2	5
Rhus aromatica	Fragrant sumac				12	11	17
Tree Species							
Acer rubrum	Red Maple						0
Juniperus virginiana	Red Cedar	3	6		7	7	23
Quercus alba	White Oak					1	1
Betula populifolia	Gray Birch					3	3
	TOTAL	36	134	117	151	65	**497**

TABLE 1b

PLANTS FOR WZ-1 BY PARCEL

	Bayside Builders		Pico Stone	Pyropel	Precix	
Herbaceous Species (Grasses and Forbs)	_____	_____	_____	_____	_____	_____
Panicum virgatum						
Panicum amarum var. amarula						
Solidago sempervirens						
Spartina alterniflora						
Spartina patens						
Distichlis spicata						
N.E. Conservation/Wildlife seed mix (lbs) (total Conservation seed zone)						
APPLICATION RATE: 25lbs/acre | 1750 sq ft/lb						
Coastal Salt Tolerant Grass seed mix (lbs)						
APPLICATION RATE: 35 lbs/acre | 1250 sq ft/lb						

KEY

- Upland Shrub & Tree Zone
- Conservation Seed Zone
- Transition Zone
- High Marsh Zone
- Low Marsh Zone

Reference Jacobs Figure WZ-1 Post Excavation Limits, Parcel Figures, and Planting Directions

ATTACHMENTS

SELECT PLANT IMAGES AND USDA DATA SHEETS

NEW ENGLAND SEED MIXES

SEASIDE GOLDENROD

SWITCH GRASS

COASTAL PANIC GRASS

VIRGINIA ROSE

SILKY WILLOW

NORTHERN BAYBERRY

New England Coastal Salt Tolerant Grass Mix

The New England Coastal Salt Tolerant Seed Mix contains a selection of native grasses that tolerate salty conditions. This mix is appropriate for drier coastal areas that receive salt spray or mist. Always apply on clean bare soil. The mix may be applied by hydro-seeding, by mechanical spreader, or on small sites it can be spread by hand. Lightly rake, or roll to ensure proper seed to soil contact. Best results are obtained with a Spring seeding. Late Spring and early Summer seeding will benefit with a light mulching of weed free straw to conserve moisture. If conditions are drier than usual, watering may be required. Late Fall and Winter dormant seeding require an increase in the seeding rate. Fertilization is not required unless the soils are particularly infertile. Preparation of a clean weed free soil surface is necessary for optimal results.

APPLICATION RATE: 35 lbs/acre | 1250 sq ft/lb
PRICE: $26.00/bulk pound
Minimum order: 4 lbs

SPECIES: Canada Wild Rye (Elymus canadensis), Red Fescue (Festuca rubra), Atlantic Coastal Panic Grass (Panicum amarum), Big Bluestem (Andropogon gerardii), Indian Grass (Sorghastrum nutans),Switch Grass (Panicum virgatum), Path Rush (Juncus tenuis)

New England Conservation / Wildlife Mix

The New England Conservation/Wildlife Mix provides a permanent cover of grasses, wildflowers, and legumes. For both good erosion control and wildlife habitat value. The mix is designed to be a no maintenance seeding, and is appropriate for cut and fill slopes, detention basin side slopes, and disturbed areas adjacent to commercial and residential projects.

APPLICATION RATE: 25lbs/acre | 1750 sq ft/lb
PRICE: $39.50/bulk pound
Minimum Order: 2 lbs

SPECIES: Virginia Wild Rye (Elymus virginicus), Little Bluestem (Schizachyrium scoparium), Big Bluestem (Andropogon gerardii), Red Fescue (Festuca rubra), Switch Grass (Panicum virgatum), Partridge Pea (Chamaecrista fasciculata), Panicledleaf Tick Trefoil (Desmodium paniculatum), Indian Grass (Sorghastrum nutans), Blue Vervain (Verbena hastata), Butterfly Milkweed (Asclepias tuberosa), Black Eyed Susan (Rudbeckia hirta), Common Sneezeweed (Helenium autunale), Heath Aster (Asterpilosus/Symphyotrichum pilosum), Early Goldenrod (Solidago juncea), Upland Bentgrass (Agrostis perennans).

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Planting Guide

SWITCHGRASS

Panicum virgatum L.

Plant Symbol = PAVI2

Robert H. Mohlenbrock
From the Southern Wetland Flora (1991)
@ plants.usda.gov

Uses

Livestock: Switchgrass is noted for its heavy growth during late spring and early summer. It provides good warm-season pasture and high quality hay for livestock.

Erosion Control: Switchgrass is perhaps our most valuable native grass on a wide range of sites. It is a valuable soil stabilization plant on strip-mine spoils, sand dunes, dikes, and other critical areas. It is also suitable for low windbreak plantings in truck crop fields.

Wildlife: Switchgrass provides excellent nesting and fall and winter cover for pheasants, quail, and rabbits. It holds up well in heavy snow (particularly 'Shelter' and 'Kanlow' cultivars) and is useful on shooting preserves. The seeds provide food for pheasants, quail, turkeys, doves, and songbirds.

Biofuel Source: Interest in switchgrass as a renewable biofuel resource has been increasing in recent years, primarily in the Southern United States. The Booneville, Arkansas, Plant Materials Center (PMC) and the Plant and Soil Science Department of Oklahoma State University (OSU) are cooperating to evaluate several upland types of switchgrass for use as a biomass energy resource. Selections of upland types of switchgrass have been evaluated by OSU for several years. The development of hybrid progeny with substantial heterosis for increased biomass yield will ultimately result in improved hybrid cultivars for the Central and Southern United States. The PMC is in the process of assessing several improved lines along with commercially available cultivars for dry-matter potential and environmental adaptation. Results of this study may contribute to producers cashing in on a growing demand for renewable fuels and a decrease on our dependency on fossil fuels.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Weediness

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or agriculture department regarding its status and use. Weed information is also available from the PLANTS Web site at plants.usda.gov.

Description

Panicum virgatum L., switchgrass, is native to all of the United States except California and the Pacific Northwest. It is a perennial sod-forming grass that grows 3 to 5 feet tall and can be distinguished from other warm-season grasses, even when plants are young, by the white patch of hair at the point where the leaf attaches to the stem. The stem is round and usually has a reddish tint. The seed head is an open, spreading panicle.

Adaptation and Distributions

On suitable soils, switchgrass is climatically adapted throughout the most of the United States. Moderately deep to deep, somewhat dry to poorly drained, sandy to clay loam soils are best. It does poorly on heavy soils. In the Northeast, it performs well on shallow and droughty soil.

Switchgrass is distributed throughout the majority of the United States, excluding the far west states. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Switchgrass should be seeded in a pure stand when used for pasture or hay because it can be managed better alone than in a mixture. It may be mixed with other native grasses, forbs, or legumes for wildlife and restoration seedings. Its slick, free-flowing seed can be planted with most seed drills or with a broadcast spreader. Sow seed at a rate of approximately 4-6 pounds of pure live seed (PLS) per acre drilled in a pure stand. Broadcast seed at a rate of 8-10 pounds of pure live seed (PLS) per acre for a pure stand. Reduce the rate of switchgrass in mixes. Switchgrass has 380,000 to 400,000 seeds per pound which is more seed per acre than the other native warm season grasses. Seeding rates must be carefully designed to provide the desired balance of species.

Tilled seedbeds in areas that were formerly cropped should be firmed with a roller prior to the drilling or broadcasting of seed. If seeds are planted using the broadcast method, the area should be rolled afterward to help cover the seed. When drilled, seeds should be planted 1/4 inch deep. Seedings in areas that were formerly pastures or hay fields have been successful, where control of sod is accomplished with clipping, grazing, or herbicides.

Switchgrass and all other native warm season grasses require exposure to cold, moist conditions (stratification) before they will germinate in warn temperatures. This is easiest to accomplish by sowing seed before the last frost. The date of the last frost in most of the Appalachian Region is April 15.

Phosphorus and potassium should be applied according to soil tests before or at seeding. Nitrogen, however, should not be used at seeding time because it will stimulate weed growth. Apply nitrogen once the switchgrass is growing and is taller than the weeds in the stand at a rate of 30 to 50 pounds per acre.

Management
To control weeds during establishment, mow switchgrass to a height of 4 inches in May or 6 inches in June or July. Grazing is generally not recommended the first year, but a vigorous stand can be grazed late in the year if grazing periods are short with at least 30 days of rest provided between grazings. Switchgrass is the earliest maturing of the common native warm-season grasses and it is ready to graze in early summer.

Established stands of switchgrass may be fertilized in accordance with soil tests. Phosphorus and potassium may not be needed if the field is grazed since these elements will be recycled back to the soil by the grazing animal.

Apply nitrogen after switchgrass has begun to produce using a single application in mid-to-late May or a split application in both May and early July. Avoid high rates of nitrogen because carry-over could spur cool-season grass growth and harm young plants the following spring. Switchgrass will utilize 80 to 100 pounds of nitrogen when it is managed well for grazing or hay. Fertilize stands managed for wildlife with 30 to 50 pounds of nitrogen per acre to produce seed.

Switchgrass will benefit from burning of plant residues just prior to initiation of spring growth. Burning fields once every 3 to 5 years decreases weed competition, eliminates excessive residue and stimulates switch grass growth. Switchgrass used for wildlife food and cover should be burned once every 3 to 4 years to reduce mulch accumulations that inhibit movement of hatchlings and attract nest predators.

Under continuous grazing management, begin grazing switchgrass after it has reached a height of 12 to 16 inches, and stop when plants are grazed to within 6 to 8 inches of the ground. A rest before frost is needed to allow plants to store carbohydrates in the stem bases and crown. Plants may be grazed to a height of 6 to 8 inches after frost. The winter stubble is needed to provide insulation. Grazed paddocks need to be rested 30-60 days before being grazed again.

Pests and Potential Problems
Grasshoppers and leafhoppers can be major pests in new seedings. Some stands are impacted by damping off and seedling blight. Leaf rust occasionally affects forage quality.

Weed Control
Establishment and maintenance of stands of switchgrass and all other native warm season grasses is highly dependent on weed control. There grasses are extremely slow to germinate and grow in their first year. Weeds can have a significant impact on stand establishment and persistence.

When establishing stands into areas that were in row crops the year before the seeding, good weed control in those cropped fields during the year prior to the seeding can minimize the impact of weeds on the seeding. Thorough tillage and cultipacking before sowing the seed is necessary to minimize the impact

of annual weeds that germinated over the winter and perennial weeds that escaped weed control measures.

When seeding into areas that were pastures or hay fields the year before the seeding, the pasture or hay crops must be killed. Cool season pasture and hay species can be grazed heavily, mowed very close, or treated with herbicide in the early spring before sowing the seed. Warm season grasses must be killed during the summer of the year prior to seeding.

The herbicide imazapic (products s Plateau and Journey) are labeled for the pre-emergent and post-emergent control of many species of weeds in native warm season grasses, but both herbicides damage switchgrass. There are no labeled pre-emergent herbicides for use on switchgrass.

Annual grass and broadleaf weeds can be controlled by mowing over the top of the switchgrass stands to cut off flowering stalks before they make mature seed. Broadleaf weeds can be controlled with broadleaf herbicides such as 2,4-D, dicamba, picloram, metsulfuron, triclopyr, and clopyralid. Broadleaf weed control can is only effective when the correct herbicide is applied to a susceptible species at the proper rate and at a susceptible stage of growth. Most herbicides must be applied when weeds are young. Cool season weeds can be controlled with a contact herbicide such as glyphosate (product Roundup) in native warm season grasses when the native warm season grasses are dormant.

Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Cultivars, Improved, and Selected Materials (and area of origin)

'KY-1625' was released by the Quicksand, Kentucky Plant Materials Center as a germplasm release in 1987. It was collected from Raleigh County, West Virginia and compared to 35 other switchgrass accessions before its release. It is not commercially available, but seed is available for research purposes from the Alderson, West Virginia Plant Materials Center.

There are commercially available cultivars of switchgrass that are adapted to the Appalachian Region. 'Cave-in-Rock' is originally from Illinois and was released by the Elsberry, Missouri Plant Materials Center. 'Cave-in-Rock' is a cultivar released for forage production. 'Shawnee' is a selection from 'Cave-in-Rock' from the Agricultural Research Service in Lincoln, Nebraska. 'Shawnee' was selected for its forage quality.

'Kanlow' is originally from southern Oklahoma and was released by the Manhattan, Kansas Plant Materials Center. 'Kanlow' is a stiff-stemmed, lowland type switchgrass well adapted to poorly drained areas and preferred for wildlife habitat. 'Shelter' is originally from West Virginia and was released by the Big Flats, New York Plant Materials Center. 'Shelter' is also a stiff-stemmed type and is preferred for wildlife habitat.

'Blackwell' is originally from northern Oklahoma and was released by the Manhattan, Kansas Plant Materials Center. 'Blackwell' is a low maintenance cultivar adapted to droughty, infertile sites.. Seeds are available from most commercial sources and through large agricultural supply firms.

Weed Control

Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Prepared By:

John Vandevender, Alderson, West Virginia Plant Materials Center

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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Natural Resources Conservation Service Plant Guide

COASTAL PANICGRASS

Panicum amarum Elliott var. *amarulum* (Hitchc. & Chase) P.G. Palmer

Plant Symbol = PAAMA2

Common Names: coastal panicgrass; dune panic grass; dune switchgrass; seabeach grass; seaside panic grass; seaside panicum; shoredune panicum; slightly bitter panic grass; southern seabeach grass; tall sand-dune panic grass

Scientific Names: *Panicum amarulum* Hitchc. & Chase; *Panicum amarum* Elliott ssp. *amarulum* (Hitchc. & Chase) Freckmann & Lelong; *Panicum amarum* var. *amarulum* (Hitchc. & Chase) P. Palmer

Description

General: Coastal panicgrass is a native, warm-season, clump forming, rhizomatous, perennial grass that grows 3-7 feet tall (Fernald, 1950; Surrency and Owsley, 2006). Its blueish green leaves grow from 8-20 inches long and up to 0.5 inches wide (Tiner, 2009; USDA-NRCS, 2012). Robust stems with a diameter of up to 0.5 inches form a hard, knotty base (Gleason and Conquist, 1963; USDA-NRCS, 2012). Narrow, densely flowered panicles up to 2 feet long form from July to August (Hough, 1983; Tiner, 2009). Flowers produce bright orange anthers. Elliptically shaped gray to tan seed 0.06-0.09 inches long and 0.04-0.05 inches wide (Palmer, 1975) is produced October through November (Hough, 1983; Lorenze et al., 1991; Tiner, 2009).

Coastal panicgrass is often mistaken for bitter panicgrass (*Panicum amarum* Elliott var. *amarum*), a closely related species. Coastal panicgrass tends to have a more erect, bunch forming habit while bitter panicgrass tends to be more prostrate. Panicle width and flower density have also been used to distinguish the two varieties. Bitter panicgrass has narrower and more sparsely flowered panicles compared to the wider and heavily flowered panicles of coastal panicgrass. These characteristics are at least somewhat impacted by ecological conditions with differences becoming more pronounced at the northern end of the species range and less distinct at the southern end of the range (Palmer, 1975).

Distribution: Coastal panicgrass commonly occurs on the dunes of sandy coastal beaches from the Northeast United States to Mexico. The widely accepted native range is along the east coast from New Jersey to as far south as the Yucatán Peninsula of Mexico (Lonard and Judd, 2011). Coastal panicgrass is rare in Rhode Island but it is reported to occur as far north as Barnstable County, Massachusetts (Tiner, 2009; USDA-NRCS, 2019). It can be grown in USDA hardiness zones 7a-12b but may winterkill during especially harsh winters at the northern extent of the zone and inland (USDA-NRCS, 2012). For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Coastal panicgrass most frequently grows in tufts in the coastal dune environment from the leeward side of the primary dune in the pioneer zone to the scrub zone in association with American beachgrass (*Ammophila breviligulata*), saltmeadow cordgrass (*Spartina patens*), seaoats (*Uniola paniculata*), seacoast marsh elder (*Iva imbricata*), devil's-tongue (*Opuntia humifusa*), amberique-bean (*Strophostyles helvola*), southeastern wildrye (*Elymus glabriflorus*), partridge pea

(*Chamaecrista fasciculata*), Adam's needle (*Yucca filamentosa*), hairawn muhly (*Muhlenbergia capillaris*), shore little bluestem (*Schizachyrium littorale*), common evening primrose (*Oenothera biennis*), Carolina rose (*Rosa carolina*), gulf croton (*Croton punctatus*), seaside goldenrod (*Solidago sempervirens*), largeleaf pennywort (*Hydrocotyle bonariensis*), yaupon *(Illex vomitoria*), wax myrtle (*Morella cerifera*), northern bayberry (*Morella pensylvanica*), eastern baccharis (*Baccharis halimifolia*), winged sumac (*Rhus copallinum*), peppervine (*Nekemias arborea*), Virginia creeper (*Parthenocissus quinquefolia*), muscadine (*Vitis rotundifolia*), devilwood (*Osmanthus americanus*), beach plum (*Prunus maritima*), eastern red cedar (*Juniperus virginiana*), and live oak (*Quercus virginiana*) (Graetz, 1973; Slattery et al., 2003; Wootton et al., 2016). Coastal panicgrass also occurs along the borders of intertidal marshes and has been reported to colonize disturbed sandy sites (Anderson and Alexander, 1985; Hill, 1986).

Adaptation

Coastal panicgrass is extremely drought resistant and salt spray tolerant making it well adapted to its indigenous habitat on the coastal dunes (Graetz, 1973; Lorenze et al., 1991). It is a barrier plant in the dune pioneer zone, protecting more salt susceptible species beyond the primary dune. In a study examining the salinity tolerance of American beachgrass, saltmeadow cordgrass, seaoats, and coastal panicgrass seedlings, Seneca (1972) found coastal panicgrass to be the second most salt tolerant of the four species tested based on growth response. Miller (2013) also found coastal panicgrass can withstand occasional saltwater treatments. Coastal panicgrass is most adapted to the well-drained, sandy soils of the Atlantic Coastal Plains but will tolerate poorly drained soils (Lorenze et al., 1991; USDA-NRCS, 2006 a). It can withstand a soil pH range of 4.5-7.5 (Salon and Miller, 2012). It is intolerant of shade and does not do well as an understory plant (Lorenze et al., 1991).

Uses

Conservation Practices: Coastal panicgrass has an upright growth habit, is resistant to lodging, is easily established, long-lived, and manageable. These characteristics make it an ideal candidate in Hedgerow (422), Vegetative Barrier (601), and Herbaceous Wind Barrier (603) plantings (USDA-NRCS, 2012). Belt (2015) reported coastal panicgrass as a top performer in a trial evaluating the ability of 40 species to reduce or limit the spread of dust, odor, and ammonia emitted by poultry farm exhaust fans. Additionally, coastal panicgrass has proven applications for the NRCS Critical Area (342) standard for dune stabilization plantings, mined land reclamation sites, and dredged material revegetation (Knight et al., 1980; USDA-NRCS, 2012). It is one of the few dune stabilization species to be successfully established by direct seeding (Wootton et al., 2016). Coastal panicgrass may also be used to stabilize other Critical Area sites e.g. gravel pits, dikes, and road banks (USDA-NRCS, 2006 a). Coastal panicgrass could also be applied to long term management plans using the NRCS Herbaceous Weed Treatment (315) standard. Planting coastal panicgrass in coastal dune environments is recommended as a means of discouraging the recolonization of the invasive Asiatic sand sedge (*Carex kobomugi*) following successful treatment control measures (TLC, 2017).

Wildlife: Coastal panicgrass provides food and shelter for a variety of species including songbirds, waterfowl, and small mammals (Slattery et al., 2003). The calorie dense seed provides doves and quail with a concentrated energy source in the late fall/early winter when other food sources may be scarce (Surrency and Owsley, 2006). In a study of grassland bird habitat frequented for breeding purposes by the regionally rare grasshopper sparrow, Rudnicky et al. (1997) reported coastal panicgrass as a dominant species at one of the sites tested. Pernell and Soots (1975) reported a highly successful herring gull colony with nests next to bunches of coastal panicgrass. In an additional study of the nesting habits of sea birds, McNair and Gore (2000) reported coastal panicgrass as the dominant vegetation on a Florida island for two breeding seasons. Coastal panicgrass habitat is the preferred habitat of eight subspecies of beach mice: Alabama beach mouse, Perdido Key beach mouse, Santa Rosa beach mouse, Choctawatchee beach mouse, St. Andrew beach mouse, Anastasia Island beach mouse, Southeastern beach mouse, and pallid beach mouse. With the exception of the Santa Rosa beach mouse, all have been listed as threatened or endangered by either the United States Fish and Wildlife Service or the Florida Fish and Wildlife Conservation Commission (Bird et al., 2002). The beach mouse subspecies (the pallid beach mouse has been declared extinct) depend on coastal panicgrass for shelter and its seed as a constituent of their diet (Dziergowski, 2009; Lonard and Judd, 2011).

Forage: Coastal panicgrass is readily grazed by cattle and provides a sufficient level (140 g kg^{-1}) of crude protein to support beef production (Mehaffey et al., 2005). In a study examining the performance of tall fescue (*Schedonorus arundinaceus*) bermudagrass (*Cynodon dactylon*), yellow bluestem (*Bothriochloa ischemum*), and coastal panicgrass pasture systems, the coastal panicgrass pasture system produced the greatest steer gains during the warm-season grass growth period (Burns et al., 2012). However, Burns et al. (2012) reported that coastal panicgrass pastures could not support the same level of steer stocking as tall fescue/bermudagrass pasture systems without signs of severe stand weakening following a second year of grazing. The researchers concluded that coastal panicgrass pastures could be advantageous for grazing if incorporated into a rotational stocking system.

Ornamental/landscaping: The blueish green leaves and bright, vibrant orange anthers of coastal panicgrass make it a desirable plant for ornamental and landscaping purposes (Craig, 1976). This is especially true for landowners in coastal communities whose properties are adjacent to or within the vicinity of the dune environment. Many traditional ornamental plants cannot tolerate the salt spray and/or the native sandy soils of the barrier islands and littoral areas where most coastal communities occur.

Flowering spikelet of coastal panicgrass displaying orange anthers and purple stigmas. Photo by Scott Snell, USDA-NRCS, Plant Materials Program.

Biofuel Production: In studies examining the biofuel potential of warm season grasses, coastal panicgrass has displayed greater biomass production than some big bluestem (*Andropogon gerardii*), eastern gamagrass (*Tripsacum dactyloides*), switchgrass (*Panicum virgatum*), and Indiangrass (*Sorghastrum nutans*) varieties (Viands, et al., 2010). The average annual yield of 'Atlantic' coastal panicgrass was slightly over 6 dry tons/acre after 4 years of data collection (USDA-NRCS, 2012). Coastal panicgrass' tolerance for saline conditions may make it the ideal choice as a biofuel crop on marginal agricultural land that has been impacted by saltwater inundation (Miller, 2016).

Ethnobotany

Various species of panicgrass were used for medicinal purposes by Native Americans. The Seminole Tribe used panicgrass medicinally as an antirheumatic (external), cough medicine, pulmonary aid, and throat aid (Hutton, 2010). The Natchez and Creek Tribes used panicgrass to treat malaria fevers (Hutton, 2010). The Miccosukee Tribe used panicgrass as a treatment for 'gopher-tortoise sickness' (Lamphere, 2006). The Cherokee Tribe padded their moccasins with stems from panicgrass (Lamphere, 2006).

Status

Threatened or Endangered: Coastal panicgrass is listed as endangered in Pennsylvania, threatened in Connecticut, and as a species of special concern in Rhode Island (USDA-NRCS, 2019). Coastal panicgrass is ranked as "S3" in New Jersey meaning "Not yet imperiled in state but may soon be if current trends continue" (Snyder, 2016).

Wetland Indicator: FAC for Atlantic and Gulf Coastal Plain region; FACU for all other regions in which it occurs (USACE, 2018).

Weedy or Invasive: Coastal panicgrass is listed as introduced in Massachusetts (CZM, 2019).

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use. Please consult the PLANTS Web site (http://plants.usda.gov/) and your state's Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Planting Guidelines

Although establishment in the coastal dune environment via vegetative plugs is the recommended method, establishment via direct seeding is possible under appropriate conditions (Lorenze et al., 1991). Soil moisture is critical with best results achieved in moist sand (Darovec et al., 1975; Slattery et al., 2003). Direct seeding into saline environments is also a feasible option. Coastal panicgrass seed will germinate at salinity levels almost equal to the levels that seedlings can tolerate (Seneca, 1972). Plant seed 1-3 inches deep; shallower for finer textured soils with higher silt content and deeper for coarse textured soils. Mulching the seeding area will improve establishment results (Craig, 1991; USDA-NRCS, 2012). In replicated seeding

depth trials on sand dunes conducted by the New Jersey Plant Materials Center, coastal panicgrass seeded 1 inch deep consistently showed greater seedling emergence than seed planted at 0.5 inch. Plant seed by broadcasting and incorporating to ensure good seed to soil contact or using a drop seeder, drill, or other seeding equipment. A single row garden push seeder is the simplest, small scale option (USDA-NRCS, 2007). Recommended seeding rates range from 6-15 lb/acre if drilled and up to 20 lb/acre if broadcast (USDA-NRCS, 2007; Wootton et al., 2016). Use containerized plugs or bare root divisions that are at least 12 inches tall for vegetative establishment. Plant spacing of 6-8 feet between rows and 18 inches within the row is recommended to obtain about 5,000 plants/acre for satisfactory coverage on dunes (Wootton et al., 2016). Recommended planting dates for seed and vegetative establishment are from November first to March first or June first to September first for the Gulf Coast region and March to May for the Mid-Atlantic region (USDA-NRCS, 2007; Wootton et al., 2016). Fertilizer application recommendations are always site dependent. While most native species do not require fertilizer amendments during the establishment year, some recommendations have been made for coastal panicgrass, see management section (Dickerson et al., 1997; USDA-NRCS, 2006 a; USDA-NRCS, 2007).

Establish seed production fields following the same guidelines and methods for coastal dune environment conservation plantings. The site should receive full sun and have soils that are well-drained and course to medium textured. Preferred annual precipitation is at least 30 inches. The soil pH should be amended if necessary, until slightly acidic to neutral (Dickerson et al., 1997).

Management

For wildlife habitat applications, mowing is a treatment option to control undesired vegetation. Coastal panicgrass withstands mowing well. Rudnicky et al. (1997) reported it to be a dominant species following mowing treatments of grassland bird habitat. Prescribed burning suppresses weeds, controls the spread of unwanted perennial species, and kills some weed seeds (USDA/EPA, n.d.). In addition to weed control, controlled burning assists in nutrient recycling and stimulates seed production (USDA-NRCS, 2006 a). Selective herbicide applications are a reliable means of weed control (USDA/EPA, n.d.). Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA-NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Fertilizer recommendations for coastal panicgrass are inconsistent. Top or side dressed single application and split applications (June and August) of 10-10-10 fertilizer applied at rates ranging from 400-600 lb/acre annually have been recommended for both seed production fields and coastal dune plantings (USDA-NRCS, 2007; USDA-NRCS, 2006 a). More recent fertilization recommendations for the coastal dune environment address water quality concerns due to excess nutrients from overfertilization. In response, lower fertilization rates (20-30 lb/acre nitrogen) and alternative nutrient sources (slow release fertilizers and organic options) are recommended for coastal dune sites (Wootton et al., 2016). In all cases, base fertilizer applications on soil test results of the planting site. Contact your local agricultural extension for soil test analysis and fertilizer application recommendations prior to implementing a fertilization plan.

Pests and Potential Problems

In the Mid-Atlantic coastal dune environment, coastal panicgrass has been reported to be negatively impacted by plant parasitic nematodes. Seliskar and Huettel (1993) reported a correlation between the presence of plant parasitic nematodes and reduction of plant health. Coastal panicgrass did not show any signs of plant stress the initial year that nematodes were found, but signs of stress were reported in following years. Coastal panicgrass is a reported host of multiple fungal rust species (Farr and Rossman, 2019).

Environmental Concerns

Coastal panicgrass is listed as introduced in Massachusetts (CZM, 2019; Lonard and Judd, 2011). Coastal panicgrass seed can remain viable for up to 5 years in its natural habitat without any specialized storage (USDA-NRCS, 2012). Although initial seed dispersal is limited to no more than 20 feet, consumption by wildlife and floatation on moving waters are two possible means by which seed could become distributed greater distances to non-native habitats (Lonard and Judd, 2011; USDA-NRCS, 2012). Coastal panicgrass rhizomes are a viable means of regeneration in favorable conditions and may spread 3 feet in a single growing season (USDA-NRCS, 2012). Coastal panicgrass has been reported to invade the frontal dune system but will not become well established due to the inevitable burial of the shifting sands (Palmer, 1975). Coastal panicgrass has not been reported to cause any allelopathic effects (USDA-NRCS, 2012).

Seeds and Plant Production

Coastal panicgrass is propagated vegetatively or by seed (USDA-NRCS, 2006 a). Seed production fields reach maturity and become productive in two growing seasons. Up to 300 lb/acre of cleaned seed is produced by properly managed seed production fields (USDA-NRCS, 2012). Seed production is stimulated by annual prescribed burns in late winter or early spring (USDA-NRCS, 2006 a). Coastal panicgrass seed ranges from 325,000-350,000 seeds/lb (Dickerson et al., 1997;

USDA-NRCS, 2012). Laboratory viability tests of seed produced at the New Jersey Plant Materials Center from 2001 to 2020 ranged from 70 to 94 percent with an average rate of 84 percent. Coastal panicgrass maintains excellent longevity under ideal storage conditions. Seed stored in a seed cooler (4°C and 40 percent relative humidity) at the New Jersey Plant Materials Center maintained 75 percent or greater viability rates after 9 years of storage with germination rates increasing after storage in some instances.

Harvest seed with hand tools (hand sickles) or on a greater scale with mechanical agricultural equipment. Seed has been successfully harvested at the New Jersey Plant Materials Center using a plot harvester with a standard grain head. Harvester settings depend on a multitude of variables (equipment, environmental conditions, management methods, etc.), but the following ranges have proven satisfactory: cylinder spacing of 0.26-0.28 inch, cylinder speed of 1000 rpm, and a low air flow setting. Seed is typically harvested in early October in the Mid-Atlantic region of the U.S.

Seed cleaning methods depend upon the harvest method. If harvested with hand tools, thresh seed before attempting to separate the chafe from the seed. Thresh seed with mechanized seed cleaning equipment or use a manual rubbing board. Small harvest amounts can be mechanically threshed using a slightly modified kitchen blender (Scianna, 2004). Air and screen seed cleaning equipment readily separates chafe from seed using 0.31-0.14 inch round holes for the top screen and 1/22 inch round holes for the bottom screen.

Cultivars, Improved, and Selected Materials (and area of origin)

These plant materials are readily available from commercial sources. 'Atlantic' coastal panicgrass is a cultivar developed and released in 1981 by the Cape May, NJ Plant Materials Center, USDA-NRCS. The source material for Atlantic was collected from Back Bay Wildlife Refuge, Princess Anne County, Virginia. It was selected for seedling vigor, uniform characteristics, and rust resistance (USDA-NRCS, 2006 b). It is recommended for critical area, forage, hedge row, salt affected sites, and wildlife applications (USDA-NRCS, 2012)

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SEASIDE GOLDENROD

Solidago sempervirens L.

Plant Symbol = SOSE

Seaside goldenrod (Solidago simpervirens L.) Photo by, William Skaradek, USDA NRCS.

Alternate Names
Common Names:
salt-marsh goldenrod

Scientific Names:
Aster sempervirens (L) Kuntze;
A. mexicanus;
Solidago mexicana L.;
S. sempervirens subsp. *mexicana*;
S. sempervirens var. *Mexicana*

Description
General: Seaside goldenrod is a native, late-flowering perennial forb. It may grow up to 6 ft tall at maturity, blooming August through October. The terminal flowering heads are dense, clustered spikes of bright yellow flowers that are larger than those of other goldenrod species.

The leaves are fleshy, somewhat succulent, dark green, oblong, and lance-shaped. They are arranged alternately along the entire length of the stem. The leaves at the base are the largest, up to 8 in long and ½ –1 ½ in wide, gradually decreasing in size towards the top of the plant.

In winter, the plant's persistent whitened leaves, coarse stalks, and dried flower parts make it easily identifiable. Red leaves sprout in late February and early March, and soon become dark green. From late August to early October, its bright yellow flowers provide an attractive contrast to its lush, thick, green vegetation.

Seaside goldenrod is a short-day perennial (flowering coincides with shortened photoperiods). So that at some point as a critical dark periods lengthens, flowering is initiated. The flowers are an important food/energy source for fall migrating monarch butterflies traveling the Atlantic coastal flyway. This species can hybridize with rough-stemmed goldenrod (*Solidago rugosa*).

The fruit of the seaside goldenrod is a capsule with a pappus in a single circle of bristles. The seeds require no cold stratification for germination. When buried, seed viability decreases after the first year in both disturbed and undisturbed areas (Lee, 1993). Therefore, seaside goldenrod does not appear to have a persistent seed bank.

Transition areas (areas of greater sand movement and accumulation) tend to have greater amounts of seed in the seed bank (up to 58 seeds/m^2) when compared to grasslands (Lee, 1993). However, studies have also found germination of the plant limited to areas of minimal sand accumulation.

Distribution: Seaside goldenrod mainly grows east of the Mississippi. It grows in the northeast from Canada and the Great Lakes region, south along the Mid-Atlantic coast to Florida, and as far west as Texas. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Stands of seaside goldenrod colonize blowouts, grasslands, and transition areas. Seaside goldenrod often occurs with other native dune plants such as coastal panicgrass (*Panicum amarum*), switchgrass (*Panicum virgatum*), salt meadow cordgrass (*Spartina patens*), and American beachgrass (*Ammophila breviligulata*).

Adaptation
Seaside goldenrod can grow in coarse to medium infertile soils with a pH range from 5.5–7.5. Seaside goldenrod is well adapted to coastal habitats including the backside of primary dunes, low secondary dunes, and edges of salt marshes. It has some tolerance for drought, allowing it to survive in the dry conditions of the dunes. Seaside goldenrod is also tolerant of high salinity, salt spray, and fire.

Uses
Wildlife Use: Like many *Solidago* spp., seaside goldenrod is an important resource for over-wintering, gall-producing insects. Some of these insects are predatory wasps that are beneficial to have near crops. In addition, gall larvae provide an excellent source of nutrition in the winter for birds such as the chickadee or woodpecker. It increases the value of wildlife habitat by providing food and shelter for butterflies, birds, and small mammals. The migrating monarch butterfly uses seaside goldenrod as one of its primary food sources in the fall.

Along with American beachgrass (*Ammophila breviligulata*), seaside goldenrod plays an important role in providing nesting habitat between primary and secondary dunes for birds such as willets (*Catoptrophorus semipalmatus*), killdeer (*Charadrius vociferous*), piping plovers (*Charadrius melodus*), and black skimmers (*Rynchops niger*)(Safina and Burger, 1983).

Erosion Control: Seaside goldenrod is a native perennial that has been successfully used in dune stabilization and erosion control projects. Stems arise from short, stocky rhizomes. The root-length is a minimum of 14 in and provides excellent erosion control. Seaside goldenrod initiates dune formation by trapping sand and debris. Sites with seaside goldenrod help the secondary establishment of annual forbs such as seaside sandmat (*Euphorbia polygonifolia*), and American searocket (*Cakile edentula*) (Ailstock, n.d.).

Ethnobotany
While the medicinal value of this particular species of goldenrod remains unknown, many species in the *Solidago* genus have been used for generations as a natural remedy for a variety of health conditions (ex. *S. Canadensis* and *S. vigaurea*). Thomas Edison explored ways of using latex from the seaside goldenrod for the production of natural rubber (caoutchouc).

Status
Threatened or Endangered: No.

Wetland Indicator: FACW (Facultative Wetland). Seaside goldenrod usually occurs in wetlands, but may occur in non-wetlands.

Please consult the PLANTS Web site (http://plants.usda.gov/) and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Planting Guidelines
Seaside goldenrod may be propagated by seed or division. Currently the only developed method of establishing seed production plots and dune restoration plantings is with containerized stock transplanted in late winter to early spring.

The first year of establishment is the most critical for survival. Once the stand is established, it requires little maintenance and only minimal irrigation due to its ability to withstand hot and dry conditions. Producers should irrigate if an extended dry period occurs. Fertilization will increase vigor of seaside goldenrod, but is not necessary for survival.

To establish, prepare a clean, weed-free seedbed. Start seeds in 2-inch deep trays, grown into vegetative plugs, planted every 2 feet in rows with 3 feet in between centers. When planting into a dune site, it is important to keep the substrate attached to the roots of the seedling to prevent desiccation (Shumway, 2008).

Growing plants with American beachgrass (*Ammophila breviligulata*) in both broadcast and seed-drilled experimental plots improves production. These nurse crops may lower temperature and increase moisture for seaside goldenrod populations. *S. sempervirens* has dehydromatricaria ester in the roots (Lam et al., 1992). This allelopathic compound is lethal to nematodes and inhibits the growth of rice seedlings.

Management
Producers often manage weeds with a pre-emergent herbicide and after establishment with mechanical cultivation. The decline in health of the closely associated American beachgrass could be used to signal when goldenrod should be fertilized.

Pests and Potential Problems
It has been reported that the release of root exudates by seaside goldenrod produce allelochemicals that negatively affect the growth of nearby vegetation. Studies by Cheplick and Aliotta (2009) found that seaside goldenrod has a negative effect on the growth of native grasses such as purple sandgrass (*Triplasis purpurea*) and sanddune sandbur (*Cenchrus tribuloides*). Being a perennial, seaside goldenrod should also have a distinct advantage over annuals when competing for limited resources. Nevertheless, because seaside goldenrod has a moderate growth rate, a shorter life span than other *Solidago* spp., a limited ability to spread through seed, and produces seedlings with low vigor, it is not considered an invasive plant.

Goldenrods in general are popular hosts to overwintering gall insects. Approximately half of all gall insects are lost to predation. Three common herbivores that feed on seaside goldenrod are the goldenrod leaf miner (*Microrhopala vittata*), red goldenrod aphid (*Uroleucon pieloui*) and the goldenrod leaf beetle (*Trirhabda Canadensis*).The goldenrod leaf miner feeds on the upper leaves, creating numerous small holes. Unlike aphids, population densities for the goldenrod leaf miner remain low and only occasionally create severe damage. The goldenrod leaf beetle is strongly attracted to the odor of the host plant *S. sempervirens*, and has been shown to prefer it to the odor of non-host plants (Puttick et al., 1988). There is no known research suggesting that *S. sempervirens* can negatively affect the growth of nearby food crops.

There is no significant herbivory recorded. Coastal or island herbivores such as rabbits and deer will occasionally browse plants in fall and winter.

Environmental Concerns
There are no environmental concerns with use of this plant.

Control
Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Seeds and Plant Production
Researchers are trying to develop effective methods to grow seaside goldenrod from direct seeding in a dune setting. Seed consistently has good germination rates when grown in controlled settings such as a greenhouse or germination chamber, but stands fail to develop when directly seeded in dune trials. Currently the best way to propagate the plant is with vegetative plugs. The seed has a 3-year average of 70 % germination from 2009–2011 at the Cape May PMC, in Cape May, NJ.

Seaside goldenrod produced 75 lb/ac of seed (first year of establishment) to 220 lb/ac of seed (2 years after establishment) at the Plant Materials Center. Plants were sown 1.5 ft apart, in rows with 3.5 ft between centers. For this same population, the germination rate was 72 % after one year of storage at 40° F and 64 % after two years of storage. The plant bed was prepared with a pre-emergent herbicide and the weeds in the inter-rows were cultivated once per season.

Cold stratification and use of a light source can break dormancy and encourage germination. Seed will germinate only on the surface of sand at high temperatures. These seeds can easily dry out and die if there is no supplemental moisture or irrigation. Cross-pollination is required for viable seed. There are approximately 700,000 seeds/lb.

Cultivars, Improved, and Selected Materials (and area of origin)
Monarch Germplasm seaside goldenrod is a source-identified composite germplasm from several native populations developed by the Cape May Plant Materials Center in Cape May, NJ. Seed was collected from natural stands among the dunes of several Mid-Atlantic States: New Jersey, Delaware, and the eastern shore of Virginia. Cape May Plant Materials Center has evaluated seaside goldenrod for over ten years.

Cultivars should be selected based on the local climate, resistance to local pests, and intended use. Consult with your local land grant university, local extension or local USDA NRCS office for recommendations on adapted cultivars for use in your area**.**

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