WETLANDS AND SUBAQUEOUS LANDS SECTION PERMIT APPLICATION FORM

For Subaqueous Lands, Wetlands, Marina and 401 Water Quality Certification Projects

State of Delaware
Department of Natural Resources and Environmental Control
Division of Water

Wetlands and Subaqueous Lands Section

APPLICATION FOR APPROVAL OF
SUBAQUEOUS LANDS, WETLANDS, MARINA
AND WATER QUALITY CERTIFICATION PROJECTS

Last Revised on: March 28, 2017

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

Application Instructions:

1. Complete each section of this basic application and appropriate appendices as thoroughly and accurately as possible. Incomplete or inaccurate applications will be returned.

2. All applications must be accompanied by a scaled plan view and cross-section view plans that show the location and design details for the proposed project. Full construction plans must be submitted for major projects.

3. All applications must have an original signature page and proof of ownership or permitted land use agreement.

4. Submit an original and two (2) additional copies of the application (total of 3) with the appropriate application fee and public notice fee* (prepared in separate checks) to:

Department of Natural Resources and Environmental Control
Wetlands and Subaqueous Lands Section
89 Kings Highway
Dover, Delaware 19901

*Application and public notice fees are non-refundable regardless of the Permit decision or application status.

5. No construction may begin at the project site before written approval has been received from this office.

Helpful Information:

1. Tax Parcel Information:

New Castle County	(302) 395-5400
Kent County	(302) 736-2010
Sussex County	(302) 855-7878

2. Recorder of Deeds:

New Castle County	(302) 571-7550
Kent County	(302) 744-2314
Sussex County	(302) 855-7785

3. A separate application and/or approval may be required through the Army Corps of Engineers. Applicants are strongly encouraged to contact the Corps for a determination of their permitting requirements. For more information, contact the Philadelphia District Regulator of the Day at (215) 656-6728 or visit their website at: http://www.nap.usace.army.mil/Missions/Regulatory.aspx.

4. For questions about this application or the Wetlands and Subaqueous Lands Section, contact us at (302) 739-9943 or visit our website at: http://www.dnrec.delaware.gov/wr/Services/Pages/WetlandsAndSubaqueousLands.aspx. Office hours are Monday through Friday 8:00 AM to 4:30 PM, except on State Holidays.

APPLICANT'S REVIEW BEFORE MAILING

DID YOU COMPLETE THE FOLLOWING?

___X_____	Yes	BASIC APPLICATION
___X_____	Yes	SIGNATURE PAGE (Page 3)
____X_____	Yes	APPLICABLE APPENDICES
_____X_____	Yes	SCALED PLAN VIEW
____X_____	Yes	SCALED CROSS-SECTION OR ELEVATION VIEW PLANS
____X_____	Yes	VICINITY MAP
____X_____	Yes	COPY OF THE PROPERTY DEED & SURVEY
_____X_____	Yes	THREE (3) COMPLETE COPIES OF THE APPLICATION PACKET
_____X_____	Yes	APPROPRIATE APPLICATION FEE & PUBLIC NOTICE FEE (Separate checks made payable to the State of Delaware)

Submit 3 complete copies of the application packet to:

Department of Natural Resources and Environmental Control
Wetlands and Subaqueous Lands Section
89 Kings Highway
Dover, Delaware 19901

Before signing and mailing your application packet, please read the following:

The Department requests that the contractor or party who will perform the construction of your proposed project, if other than the applicant, sign the application signature page along with the applicant in the spaces provided. When the application is signed by the contractor as well as the applicant, the Department will issue the Permit to both parties. For Leases, the contractor will receive a separate construction authorization that will make them subject to all of the terms and conditions of the Lease relating to the construction

Section 1: Applicant Identification

1. Applicant's Name: University of Delaware/Peter Krawchyk
   Mailing Address: 222 S Chapel Street
   Newark DE 19716
   Telephone #: 302-766-4703
   Fax #:
   E-mail: krawchyk@udel.edu

2. Consultant's Name: N/A
   Mailing Address:
   Company Name:
   Telephone #:
   Fax #:
   E-mail:

3. Contractor's Name: University of Delaware
   Mailing Address: 259 Academy Street
   Newark, DE 19716
   Company Name: UD (Jack Puleo)
   Telephone #: 302-339-0343
   Fax #: NA
   E-mail: jpuleo@udel.edu

Section 2: Project Description

4. Check those that apply:
☒ New Project/addition to existing project? ☐ Repair/Replace existing structure? (If checked, must answer #16)

5. Project Purpose (attach additional sheets as necessary):
The primary purpose of this project is to enhance coastal resilience and ecological health along the narrow shoreline between Canary Creek and the UD Boat Basin. With increasing shoreline erosion and habitat degradation due to climate change and human activity this initiative aims to stabilize the shoreline, promote biodiversity, and restore critical aquatic habitats

6. Check each Appendix that is enclosed with this application:

	A. Boat Docking Facilities		G. Bulkheads		N. Preliminary Marina Checklist
	B. Boat Ramps		H. Fill		O. Marinas
	C. Road Crossings		I. Rip-Rap Sills and Revetments		P. Stormwater Management
	D. Channel Modifications/Dams	X	J. Vegetative Stabilization		Q. Ponds and Impoundments
	E. Utility Crossings	X	K. Jetties, Groins, Breakwaters		R. Maintenance Dredging
	F. Intake or Outfall Structures	X	M. Activities in State Wetlands		S. New Dredging

Section 3: Project Location

7. Project Site Address: 700 Pilottown Rd
   County: ☐ N.C. ☐ Kent ☒ Sussex
   Site owner name (if different from applicant):
   Address of site owner: University of Delaware

8. Driving Directions: The location is on right side of Pilottown Road (before the Canary Creek Bridge)
(Attach a vicinity map identifying road names and the project location)

9. Tax Parcel ID Number: 335-4.00-13.01 Subdivision Name:

WSLS Use Only: **Permit #s:**

Type **SP** ☐ **SL** ☐ **SU** ☐ **WE** ☐ **WQ** ☐ **LA** ☐ **SA** ☐ **MP** ☐ **WA** ☐

Corps Permit: SPGP 18 ☐ **20** ☐ **Nationwide Permit #:** **Individual Permit #**
Received Date: **Project Scientist:**
Fee Received? Yes ☐ **No** ☐ **Amt: $** **Receipt #:**
Public Notice #: **Public Notice Dates: ON** **OFF**

Section 3: Project Location (Continued)

10. Name of waterbody at Project Location: Canary Creek and UD Boat Basin Waterbody is a tributary to: DE Bay

11. Is the waterbody: ☒ Tidal ☐ Non-tidal Waterbody width at mean low or ordinary high water _____

12. Is the project: ☐ On public subaqueous lands? ☒ On private subaqueous lands?*
☒ In State-regulated wetlands? ☒ In Federally-regulated wetlands?

*If the project is on private subaqueous lands, provide the name of the subaqueous lands owner:
University of Delaware
(Written permission from the private subaqueous lands owner must be included with this application)

13. Present Zoning: ☐ Agricultural ☐ Residential ☐ Commercial ☐ Industrial ☒ Other

Section 4: Miscellaneous

14. A. List the names and complete mailing addresses of the immediately adjoining property owners on all sides of the project (attach additional sheets as necessary):

B. For wetlands and marina projects, list the names and complete mailing addresses of property owners within a 1,000 foot radius of the project (attach additional sheets as necessary):
US Coast Guard, 802 Pilottown Rd, Lewes DE, 19958

15. Provide the names of DNREC and/or Army Corps of Engineers representatives whom you have discussed the project with:
Julie Molina
Mike Snyder Matthew Jones

A. Have you had a State Jurisdictional Determination performed on the property? ☐ Yes ☒ No
B. Has the project been reviewed in a monthly Joint Permit Processing Meeting? ☒ Yes ☐ No
*If yes, what was the date of the meeting? Sept 19, 2024

16. Are there existing structures or fill at the project site in subaqueous lands? ☐ Yes ☒ No
*If yes, provide the permit and/or lease number(s):

*If no, were structures and/or fill in place prior to 1969? ☐ Yes ☒ No

17. Have you applied for or obtained a Federal permit from the Army Corps of Engineers?
☐ No ☒ Pending ☒ Issued ☐ Denied Date: March 18, 2025

Type of Permit: Nationwide 54 Federal Permit or ID #: NAP-2024-00792-85

18. Have you applied for permits from other Sections within DNREC?
☒ No ☐ Pending ☐ Issued ☐ Denied Date: _____ Permit or ID #: _____

Type of permit (circle all that apply): Septic Well NPDES Storm Water

Other: _____

Section 5: Signature Page

19. Agent Authorization:

If you choose to complete this section, all future correspondence to the Department may be signed by the duly authorized agent. In addition, the agent will become the primary point of contact for all correspondence from the Department.

I do not wish to authorize an agent to act on my behalf ☒

I wish to authorize an agent as indicated below ☐

I, _____, hereby designate and authorize _____
(Name of Applicant) (Name of Agent)
to act on my behalf in the processing of this application and to furnish any additional information requested by the Department.

Authorized Agent's Name: _____ Telephone #: _____
Mailing Address: _____ Fax #: _____
_____ E-mail: _____
_____

20. Agent's Signature:

I hereby certify that the information on this form and on the attached plans are true and accurate to the best of my knowledge. I further understand that the Department may request information in addition to that set forth herein if deemed necessary to appropriately consider this application.

_____ _____
Agent's Signature Date

21. Applicant's Signature:

I hereby certify that the information on this form and on the attached plans are true and accurate to the best of my knowledge and that I am required to inform the Department of any changes or updates to the information provided in this application. I further understand that the Department may request information in addition to that set forth herein if deemed necessary to appropriately consider this application. I grant permission to authorized Department representatives to enter upon the premises for inspection purposes during working hours.

DocuSigned by:
Peter Krawchyk
7E756BB0C0A2450...
Applicant's Signature

8/25/2025
Date

University of Delaware/Peter Krawchyk Print Name

22. Contractor's Signature:
I hereby certify that the information on this form and on the attached plans are true and accurate to the best of my knowledge, and that I am required to inform the Department of any changes or updates to the information provided in this application. I further understand that the Department may request information in addition to that set forth herein if deemed necessary to appropriately consider this application.

_____ _____
Contractor's Name Date

_____
Print Name

Certificate Of Completion

Envelope Id: 7548D3DF-078A-4BDA-92C9-1CE381D338D9
Status: Completed
Subject: Living Shoreline - Lewes
Source Envelope:
Document Pages: 6
Signatures: 1
Certificate Pages: 4
Initials: 0
AutoNav: Enabled
EnvelopeId Stamping: Enabled
Time Zone: (UTC-05:00) Eastern Time (US & Canada)

Envelope Originator:
Darlene Hoy
University of Delaware
222 South Chapel Street
Newark, DE 19716
dahoy@udel.edu
IP Address: 174.55.237.187

Record Tracking

Status: Original
8/25/2025 9:35:59 AM
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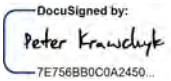
Signer Events	Signature	Timestamp
Peter Krawchyk krawchyk@udel.edu VP 1 - FREAS Security Level: Email, Account Authentication (None)	 Signature Adoption: Pre-selected Style Using IP Address: 2a02:26f7:f6d9:a6a7:0:2000:0:5 Signed using mobile	Sent: 8/25/2025 9:41:25 AM Viewed: 8/25/2025 9:43:31 AM Signed: 8/25/2025 9:43:38 AM

Electronic Record and Signature Disclosure:
Accepted: 3/13/2020 6:25:47 PM
ID: 8c1f6be4-9893-4128-aad1-d700789005a6

In Person Signer Events	Signature	Timestamp

Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp

Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps
Envelope Sent	Hashed/Encrypted	8/25/2025 9:41:25 AM
Certified Delivered	Security Checked	8/25/2025 9:43:31 AM
Signing Complete	Security Checked	8/25/2025 9:43:38 AM
Completed	Security Checked	8/25/2025 9:43:38 AM

Payment Events	Status	Timestamps

Electronic Record and Signature Disclosure

ELECTRONIC RECORD AND SIGNATURE DISCLOSURE

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Withdrawing your consent

If you decide to receive notices and disclosures from us electronically, you may at any time change your mind and tell us that thereafter you want to receive required notices and disclosures only in paper format. How you must inform us of your decision to receive future notices and disclosure in paper format and withdraw your consent to receive notices and disclosures electronically is described below.

Consequences of changing your mind

If you elect to receive required notices and disclosures only in paper format, it will slow the speed at which we can complete certain steps in transactions with you and delivering services to you because we will need first to send the required notices or disclosures to you in paper format, and then wait until we receive back from you your acknowledgment of your receipt of such paper notices or disclosures. Further, you will no longer be able to use the DocuSign system to receive required notices and consents electronically from us or to sign electronically documents from us.

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Unless you tell us otherwise in accordance with the procedures described herein, we will provide electronically to you through the DocuSign system all required notices, disclosures, authorizations, acknowledgements, and other documents that are required to be provided or made available to you during the course of our relationship with you. To reduce the chance of you inadvertently not receiving any notice or disclosure, we prefer to provide all of the required notices and disclosures to you by the same method and to the same address that you have given us. Thus, you can receive all the disclosures and notices electronically or in paper format through the paper mail delivery system. If you do not agree with this process, please let us know as described below. Please also see the paragraph immediately above that describes the consequences of your electing not to receive delivery of the notices and disclosures electronically from us.

How to contact University of Delaware:

You may contact us to let us know of your changes as to how we may contact you electronically, to request paper copies of certain information from us, and to withdraw your prior consent to receive notices and disclosures electronically as follows:
To contact us by email send messages to: gwalueff@udel.edu

To advise University of Delaware of your new email address

To let us know of a change in your email address where we should send notices and disclosures electronically to you, you must send an email message to us at gwalueff@udel.edu and in the body of such request you must state: your previous email address, your new email address. We do not require any other information from you to change your email address.

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To inform us that you no longer wish to receive future notices and disclosures in electronic format you may:

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ii. send us an email to gwalueff@udel.edu and in the body of such request you must state your email, full name, mailing address, and telephone number. We do not need any other information from you to withdraw consent.. The consequences of your withdrawing consent for online documents will be that transactions may take a longer time to process..

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To confirm to us that you can access this information electronically, which will be similar to other electronic notices and disclosures that we will provide to you, please confirm that you have read this ERSD, and (i) that you are able to print on paper or electronically save this ERSD for your future reference and access; or (ii) that you are able to email this ERSD to an email address where you will be able to print on paper or save it for your future reference and access. Further, if you consent to receiving notices and disclosures exclusively in electronic format as described herein, then select the check-box next to 'I agree to use electronic records and signatures' before clicking 'CONTINUE' within the DocuSign system.

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- You can print on paper this Electronic Record and Signature Disclosure, or save or send this Electronic Record and Disclosure to a location where you can print it, for future reference and access; and
- Until or unless you notify University of Delaware as described above, you consent to receive exclusively through electronic means all notices, disclosures, authorizations, acknowledgements, and other documents that are required to be provided or made available to you by University of Delaware during the course of your relationship with University of Delaware.

Supplemental Material

UD Permit Request

Delaware Boast Basin Living Shoreline Project

Project description: The USACE has funded an interdisciplinary team of researchers to investigate the capability of hybrid living shoreline features for shoreline stabilization and shellfish colonization. The team has selected the UD Boat basin off Pilottown Road in Lewes, DE for a variety of reasons: the spit of land separating Canary Creek from the boat basin is eroding (Figure 1), there are varying forces on the north and south sides of the land spit, the University of Delaware (UD) is the landowner, it is in close proximity to the UD Lewes Campus, there is interest from DelDOT and Sea Grant, and the project creates an opportunity to test various protection approaches in areas with different wave energy. The entire work area lies within state mapped wetland boundary (M). The work area does not extend more than 30 ft from the mean low water (MLW) and does not encroach on Canary Creek. The entire project is within the footprint of the high astronomical tide (3.5 ft). Total project is less than 500 linear ft. The north boundary is 88 ft and the south boundary is 81 ft total length.

Figure 1. Aerial view of the spit of land showing erosion and scarping.

During the JPP meeting on September 19, 2024, there was some discussion about considering a "terraced" approach for the installation on the north side of the spit of land. We subsequently discussed this option internally. The forcing on the north side is considered significant, which means that gaps between implements on the intermittently wet portion of the profile are unlikely to encourage deposition and may instead enhance scour around any plants positioned there. Therefore, we decided to mimic the existing sloping bathymetry as this reflects the erosion patterns caused by the prevailing hydrodynamics in the area.

The permit details the various elements we plan to deploy as a hybrid living shoreline. Pictures are provided in the following pages for visual awareness.

Reefballs: The picture on the top (Figure 2) shows the various reef ball structure sizes. The proposed installation uses Bay Ball, Mini-Bay Ball, Lo-Pro Ball, and Oyster Ball. The structures will use fiber reinforced basalt rebar to help anchor them in place. The picture on the bottom shows a different deployment of Reef Balls of various sizes to give the reviewer an idea of what they look like in the field. Note: The picture does not represent the planned installation requested in the proposal.

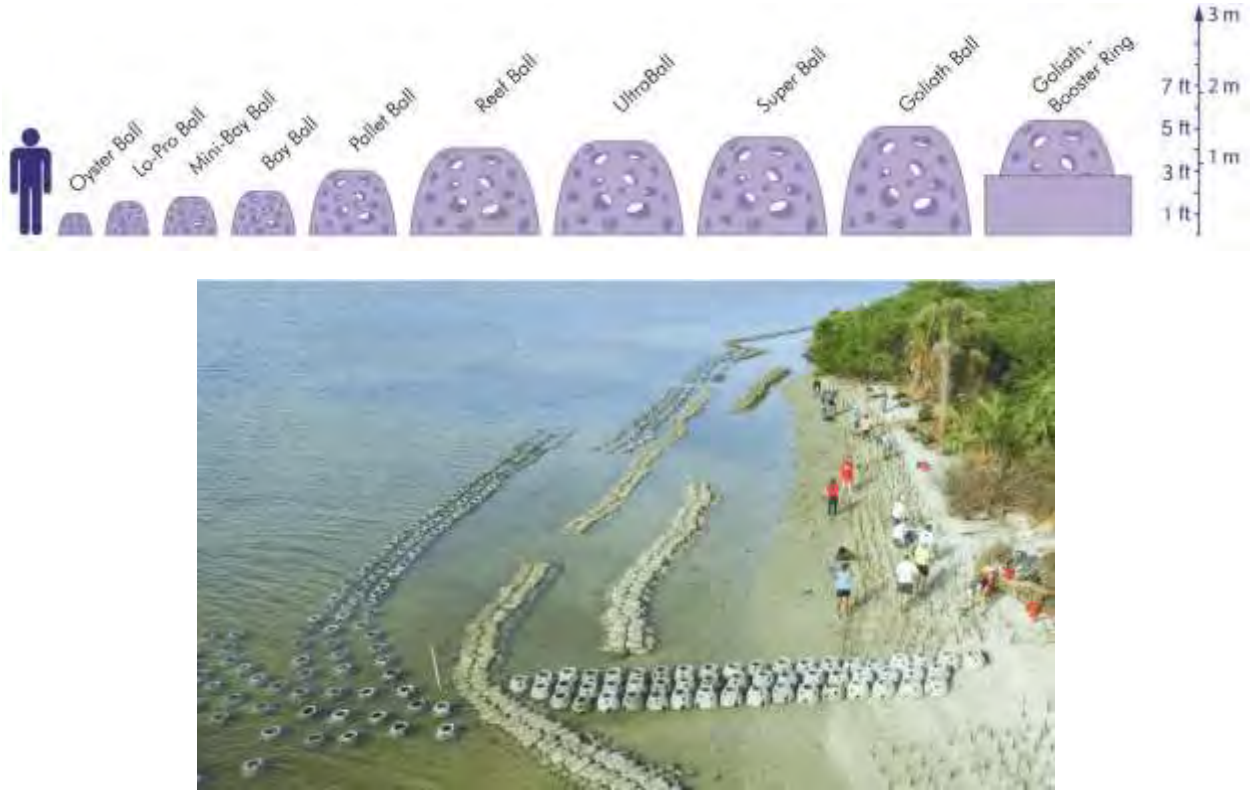


Figure 2. Reef balls: various sizes (top). The proposed installation uses Bay Ball, Mini-Bay Ball, Lo-Pro Ball, and Oyster Ball. Example deployment showing a different field configuration (bottom).

Shellfish Mattresses: The mattresses are composed of an array of shell bags, filled with oyster and mixed shell, measuring 3 ft x 6 ft. The shell bags are then encased in coir or jute netting forming mattresses. The mattresses are secured with wood stakes and fiber rope ties, and arranged along the existing slope as shown on the drawing. The design is beneficial because the rope creates additional strength and stability in the high energy environment to keep the bags in the proper formation. The fiber robe provides more shellfish setting surface and will biodegrade over time such that colonized shellfish remain.

Figure 3. Oyster bags are encased with jute netting and secured using wooden stakes.

BESE-ELEMENTS® Biodegradable ecosystem engineering elements: We propose to test a novel potato-derived starch polymer matrix for shellfish colonization and hydrodynamic attenuation. The matrix is assembled via flat sheets that are roughly 1.5 ft by 3 ft in plan and are 10 in thick. The sheets will be staked in using rebar as per manufacturer recommendation. The sheets biodegrade over time such that the colonized shellfish remain. The picture on the left shows the matrix after shellfish colonization. The picture on the right shows the matrix prior to deployment as it is being seeded with oyster shells to help promote colonization. **Pages at the end of this document show the specifications on the polymer and the certifications on environmental safety**.

Figure 4. BESE-ELEMENTS® Biodegradable ecosystem engineering elements secure mixed shells in the lower energy environment.

Figure 5. Oyster growth on BESE-ELEMENTS.

Oyster Shell Bags: Shell bags filled with recycled oyster shell are commonly used in living shoreline projects throughout the Delaware Estuary and beyond. The Partnership for the Delaware Estuary (PDE) operates the Oyster Shell Recycling Program that collects spent oyster shells from participating restaurants in Delaware and Philadelphia. After at least six months of curing, during which the shells are stored outdoors and exposed to environmental elements such as rain, sun, snow, freezing temperatures, and insect grazing, the shells are effectively cleaned and later bagged by volunteers.

Oyster shell is the preferred substrate for larval oysters to settle upon during recruitment, so the recycling of spent shell after consumption in restaurants provides the ideal opportunity for oyster recruitment in vulnerable areas like the Lewes Boat Basin. This product has proven effective in supporting shellfish recruitment (i.e., oysters and ribbed mussels) and retaining sediment in other living shoreline installations in southern Delaware (Lewes Ball Field, Mispillion).

Each filled shell bags when laying down (right image) is approximately 18 in. x 9.5 in. x 5.5 in. A knot secures the open end of the bag. The bags can be arranged in a variety of designs in multiple settings to protect the shoreline, as well as establish a substrate for local oyster recruitment.

NOTE: several of the oyster bags will use biodegradable material (Ketcham Supply or BESE) as a test of their efficacy in natural environments. Please see the adaptive management plan regarding these oyster bags.

Figure 6. Plastic oyster bags containing cured oyster shell.

Figure 7. Example of oyster and ribbed mussel recruitment in a bag of recycled oyster shell after installation as part of a living shoreline.

Figure 8. Shell bags installed as part of a living shoreline at Mispillion (left) and Lewes Ball Field (right).

Oyster Shells and Spat: Larval oysters require substrate, such as oyster shell, for successful settlement. Once attached, we refer to these oysters as spat. Multiple spat can settle onto one shell and eventually promote the formation of oyster clusters and reefs. These reefs can help reduce shoreline erosion through wave dissipation.

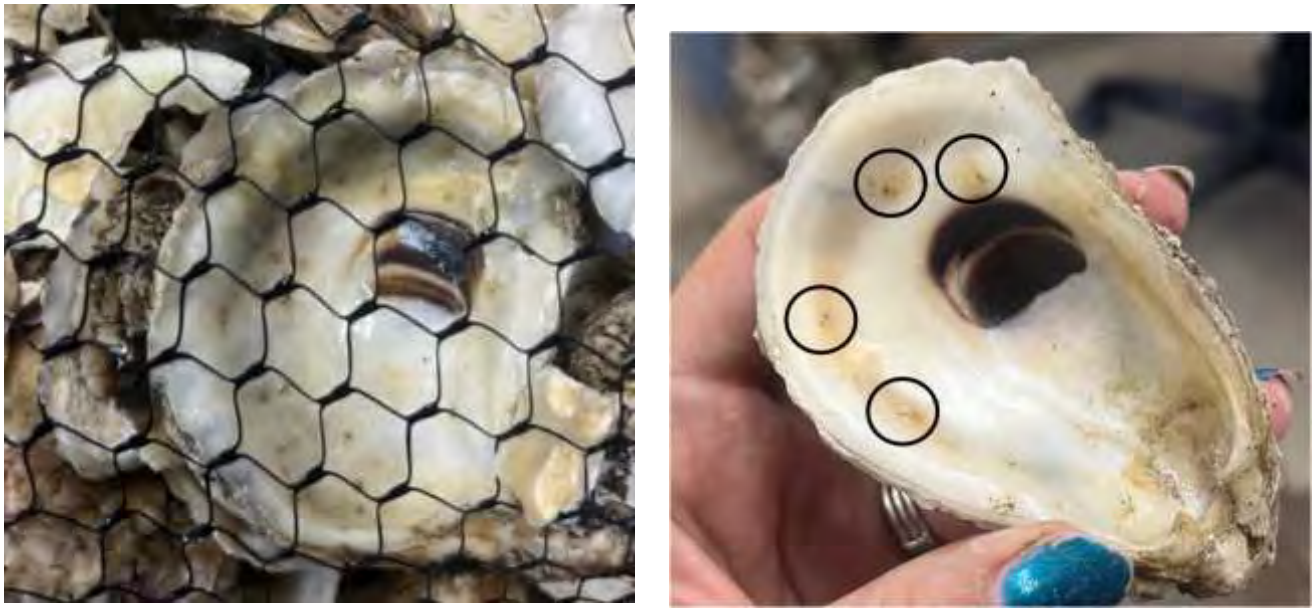


Figure 9. Oyster spat on shell within shell bag (left) and example of early spat circled in black (right).

Plantings: The initial planting will occur behind the mattress and BESE installations on both the north and south sides, and therefore, will supplement the sparse *Spartina alterniflora* that is existing throughout the middle of the spit of land. The energy requires an effective anchoring

mechanism, so we will use BESE elements and plant approximately 300 *Spartina sp.* landscape plugs through the matrix (Figure 10) to ensure proper plant anchoring during root development. The *Spartina sp.* will be closely monitored. Please see the adaptive management plan regarding planting considerations.

Figure 10. The plantings will consist of Spartina alterniflora, Distichlis spicata, and Iva frutescens (upper left to right). Images from Go Botany. BESE elements used to support plant growth (lower). Images from Bese.com.

Monitoring Plan: The team seeks to identify the efficacy of the deployment in encouraging sediment deposition, reducing hydrodynamic forcing, encouraging additional plant growth, and ecological recruitment. We will undertake a rigorous monitoring plan as part of the deployment. The following tables identify the plan for the three main attributes of the project

Biological Monitoring

METHOD	ANALYSIS QUESTION(S)	ANALYSIS METHOD	TEMPORAL RESOLUTION	SPATIAL RESOLUTION	METHOD CITATION
Eel Trap Collection	Determine habitat provision services of off-bottom aquaculture	Invertebrate and fish abundance, diversity metrics	Weekly from May-September	Predefined points on aquaculture racks	Reeds et al. 2018
Fish Tagging	Determine habitat provision services of off-bottom aquaculture	Capture-mark-recapture analyses, diversity metrics	Weekly from May-September	Predefined points on/off of aquaculture racks	Reeds et al. 2018
Oyster Performance	Understand spatiotemporal influences on shellfish production	Pairwise tests between strain, tidal position, replicate group	Weekly from July-October (2023)	Predefined points of aquaculture racks	
Wild Oyster Recruitment	Understand spatiotemporal influences on shellfish recruitment	Pairwise tests between tidal position and replicate group. Retention of spat	Weekly from July-October (2023) & Weekly from May-September (2024)	Predefined points of aquaculture racks	
SIA Ecosystem Model	Develop a food-web driven ecosystem model surrounding off-bottom oyster aquaculture structures	Bayesian mixing model (SIMMR), Ecopath with Ecosim model	Weekly from July-October (2023)	Predefined points of aquaculture racks	

Physical Monitoring

METHOD	ANALYSIS QUESTION(S)	ANALYSIS METHOD	TEMPORAL RESOLUTION	SPATIAL RESOLUTION	METHOD CITATION
Name of method	Question to address through data capture	Likely analysis to be used	Frequency and duration of data collection	Location details (e.g. predefined point, transects)	Reference if applicable
Water depths (tidal fluctuations)	Analyze water depths due to waves, tides, and storm surge	Pressure sensors; Matlab/Python for plotting data	Hourly since November 2023	Predefined points at sensor locations since November 2023	Vu and Stewart 2000; Najafi et al. 2021; Moomen et al. 2016; DeMello and Bridge (2024)
Currents	Determine fluid velocities in the vicinity of the installation.	Bottom-mounted current meters	Burst deployments - quarterly	Predefined points near the installation	N/A
Resistivity measurements (salinity)	Determine salinity levels which contribute more towards concrete deterioration	Pressure sensors; Python for plotting data	Hourly since November 2023	Predefined points at sensor locations since November 2023	Vu and Stewart 2000; Najafi et al. 2021
Chloride penetration from saltwater intrusion	Correlate salinity levels with measured chloride penetration concentrations	Resonance frequency testing, chloride analysis; compression testing	Weekly since September 2024	Concrete specimens replicated in the lab for accelerated testing (wet/dry & freeze-thaw cycling)	Vu and Stewart 2000; Najafi et al. 2021

Social and Planting Monitoring

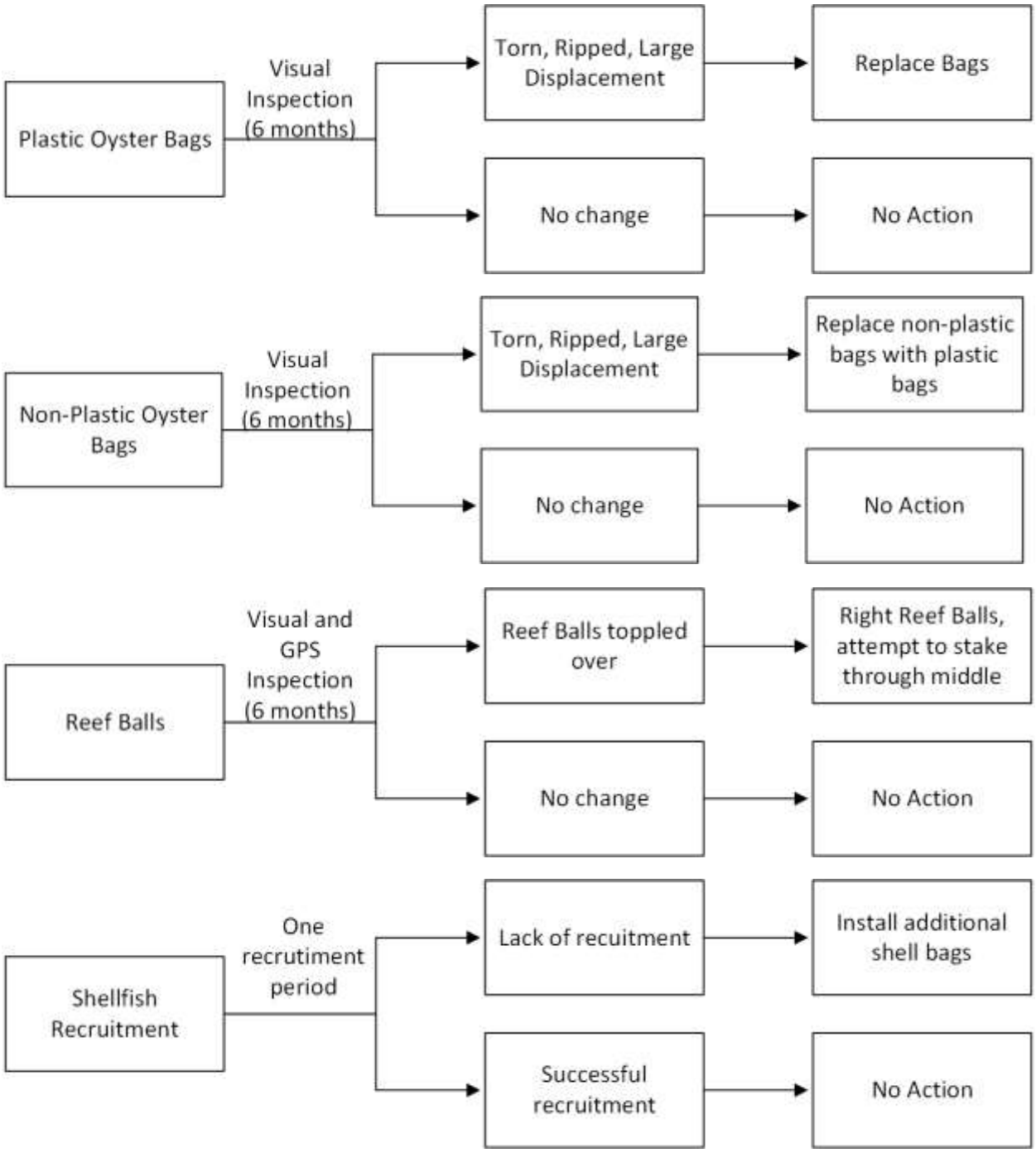
METHOD	ANALYSIS QUESTION(S)	ANALYSIS METHOD	TEMPORAL RESOLUTION	SPATIAL RESOLUTION	METHOD CITATION
Name of method	Question to address through data capture	Likely analysis to be used	Frequency and duration of data collection	Location details (e.g. predefined point, transects)	Reference if applicable
Public Participation	Determine level of community involvement	Record number of participants with activities, workshops, and volunteer events	Weekly then monthly		
Engagement	Understand community sentiment and awareness	Social media analysis	Before and after each event		
Education and Action	Determine changes in knowledge and survival of native plant species	Physical and chemical attributes	Before installation and each year	Four sample cores from horizontal transects	
Soil Moisture, Temperature, and Salinity	Determine changes in knowledge and survival of native plant species	TDR	Four times per year		
Stabilization	Evaluate the facilitation of vertical sediment accretion	RTK-GPS, sediment traps	Four times per year	Transects from shoreline to interior	Reed, 1992. Leonard et al., 2002
Vegetative Productivity	Determine changes in knowledge and survival of native plant species	Stem densities, average height, basal stem diameters	Four times per year	Transects	Leonard et al., 2002

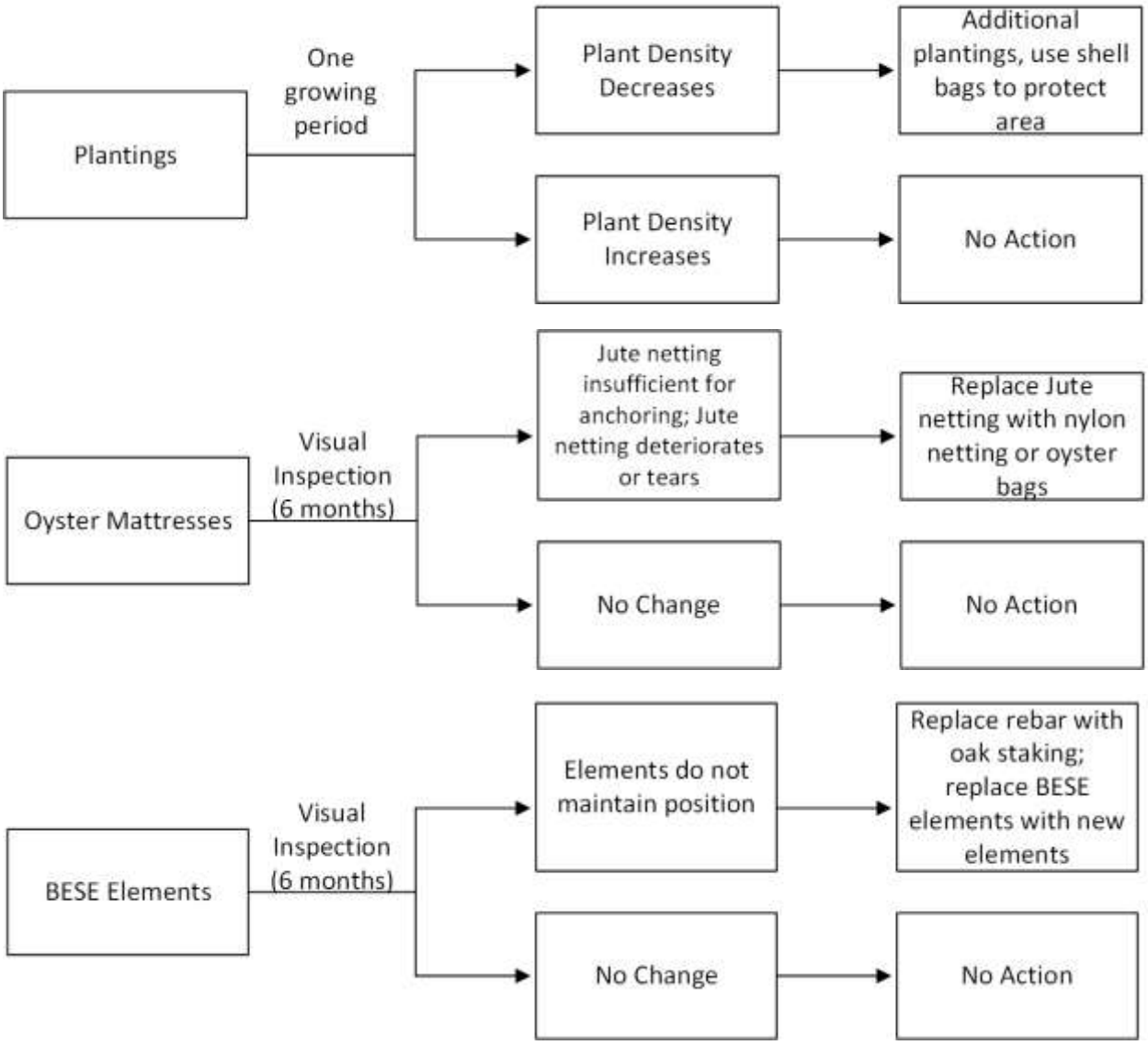
Adaptive Management Plan

Category of Concern	Monitoring Methods	Management Trigger	Expected Timeframe for Decision-Making	Potential Management Action
Plastic oyster bags	Visual inspection	Torn, ripped, large displacement	6 months	Replace bags
Non-plastic oyster bags	Visual inspection	Torn, ripped, biodegraded, large displacement	6 months	Replace non-plastic bags with plastic bags
Reef Balls	Visual and GPS surveying	Reef Balls toppled over	6 months	Right Reef Balls and attempt to stake through middle using oak stakes and sill cap
Shellfish (oyster and ribbed mussel) recruitment	Evaluate recruitment to installed shell bags	Low/no recruitment of oysters or ribbed mussels; inability for shell bags to remain accessible by field staff after recruitment season and/or overwintering	Minimum one recruitment period (June-October)	Successful recruitment of oyster larvae to the shell bags indicates that the deposition of shell bags is sufficient to recruit new oyster reef growth. A lack of recruitment would suggest that shell bag

				placement was insufficient, and a need to return to install more shell bags
Plantings	Plant density	Plant density increases, or decreases	Minimum one growing period	An increase in plant density indicates the approach is sufficient. A decrease in plant density indicates the approach was insufficient, return to plant more (increase density), and use shell bags to protect planted areas
Oyster mattresses	Visual inspection	Jute netting insufficient to hold oyster shell in place, Jute netting material deteriorates or tears	6 months	Replace Jute netting with nylon netting or overtop with oyster bags
BESE elements	Visual inspection	Elements do not maintain position	6 months	Replace rebar staking with oak staking, replace BESE elements with new BESE elements

Adaptive Management Plan Flow Charts




Plantings
One growing period
Plant Density Decreases
Additional plantings, use shell bags to protect area
Plant Density Increases
No Action
Oyster Mattresses
Visual Inspection (6 months)
Jute netting insufficient for anchoring; Jute netting deteriorates or tears
Replace Jute netting with nylon netting or oyster bags
No Change
No Action
BESE Elements
Visual Inspection (6 months)
Elements do not maintain position
Replace rebar with oak staking; replace BESE elements with new elements
No Change
No Action

Appendix J Vegetative Stabilization

Vegetative Stabilization

- Please make sure that all answers in this appendix correspond to information on the application drawing.

1. Submit a brief description of the proposed activity

The project will install a living shoreline in the UD boat basin next to canary creek. It involves habitat enhancement through the addition of Spartina planting and oyster habitat which will stabilize the shoreline and improve ecological function in the intertidal zone. Construction activity will occur during daylight only using a shallow-draft barge with minimal noise. Existing trees in the area will not be disturbed. Planned installation is August 2025. Project size is roughly 0.2 acres.

2. Is grading of bank and/or placement of fill part of this project? Yes **No**
   If yes complete Appendix H

3. Indicate the area of proposed planting that is channelward of the:
   a. Tidal Waters: mean high water line? 370 ft^2
      mean low water line? 0 ft^2
   b. Non-tidal waters: ordinary high water line? 0 ft^2

4. What will the water depth of the plantings be relative to the: (provide the range if it varies)
   a. Tidal Waters: mean high water line? 0.5-1 ft
      mean low water line? 0 ft
   b. Non-tidal waters: ordinary high water line? n/a ft

5. Provide the list of plant species that will be utilized.
   Spartina alterniflora

6. Describe the sequence of construction and planting.
   1. Install Oyster habitat - Reef balls, BESE Elements, Shell bags
   2. Install Spartina plugs at spacing indicated on plan
   3. Cut holes in rigid biodegradable BESE Elements and install over plugs as structure to hold/secure planting
   4. Secure BESE Element using rebar
   5. Ensure stability of plugs.

7. Describe the maintenance and monitoring plan for the vegetation.
   After initial installation, plants will be evaluated **monthly** until established.
   Ongoing monitoring on a 6-month basis to evaluate plant health. Monitoring includes: counts of stem densities, average plant height, and basal stem diameters.

Appendix M Activities in State Wetlands

ACTIVITIES IN STATE WETLANDS

Please make sure that all answers in this appendix correspond to information on the application drawings

1. Project description and explanation of need.
The project will install a living shoreline in the UD boat basin next to canary creek. It involves habitat enhancement through the addition of Spartina planting and oyster habitat which will stabilize the shoreline and improve ecological function in the intertidal zone. Construction activity will occur during daylight only using a shallow-draft barge with minimal noise. Existing trees in the area will not be disturbed. Planned installation is August 2025. Project size is roughly 0.2 acres.

2. What is area of impact for each activity in state wetlands? 1630 sq ft channelward of MHWL

Wetlands Walkways/Other Structures: Walkways: N/A

Length 92_____ ft. Width 15_____ ft. channelward of MHWL
Piles _____ Height_____ ft. over marsh

3. What is volume of fill or excavated material involved in this project? No fill material to be added as part of this shoreline stabilization.

Fill _____cubic yards
Excavation _____cubic yards

4. Map number of state wetland map where project is located: DNR # 87_____

ENVIRONMENTAL SUMMARY - PLEASE SUBMIT AN EVALUATION OF IMPACT OF THE PROPOSED ACTIVITY (ATTACH ADDITIONAL SHEETS AS NEEDED):

5. State reasons that structures cannot feasibly be located on lands other than wetlands.
The narrow strip of land to be protected exists within the wetland area and is owned by the University of Delaware.

6. Detail temporary and permanent changes which would be caused by the proposed project and the impact of these changes on the project area and adjacent areas.

The project will install various features meant to protect the shoreline and possibly encourage sediment deposition. The structures may also act to encourage oyster growth and serve as ecological enhancement. The BESE elements will be temporary as they are biodegradable. It is hoped that oyster colonization occurs on the substrate within the timeframe of biodegradation. Plantings will be used to further stabilize the area.

7. Describe alternatives to the proposed action which would reduce or avoid environmental damage.

The project already uses well-established and/or environmentally friendly (nature based) solutions to protect the narrow spit of land adjacent to the boat basin. Alternatives would be hardened structure that are deemed inappropriate for the area

8. Describe all measures to be taken during and after the completion of the proposed project to reduce detrimental effects.

This spit of land is severely degraded. No action would certainly lead to complete erosion over the years. Thus, the effort will enhance the area rather than cause detrimental effects. Care will be taken during install to minimize foot traffic in adjacent areas with vegetation. Further, installation will occur only during the time frame when allowed based on aquatic and other species restrictions (starting after August 2025). Items will be delivered to the spit via barge when possibly to reduce foot traffic through the wetland. An adaptive management plan details actions to be taken upon completion and for the future for project success.

9. Describe all permanent environmental impacts which cannot be avoided.
Some oyster shell bags used in the installation are composed of nylon. Nylon bags are the standard and we are testing alternatives using biopolymer.

Rebar is used to stake BESE elements. Rebar is the manufacturer recommended approach for staking BESE elements

10. Submit detailed evaluation of impact of the proposed project on the following:

a. Value of tidal ebb and flow

i. Production Value: carrying organic matter to adjacent estuaries and coastal waters which serve as breeding areas for certain animal species (especially fish and shellfish).

These near to shoreline features will not disrupt the overall flow in the area. They are meant to reduce the energy near the shoreline and promote sediment deposition

ii. Value as a natural protective system of absorption of storm wave energy, flood waters, and heavy rainfall, thereby decreasing flood and erosion damage.

This aspect is the main thrust of the project. The features to be installed are meant to dissipate wave energy and extract momentum from the currents protecting the shoreline and encouraging sediment deposition

iii. The prevention of silting in certain harbors and inlets thereby reducing dredging.

N/A. The project is not located close enough to or of sufficient size to affect the area where ships dock in the UD boat basin or the Roosevelt Inlet channel.

iv. Removal and recycling of inorganic nutrients.

N/A.

v. Effect on the estuarine waters.

The installed features are meant to reduce flow energy near the shoreline.

b. Habitat Value

i. Habitat for resident species of wildlife including furbearers, invertebrates, finfish.

The shoreline installation will feature design elements that provide habitat for sessile invertebrates, and motile vertebrate animals alike. The oyster shell bags will attract larval oysters to build a living

reef which will provide ~600 sq ft of intertidal habitat for sponges, small shrimp (e.g. Sand Shrimp, Grass shrimp) and polychaete worms. The Reef Balls will similarly provide external rugosity sufficient for colonization of sessile invertebrates (e.g. barnacles, oysters, red beard sponge, ribbed mussels) thus contributing in a positive manner to the ecological benefit of installation through the creation of microhabitat and food production for higher trophic levels. Additionally, the volume within the Reef Balls will provide refugia for juvenile fishes. We have found that juvenile (age-0) Black Sea Bass along with other species inhabit aquaculture gear in the boat basin area. We anticipate that these Reef Balls will similarly host increased concentrations of reef dwelling fishes (e.g. Black Sea Bass, Spot, White Perch) and provide ancillary benefits for benthic species that feed on small pelagic forage fishes that associate with the prey base like Summer Flounder.

ii. Habitat for migratory wildlife species including waterfowl, wading birds, shorebirds, shorebirds, passerines, finfish, shrimp.

Given our shoreline installation will create several different layers of aquatic habitat, it is completely possible that avian species that prey on invertebrates and/or small fishes like Least and Common Terns might benefit from an increase in forage fish production. Similarly, wading birds like Night Herons and Great Blue Herons would similarly benefit from the potential production of invertebrate (small shrimp) and forage fishes because of our installation. Given we have seen migratory fish species (e.g. White Perch) inhabit aquaculture gear in the boat basin area, it is entirely plausible that the shallow, subtidal habitats associated with the Reef Balls would provide habitat for migratory fishes in the future as well.

iii.

iv. Rearing area, nesting area, breeding grounds for various species.

We would anticipate localized production of forage fishes associated with the installation of new plants, as well as with the oyster bags and Reef Balls. Atlantic Silversides are known to spawn on intertidal plants coinciding with high flood tides to help eggs and larvae avoid predation. Any plants that we install could potentially positively impact production of this species. Additionally, Mummichog are known to spawn on harder materials in subtidal areas. So, we might anticipate a positive impact on Mummichog production.

v. Habitat for rare or endangered plants.

We are unaware of any benefit or threat associated with the prescribed installation that might impact endangered plants.

vi. Presence of plants or animals known to be rare generally, or unique to the particular location.

The habitat is too shallow to be of any benefit to rare aquatic fishes like Atlantic Sturgeon. Similarly, we do not see Horseshoe Crabs in any significant number (> 12) or Red Knots at all at this location. We believe the area of impact is either too shallow or of too little interest to these species. However, we have installed an acoustic receiver array to detect acoustically tagged fishes. So, we should be able to report out if any species is nearby warranting attention.

vii. Presence of plants or animals near the limits of their territorial range.

We are unaware of any benefit or threat associated with the prescribed installation that might result from animals near the limits of their territorial range.

viii. Presence of unique geological or wetland features.
The habitat is reflective of an Atlantic coastal plain salt marsh. There are known areas of oyster shell, sand, and mud. So, the installation is largely reflective of what already exists at the location. Any negative impact associated with installation activities will surely be mitigated through the years of positive environmental impact these design elements will provide.

c. Aesthetic Effect - Consideration of the aesthetic effect may include:
i. Presence of plants or animals of a high visual quality.

We will use native plants (*Spartina alterniflora*) – native plants have the benefit of enhancing overall aesthetics of place. Oyster reefs have the potential to increase the presence of shorebirds which enhance overall aesthetics of place. Overall, living shorelines which incorporate oyster reefs and oyster substrate in the form of reef balls are more natural and aesthetically pleasing than alternative traditional seawalls.

ii. The presence of an associated water body.

N/A

iii. Wetland type of topographic diversity.

N/A

d. Impact of Supporting Facilities

The supporting facilities to be considered include any public or private construction, whether or not the construction occurs in the wetlands, which would be required for construction or operation of the proposed wetlands activity, such as roads, sewage disposal facilities, electric lines, water supply systems, and schools. Effects shall be separately determined for the lands neighboring such facilities

There is no effect to supporting facilities.

e. Effect on Neighboring Land Uses
i. The effects of the proposed wetland activity on neighboring land use are to be considered whether or not the neighboring lands are wetlands.

The spit of land protects creates a low energy cove where the UD Boat Basin keeps boats.

ii. The environmental, aesthetic and economic effects of the proposed wetlands activity on land uses neighboring the lands on which supporting facilities will be located may be considered.

Protecting areas near the boat basin ensures proper operation of the facility

f. Federal, State, Regional, County and Municipal Comprehensive Plans.
Compliance of the proposed activities with the plans of the jurisdiction in which it is proposed to take place, and its impact on the plans of other affected jurisdictions.

The 2015 Lewes Comprehensive Plan quotes the Climate Change and Hazard Mitigation plan and highlights: *the key threats facing Lewes are coastal flooding and inland flooding as a result of coastal storms, sea-level*

rise and severe thunderstorms. Not only is flooding expected to occur more frequently, but its severity and scope are also expected to increase. Some additional effects include. "...erosion, which will also be greater as sea levels rise. This effect applies to both chronic erosion and storm-induced erosion.
Our living shoreline will research and attempt to address erosion concerns that could be applied widely within Lewes and other coastal communities.

g. Economic Impact

the scale of this project not sufficient to have significant economic impact.

Economic Impact shall include a short and long-term evaluation of the following factors to the extent the effect is directly attributable to the proposed activity:

i. Jobs created or lost and the net income effect of jobs.
N/A
ii. Increases in revenues to or increases in expenditure by State, County and local governments (e.g., increased taxes from an increased tax base and increased expenditure for maintaining supporting facilities).
N/A
iii. Increases or decreases in the value attributable to the wetland as a source of nutrients to finfish, crustacea and shellfish and as habitats of such species or other flora or fauna of significant actual or potential economic value.
N/A
iv. Increases or decreases in the value of the land as a recreational area.
N/A
v. Increases or decreases in the cost of flood control or expected flood damage which might be caused by the effect of the activity on the natural capacity of the wetland to reduce flood damage.
N/A
vi. Increases or decreases the costs of maintaining navigable harbors and waterways which would result from altering the capacity of the wetlands to absorb silt.
N/A
vii. The net economic effect, both public and private, or any contemplated supporting facilities.
N/A
viii. The net economic effect, both public and private, of the proposed activity on neighboring land uses.
ix. N/A

Biodegradeable oyster shell bags

Description of the Ketcham oyster bags already being used in a Partnership for the Delaware Estuary Study (https://ketchamsupply.com/2021/11/08/its-okay-to-throw-away-introducing-biodegradable-shellfish-netting/)

For regulatory purposes, “biodegradability” is defined as the ability of a material to decompose within 6 months under the types of conditions found in a landfill. Under the harmonized international testing guidelines for biodegradability, our netting material meets both the international ISO 20200 and European EN13432 standards. Certification is carried out by an independent agency according to strict testing protocols, and requires that the plastics break down under industrial-scale composting conditions, leaving no more than 10 percent of the original material in pieces no bigger than 2 mm. In addition, the decomposition process cannot leave harmful residue that inhibits the soil’s composting properties. The material in this netting, a co-polyester, is so tasty to microbes that lighter extrusions can be certified under the even stricter “compostable” standard, which means it degrades within 3 months.

Though not quite on par with a banana peel composting-wise, these tests indicate that the co-polyester will eventually completely biodegrade. That means the only byproduct of the process will be bacterial biomass and CO_2 (or methane, since anaerobic bacteria also degrade the polymer). Although biodegradation in a marine environment is not part of certification testing, the fact that polyester readily degrades by both aerobic and anaerobic land-based bacteria means that it will likely degrade in seawater as well. Although testing standards for marine biodegradability do not currently exist, some studies indicate that marine micro-organisms can in fact biodegrade this material. (Meyer-Cifuentes, I.E., *et al.* Synergistic biodegradation of aromatic-aliphatic co-polyester plastic by a marine microbial consortium. *Nature Communications* **11**, 5790 (2020).)

The BESE oyster bags are made of the same material as the BESE elements with the specifications provided in subsequent pages.

122 Hullihen Hall
Newark, DE 19716-0160
Phone: 302-831-2200
Fax: 302-831-7060
Email: executivevp@udel.edu

January 8, 2025

DNREC
Division of Water Wetlands and Waterways Section
Attn: Julie Molina
89 Kings Highway
Dover, DE 19901

Re: Delaware Boat Basin Project

Dear Ms. Molina:

The University of Delaware is the owner of record of property in Sussex County, Delaware – Parcel 335-4.00-13.01, . A portion of this property has been earmarked for a project to stabilize and enhance the shoreline.

This letter shall serve as notice that the University approves the installation of materials necessary for the construction of a "living shoreline" in the area between Canary Creek and the boat basin as described on the plan provided for review.

If you have any questions, feel free to reach out to Darlene Hoy in the University's Real Estate Office via email at dahoy@udel.edu or phone 302-831-7501.

Sincerely,

John Long
38E03136349E413...

John W. Long
Executive Vice President
And Chief Operating Officer

JWL:dah

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chesapeake Bay Ecological Services Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401-7307
Phone: (410) 573-4599 Fax: (410) 266-9127

In Reply Refer To: 12/30/2024 15:29:06 UTC
Project code: 2025-0036355
Project Name: UD Boat Basin - Living Shoreline

Federal Nexus: yes
Federal Action Agency (if applicable): Army Corps of Engineers

Subject: Technical assistance for 'UD Boat Basin - Living Shoreline'

Dear Jack Puleo:

This letter records your determination using the Information for Planning and Consultation (IPaC) system provided to the U.S. Fish and Wildlife Service (Service) on December 30, 2024, for “UD Boat Basin - Living Shoreline” (here forward, Project). This project has been assigned Project Code 2025-0036355 and all future correspondence should clearly reference this number.

The Service developed the IPaC system and associated species’ determination keys in accordance with the Endangered Species Act of 1973 (ESA; 87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) and based on a standing analysis. All information submitted by the Project proponent into the IPaC must accurately represent the full scope and details of the Project. Failure to accurately represent or implement the Project as detailed in IPaC or the Northeast Determination Key (Dkey), invalidates this letter. ***Answers to certain questions in the DKey commit the project proponent to implementation of conservation measures that must be followed for the ESA determination to remain valid.***

To make a no effect determination, the full scope of the proposed project implementation (action) should not have any effects (either positive or negative effect(s)), to a federally listed species or designated critical habitat. Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. (See § 402.17). Under Section 7 of the ESA, if a federal action agency makes a no effect determination, no further consultation with, or concurrence from, the Service is required (ESA §7). If a proposed Federal action may affect a listed species or designated critical habitat, formal consultation is required (except when the Service concurs, in writing, that a

proposed action "is not likely to adversely affect (NLAA)" listed species or designated critical habitat [50 CFR §402.02, 50 CFR§402.13]).

The IPaC results indicated the following species is (are) potentially present in your project area and, based on your responses to the Service's Northeast DKey, you determined the proposed Project will have the following effect determinations:

Species	Listing Status	Determination
Rufa Red Knot (*Calidris canutus rufa*)	Threatened	May affect

Consultation with the Service is not complete. Further consultation or coordination with the Service is necessary for those species or designated critical habitats with a determination of "May Affect". Please contact our Chesapeake Bay Ecological Services Field Office to discuss methods to avoid or minimize potential adverse effects to those species or designated critical habitats.

In addition to the species listed above, the following species and/or critical habitats may also occur in your project area and are not covered by this conclusion:

- Monarch Butterfly *Danaus plexippus* Proposed Threatened
- Tricolored Bat *Perimyotis subflavus* Proposed Endangered

Please Note: If the Action may impact bald or golden eagles, additional coordination with the Service under the Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d) by the prospective permittee may be required. Please contact the Migratory Birds Permit Office, (413) 253-8643, or PermitsR5MB@fws.gov, with any questions regarding potential impacts to Eagles.

If you have any questions regarding this letter or need further assistance, please contact the Chesapeake Bay Ecological Services Field Office and reference the Project Code associated with this Project.

Action Description
You provided to IPaC the following name and description for the subject Action.

1. Name

UD Boat Basin - Living Shoreline

2. Description

The following description was provided for the project 'UD Boat Basin - Living Shoreline':

> The project will install a living shoreline in the UD boat basin next to canary creek. It involves habitat enhancement through the addition of Spartina planting and oyster habitat which will stabilize the shoreline and improve ecological function in the intertidal zone. Construction activity will occur during daylight only using a shallow-draft barge with minimal noise. Existing trees in the area will not be disturbed. Planned installation is May 2025. Project size is roughly 0.2 acres.

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@38.7890342,-75.16256276683991,14z

QUALIFICATION INTERVIEW

1. As a representative of this project, do you agree that all items submitted represent the complete scope of the project details and you will answer questions truthfully?

   Yes

2. Does the proposed project include, or is it reasonably certain to cause, intentional take of listed species?

   Note: This question could refer to research, direct species management, surveys, and/or studies that include intentional handling/encountering, harassment, collection, or capturing of any individual of a federally listed threatened, endangered, or proposed species.

   No

3. Is the action authorized, permitted, licensed, funded, or being carried out by a Federal agency in whole or in part?

   Yes

4. Is the Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), or Federal Transit Administration (FTA) the lead agency for this project?

   No

5. Are you including in this analysis all impacts to federally listed species that may result from the entirety of the project (not just the activities under federal jurisdiction)?

   Note: If there are project activities that will impact listed species that are considered to be outside of the jurisdiction of the federal action agency submitting this key, contact your local Ecological Services Field Office to determine whether it is appropriate to use this key. If your Ecological Services Field Office agrees that impacts to listed species that are outside the federal action agency's jurisdiction will be addressed through a separate process, you can answer yes to this question and continue through the key.

   Yes

6. Are you the lead federal action agency or designated non-federal representative requesting concurrence on behalf of the lead Federal Action Agency?

   No

7. Is the lead federal action agency the Environmental Protection Agency (EPA) or Federal Communications Commission (FCC)?

   No

8. Is the lead federal action agency the Federal Energy Regulatory Commission (FERC)?

   No

9. Is the lead federal action agency the Natural Resources Conservation Service?

   No

10. Will the proposed project involve the use of herbicide where listed species are present?

    No

11. Are there any caves or anthropogenic features suitable for hibernating or roosting bats within the area expected to be impacted by the project?

    No

12. Does any component of the project associated with this action include activities or structures that may pose a collision risk to **birds** (e.g., plane-based surveys, land-based or offshore wind turbines, communication towers, high voltage transmission lines, any type of towers with or without guy wires)?

    Note: For federal actions, answer ‘yes’ if the construction or operation of wind power facilities is either (1) part of the federal action or (2) would not occur but for a federal agency action (federal permit, funding, etc.).

    No

13. Does any component of the project associated with this action include activities or structures that may pose a collision risk to **bats** (e.g., plane-based surveys, land-based or offshore wind turbines)?

    Note: For federal actions, answer ‘yes’ if the construction or operation of wind power facilities is either (1) part of the federal action or (2) would not occur but for a federal agency action (federal permit, funding, etc.).

    No

14. Will the proposed project result in permanent changes to water quantity in a stream or temporary changes that would be sufficient to result in impacts to listed species?

    For example, will the proposed project include any activities that would alter stream flow, such as water withdrawal, hydropower energy production, impoundments, intake structures, diversion structures, and/or turbines? Projects that include temporary and limited water reductions that will not displace listed species or appreciably change water availability for listed species (e.g. listed species will experience no changes to feeding, breeding or sheltering) can answer "No". Note: This question refers only to the amount of water present in a stream, other water quality factors, including sedimentation and turbidity, will be addressed in following questions.

    No

15. Will the proposed project affect wetlands where listed species are present?

    This includes, for example, project activities within wetlands, project activities within 300 feet of wetlands that may have impacts on wetlands, water withdrawals and/or discharge of contaminants (even with a NPDES).

    Yes

16. Will the proposed project activities (including upland project activities) occur within 0.125 miles of the water's edge of a stream or tributary of a stream where listed species may be present?

    Yes

17. Will the proposed project directly affect a streambed (below ordinary high water mark (OHWM)) of the stream or tributary where listed species may be present?

    Yes

18. Will the proposed project bore underneath (directional bore or horizontal directional drill) a stream where listed species may be present?

    No

19. Will the proposed project involve a new point source discharge into a stream or change an existing point source discharge (e.g., outfalls; leachate ponds) where listed species may be present?

    No

20. Will the proposed project involve the removal of excess sediment or debris, dredging or in-stream gravel mining where listed species may be present?

    No

21. Will the proposed project involve the creation of a new water-borne contaminant source where listed species may be present?

    Note New water-borne contaminant sources occur through improper storage, usage, or creation of chemicals. For example: leachate ponds and pits containing chemicals that are not NSF/ANSI 60 compliant have contaminated waterways. Sedimentation will be addressed in a separate question.

    No

22. Will the proposed project involve perennial stream loss, in a stream of tributary of a stream where listed species may be present, that would require an individual permit under 404 of the Clean Water Act?

    No

23. Will the proposed project involve blasting where listed species may be present?

    No

24. Will the proposed project include activities that could negatively affect fish movement temporarily or permanently (including fish stocking, harvesting, or creation of barriers to fish passage).

    No

25. Will the proposed project involve earth moving that could cause erosion and sedimentation, and/or contamination along a stream or tributary of a stream where listed species may be present?

    Note: Answer "Yes" to this question if erosion and sediment control measures will be used to protect the stream.

    No

26. Will earth moving activities result in sediment being introduced to streams or tributaries of streams where listed species may be present through activities such as, but not limited to, valley fills, large-scale vegetation removal, and/or change in site topography?

    No

27. Will the proposed project involve vegetation removal within 200 feet of a perennial stream bank where aquatic listed species may be present?

    No

28. Will erosion and sedimentation control Best Management Practices (BMPs) associated with applicable state and/or Federal permits, be applied to the project? If BMPs have been provided by and/or coordinated with and approved by the appropriate Ecological Services Field Office, answer "Yes" to this question.

    No

29. Is the project being funded, lead, or managed in whole or in part by U.S Fish and Wildlife Restoration and Recovery Program (e.g., Partners, Coastal, Fisheries, Wildlife and Sport Fish Restoration, Refuges)?

    No

30. Will the proposed project result in changes to beach dynamics that may modify formation of habitat over time?

    Note: Examples of projects that result in changes to beach dynamics include 1) construction of offshore breakwaters and groins; 2) mining of sand from an updrift ebb tidal delta; 3) removing or adding beach sands; and 4) projects that stabilize dunes (including placement of sand fences or planting vegetation).

    Yes

31. [Hidden Semantic] Is the project area located within the red knot AOI?

    Automatically answered
    Yes

32. If you have determined that the red knot is unlikely to occur within your project’s action area or that your project is unlikely to have any potential effects on the red knot, you may wish to make a “no effect” determination for the red knot. Additional guidance on how to make this decision can be found in the project review section of your local Ecological Services Field Office's website. CBFO: https://www.fws.gov/office/chesapeake-bay-ecological-services/project-review ; MEFO: https://www.fws.gov/office/maine-ecological-services ; NJFO: https://www.fws.gov/office/new-jersey-ecological-services/new-jersey-field-office-project-review-guide ; NEFO: https://www.fws.gov/office/new-england-ecological-services/endangered-species-project-review#Step5 ; WVFO: https://www.fws.gov/office/west-virginia-ecological-services/project-planning. If you are unsure, answer "No" and continue through the key.

    Would you like to make a no effect determination for the red knot?

    No

33. Will the proposed project include only the creation of new shorebird habitat (e.g., by nourishing severely eroded shorelines) where no shorebird habitat currently exists (in any part of the action area)?

    No

34. Will the proposed project include only the creation of new shorebird habitat (e.g., by nourishing severely eroded shorelines) where there is no potential for natural shorebird habitat formation (e.g., overwash or breaching) in the absence of the proposed project?

    No

35. Will the proposed project alter any of the following components of red knot foraging habitat: (sandy, gravel, or cobble beaches; tidal mudflats; salt marshes, shallow coastal impoundments, lagoons, peak banks and washover features)?

    Note: This also includes impacts that occur during any time when birds are not present, if impacts will persist until birds are present on site (e.g., removal of substrate, excavating, grading, placing fill material, application of chemicals, conversion of habitat to non-suitable habitat, changes to food resources).

    Yes

36. [Semantic] Does the project intersect the Virginia big-eared bat critical habitat?

    Automatically answered
    No

37. [Semantic] Does the project intersect the Indiana bat critical habitat?

    Automatically answered
    No

38. [Semantic] Does the project intersect the candy darter critical habitat?

    Automatically answered
    No

39. [Semantic] Does the project intersect the diamond darter critical habitat?

    Automatically answered
    No

40. [Semantic] Does the project intersect the Big Sandy crayfish critical habitat?

    Automatically answered
    No

41. [Hidden Semantic] Does the project intersect the Guyandotte River crayfish critical habitat?

    Automatically answered
    No

42. Do you have any other documents that you want to include with this submission?

    No

PROJECT QUESTIONNAIRE

1. Briefly describe the habitat within the construction/disturbance limits of the project site.
   tidal wetlands within the UD boat basin
2. Approximately how many acres of trees would the proposed project remove?
   0
3. Approximately how many total acres of disturbance are within the disturbance/ construction limits of the proposed project?
   0.2

IPAC USER CONTACT INFORMATION

Agency: Private Entity
Name: Jack Puleo
Address: 259 Academy Street
City: Newark
State: DE
Zip: 19716
Email jpuleo@udel.edu
Phone: 3023390343

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Army Corps of Engineers
Name: Jack Puleo
Email: jpuleo@udel.edu
Phone: 3023390343

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chesapeake Bay Ecological Services Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401-7307
Phone: (410) 573-4599 Fax: (410) 266-9127

In Reply Refer To: 02/05/2025 20:39:19 UTC
Project code: 2025-0036355
Project Name: UD Boat Basin - Living Shoreline

Federal Nexus: yes
Federal Action Agency (if applicable): Army Corps of Engineers

Subject: Record of project representative's no effect determination for 'UD Boat Basin - Living Shoreline'

Dear Jack Puleo:

This letter records your determination using the Information for Planning and Consultation (IPaC) system provided to the U.S. Fish and Wildlife Service (Service) on February 05, 2025, for 'UD Boat Basin - Living Shoreline' (here forward, Project). This project has been assigned Project Code 2025-0036355 and all future correspondence should clearly reference this number. **Please carefully review this letter.**

Ensuring Accurate Determinations When Using IPaC

The Service developed the IPaC system and associated species' determination keys in accordance with the Endangered Species Act of 1973 (ESA; 87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) and based on a standing analysis. All information submitted by the Project proponent into IPaC must accurately represent the full scope and details of the Project.

Failure to accurately represent or implement the Project as detailed in IPaC or the **Northern Long-eared Bat and Tricolored Bat Range-wide Determination Key (Dkey)**, invalidates this letter. ***Answers to certain questions in the DKey commit the project proponent to implementation of conservation measures that must be followed for the ESA determination to remain valid.***

Determination for the Northern Long-Eared Bat and/or Tricolored Bat

Based upon your IPaC submission and a standing analysis, your project has reached the following effect determinations:

Species	Listing Status	Determination

Tricolored Bat (*Perimyotis subflavus*)	Proposed Endangered	No effect

Federal agencies must consult with U.S. Fish and Wildlife Service under section 7(a)(2) of the Endangered Species Act (ESA) when an action *may affect* a listed species. Tricolored bat is proposed for listing as endangered under the ESA, but not yet listed. For actions that may affect a proposed species, agencies cannot consult, but they can *confer* under the authority of section 7(a)(4) of the ESA. Such conferences can follow the procedures for a consultation and be adopted as such if and when the proposed species is listed. Should the tricolored bat be listed, agencies must review projects that are not yet complete, or projects with ongoing effects within the tricolored bat range that previously received a NE or NLAA determination from the key to confirm that the determination is still accurate.

To make a no effect determination, the full scope of the proposed project implementation (action) should not have any effects (either positive or negative), to a federally listed species or designated critical habitat. Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. (See § 402.17).

Under Section 7 of the ESA, if a federal action agency makes a no effect determination, no consultation with the Service is required (ESA §7). If a proposed Federal action may affect a listed species or designated critical habitat, formal consultation is required except when the Service concurs, in writing, that a proposed action "is not likely to adversely affect" listed species or designated critical habitat [50 CFR §402.02, 50 CFR§402.13].

Other Species and Critical Habitat that May be Present in the Action Area

The IPaC-assisted determination key for the northern long-eared bat and tricolored bat does not apply to the following ESA-protected species and/or critical habitat that also may occur in your Action area:

- Monarch Butterfly *Danaus plexippus* Proposed Threatened
- Rufa Red Knot *Calidris canutus rufa* Threatened

You may coordinate with our Office to determine whether the Action may affect the animal species listed above and, if so, how they may be affected.

Next Steps

If there are no updates on listed species, no further consultation/coordination for this project is required with respect to the species covered by this key. However, the Service recommends that project proponents re-evaluate the Project in IPaC if: 1) the scope, timing, duration, or location of the Project changes (includes any project changes or amendments); 2) new information reveals

the Project may impact (positively or negatively) federally listed species or designated critical habitat; or 3) a new species is listed, or critical habitat designated. If any of the above conditions occurs, additional coordination with the Service should take place to ensure compliance with the Act.

If you have any questions regarding this letter or need further assistance, please contact the Chesapeake Bay Ecological Services Field Office and reference Project Code 2025-0036355 associated with this Project.

Action Description
You provided to IPaC the following name and description for the subject Action.

1. Name

UD Boat Basin - Living Shoreline

2. Description

The following description was provided for the project 'UD Boat Basin - Living Shoreline':

> The project will install a living shoreline in the UD boat basin next to canary creek. It involves habitat enhancement through the addition of Spartina planting and oyster habitat which will stabilize the shoreline and improve ecological function in the intertidal zone. Construction activity will occur during daylight only using a shallow-draft barge with minimal noise. Existing trees in the area will not be disturbed. Planned installation is May 2025. Project size is roughly 0.2 acres.

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@38.7890342,-75.16256276683991,14z

DETERMINATION KEY RESULT

Based on the information you provided, you have determined that the Proposed Action will have no effect on the species covered by this determination key. Therefore, no consultation with the U.S. Fish and Wildlife Service pursuant to Section 7(a)(2) of the Endangered Species Act of 1973 (87 Stat. 884, as amended 16 U.S.C. 1531 *et seq.*) is required for those species.

QUALIFICATION INTERVIEW

1. Does the proposed project include, or is it reasonably certain to cause, intentional take of listed bats or any other listed species?

   Note: Intentional take is defined as take that is the intended result of a project. Intentional take could refer to research, direct species management, surveys, and/or studies that include intentional handling/encountering, harassment, collection, or capturing of any individual of a federally listed threatened, endangered or proposed species?

   No

2. Is the action area wholly within Zone 2 of the year-round active area for northern long-eared bat and/or tricolored bat?

   Automatically answered
   No

3. Does the action area intersect Zone 1 of the year-round active area for northern long-eared bat and/or tricolored bat?

   Automatically answered
   No

4. Does any component of the action involve leasing, construction or operation of wind turbines? Answer 'yes' if the activities considered are conducted with the intention of gathering survey information to inform the leasing, construction, or operation of wind turbines.

   Note: For federal actions, answer ‘yes’ if the construction or operation of wind power facilities is either (1) part of the federal action or (2) would not occur but for a federal agency action (federal permit, funding, etc.).

   No

5. Is the proposed action authorized, permitted, licensed, funded, or being carried out by a Federal agency in whole or in part?

   Yes

6. Is the Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), or Federal Transit Administration (FTA) funding or authorizing the proposed action, in whole or in part?

   No

7. Are you an employee of the federal action agency or have you been officially designated in writing by the agency as its designated non-federal representative for the purposes of Endangered Species Act Section 7 informal consultation per 50 CFR § 402.08?

   Note: This key may be used for federal actions and for non-federal actions to facilitate section 7 consultation and to help determine whether an incidental take permit may be needed, respectively. This question is for information purposes only.

   No

8. Is the lead federal action agency the Environmental Protection Agency (EPA) or Federal Communications Commission (FCC)? Is the Environmental Protection Agency (EPA) or Federal Communications Commission (FCC) funding or authorizing the proposed action, in whole or in part?

   No

9. Is the lead federal action agency the Federal Energy Regulatory Commission (FERC)?

   No

10. [Semantic] Is the action area located within 0.5 miles of a known bat hibernaculum?

    Note: The map queried for this question contains proprietary information and cannot be displayed. If you need additional information, please contact your State wildlife agency.

    Automatically answered
    No

11. Does the action area contain any winter roosts or caves (or associated sinkholes, fissures, or other karst features), mines, rocky outcroppings, or tunnels that could provide habitat for hibernating bats?

    No

12. Will the action cause effects to a bridge?

    Note: Covered bridges should be considered as bridges in this question.

    No

13. Will the action result in effects to a culvert or tunnel at any time of year?

    No

14. Are trees present within 1000 feet of the action area?

    Note: If there are trees within the action area that are of a sufficient size to be potential roosts for bats answer "Yes". If unsure, additional information defining suitable summer habitat for the northern long-eared bat and tricolored bat can be found in Appendix A of the USFWS' Range-wide Indiana Bat and Northern long-eared bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines.

    Yes

15. Does the action include the intentional exclusion of bats from a building or structure?

    Note: Exclusion is conducted to deny bats' entry or reentry into a building. To be effective and to avoid harming bats, it should be done according to established standards. If your action includes bat exclusion and you are unsure whether northern long-eared bats or tricolored bats are present, answer "Yes." Answer "No" if there are no signs of bat use in the building/structure. If unsure, contact your local Ecological Services Field Office to help assess whether northern long-eared bats or tricolored bats may be present. Contact a Nuisance Wildlife Control Operator (NWCO) for help in how to exclude bats from a structure safely without causing harm to the bats (to find a NWCO certified in bat standards, search the Internet using the search term "National Wildlife Control Operators Association bats"). Also see the White-Nose Syndrome Response Team's guide for bat control in structures.

    No

16. Does the action involve removal, modification, or maintenance of a human-made structure (barn, house, or other building) **known or suspected to contain roosting bats?**

    No

17. Will the action cause construction of one or more new roads open to the public?

    For federal actions, answer 'yes' when the construction or operation of these facilities is either (1) part of the federal action or (2) would not occur but for an action taken by a federal agency (federal permit, funding, etc.).

    No

18. Will the action include or cause any construction or other activity that is reasonably certain to increase average daily traffic permanently or temporarily on one or more existing roads?

    Note: For federal actions, answer 'yes' when the construction or operation of these facilities is either (1) part of the federal action or (2) would not occur but for an action taken by a federal agency (federal permit, funding, etc.). .

    No

19. Will the action include or cause any construction or other activity that is reasonably certain to increase the number of travel lanes on an existing thoroughfare?

    For federal actions, answer 'yes' when the construction or operation of these facilities is either (1) part of the federal action or (2) would not occur but for an action taken by a federal agency (federal permit, funding, etc.).

    No

20. Will the proposed Action involve the creation of a new water-borne contaminant source (e.g., leachate pond, pits containing chemicals that are not NSF/ANSI 60 compliant)?

    Note: For information regarding NSF/ANSI 60 please visit https://www.nsf.org/knowledge-library/nsf-ansi-standard-60-drinking-water-treatment-chemicals-health-effects

    No

21. Will the proposed action involve the creation of a new point source discharge from a facility other than a water treatment plant or storm water system?

    No

22. Will the action include drilling or blasting?

    No

23. Will the action involve military training (e.g., smoke operations, obscurant operations, exploding munitions, artillery fire, range use, helicopter or fixed wing aircraft use)?

    No

24. Will the proposed action involve the use of herbicides or other pesticides other than herbicides (e.g., fungicides, insecticides, or rodenticides)?

    No

25. Will the action include or cause activities that are reasonably certain to cause chronic or intense nighttime noise (above current levels of ambient noise in the area) in suitable summer habitat for the northern long-eared bat or tricolored bat during the active season?

    Chronic noise is noise that is continuous or occurs repeatedly again and again for a long time. Sources of chronic or intense noise that could cause adverse effects to bats may include, but are not limited to: road traffic; trains; aircraft; industrial activities; gas compressor stations; loud music; crowds; oil and gas extraction; construction; and mining.

    Note: Additional information defining suitable summer habitat for the northern long-eared bat and tricolored bat can be found in Appendix A of the USFWS' Range-wide Indiana Bat and Northern long-eared bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines.

    No

26. Does the action include, or is it reasonably certain to cause, the use of permanent or temporary artificial lighting within 1000 feet of suitable northern long-eared bat or tricolored bat roosting habitat?

    Note: Additional information defining suitable summer habitat for the northern long-eared bat and tricolored bat can be found in Appendix A of the USFWS' Range-wide Indiana Bat and Northern long-eared bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines.

    No

27. Will the action include tree cutting or other means of knocking down or bringing down trees, tree topping, or tree trimming?

    No

28. Will the proposed action result in the use of prescribed fire?

    Note: If the prescribed fire action includes other activities than application of fire (e.g., tree cutting, fire line preparation) please consider impacts from those activities within the previous representative questions in the key. This set of questions only considers impacts from flame and smoke.

    No

29. Does the action area intersect the tricolored bat species list area?

    Automatically answered
    Yes

30. [Semantic] Is the action area located within 0.25 miles of a culvert that is known to be occupied by northern long-eared or tricolored bats?

    Note: The map queried for this question contains proprietary information and cannot be displayed. If you need additional information, please contact your State wildlife agency.

    Automatically answered
    No

31. Has a presence/probable absence bat survey targeting the tricolored bat and following the Service's Range-wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines been conducted within the project area?

    No

32. Is suitable summer habitat for the tricolored bat present within 1000 feet of project activities?
    (If unsure, answer ""Yes."")

    Note: If there are trees within the action area that may provide potential roosts for tricolored bats (e.g., clusters of leaves in live and dead deciduous trees, Spanish moss (Tillandsia usneoides), clusters of dead pine needles of large live pines) answer ""Yes."" For a complete definition of suitable summer habitat for the tricolored bat, please see Appendix A in the Service's Range-wide Indiana Bat and Northern long-eared Bat Survey Guidelines.

    Yes

33. Do you have any documents that you want to include with this submission?

    No

PROJECT QUESTIONNAIRE

IPAC USER CONTACT INFORMATION

Agency: Private Entity
Name: Jack Puleo
Address: 259 Academy Street
City: Newark
State: DE
Zip: 19716
Email jpuleo@udel.edu
Phone: 3023390343

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Army Corps of Engineers
Name: Jack Puleo
Email: jpuleo@udel.edu
Phone: 3023390343

STATE OF DELAWARE

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF CLIMATE, COASTAL AND ENERGY
818 KITTS HUMMOCK ROAD
DOVER, DELAWARE 19901

Delaware National Estuarine Research Reserve

PHONE
(302) 739-6377

December 23, 2024

Jules Bruck
University of Delaware
700 Pilottown Road
Lewes De, 19958

RE: National Estuarine Research Reserve Boundaries

Dear Dr. Bruck,

The Delaware National Estuarine Research Reserve (DNERR) boundaries encompass land in Dover Delaware, and Townsend Delaware. The DNERR is the only National Estuarine Research Reserve in Delaware. The land at the 700 Pilottown Road location in Lewes Delaware is not within the boundaries of a National Estuarine Research Reserve. The boundaries can be found online – in the DNERR management plan.

Please feel free to reach out with any additional questions.

Sincerely,

Rachael Phillos
Reserve Manager
Delaware National Estuarine Research Reserve
(302) 739-6377
Rachael.Phillos@delaware.gov

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF FISH & WILDLIFE
RICHARDSON & ROBBINS BUILDING
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

DIRECTOR'S OFFICE

PHONE
(302) 739-9910

January 27, 2025

Jack Puleo
University of Delaware
301 B DuPont Hall
Newark, DE 19716

Re: JPP 2025 UDel DEEDS Lewes Living Shoreline (335-4.00-13.01)

Dear Jack:

Thank you for contacting the Division of Fish and Wildlife (DFW) Species Conservation and Research Program about information on rare, threatened and endangered species, unique natural communities, and other significant natural resources as they relate to the above referenced project.

Nature Preserve
Nature Preserves are Natural Areas that have been formally dedicated under Delaware State Code, Title 7, Chapter 73. Each Nature Preserve is dedicated by means of Articles of Dedication that are legally binding, run with the land in perpetuity, and outline restrictions specific to that Nature Preserve. The Great Marsh Preserve is adjacent to this project site.

State Natural Areas involve areas of land or water, or of both land and water, whether in public or private ownership, which either retains or has reestablished its natural character (although it need not be undisturbed), or has unusual flora or fauna, or has biotic, geological, or archaeological features of scientific or educational value. State Natural Areas are depicted on maps maintained by the Department of Natural Resources and Environmental Control, Division of Parks and Recreation, Natural Areas Program, as approved by the Department Secretary upon recommendation by a Governor appointed Natural Areas Advisory Council. If you require further information about this area for your planning project, please contact Eileen Butler, Natural Areas Program Manager, at 302-739-9235.

Wetlands

Wetlands are perhaps Delaware's most significant natural feature, covering one-fourth of the state, with a total of approximately 320,000 acres. An estimated 47 percent of wetlands are located in Sussex County, 38 percent in Kent County, and 15 percent in New Castle County. Wetland habitats include a wide range of types – tidal, nontidal, freshwater, brackish, and saltwater, and include coastal wetland impoundments, vernal pools, Coastal Plain seasonal pond wetlands, peat wetlands, and Piedmont stream valley wetlands. Wetlands are found along the shores of the Delaware Bay and Inland Bays, along rivers, streams, and ponds, and in forests and fields throughout the state. Delaware is one of only 16 U.S. states with greater than 50% loss of wetlands. The majority of these were freshwater wetlands that were lost to ditching, stream channelization, conversion to ponds, and filling for development. Tidal wetlands were also lost to filling for development, shoreline hardening, conversion to impoundments, and ditching for mosquito control or agricultural drainage. Fortunately, wetland regulations at both the state and federal levels have greatly curtailed these losses in the last several decades. Tidal wetland losses have slowed dramatically, but protection of isolated freshwater wetlands remains insufficient.

Many wetlands in the state suffer from degradation caused by sedimentation, nutrient enrichment, and invasive plant species. These problems are exacerbated by insufficient natural buffers around many wetland blocks. Tidal wetlands, which constitute the great bulk of wetland blocks, are almost all threatened by sea level rise, especially given the lack of buffers to accommodate migration. Although there are no records of rare species or natural communities at this location, the cumulative impacts of projects such as this could lead to the long-term degradation of the marsh habitat through fragmentation and disturbance.

Wetland Buffer

Buffers are an integral component of aquatic and wetland habitats, reducing the amount of sediments, pollutants, and other non-point source material that may affect the function and integrity of habitat and the condition and survivability of aquatic organisms. Forested buffers serve as habitat for many terrestrial species that are dependent on aquatic and wetlands habitats for a portion of their annual life cycle.

In the interest of water quality and wildlife habitat, we recommend maintaining an upland buffer of at least 100 ft along rivers, streams and wetlands. This recommendation is based on peer reviewed research that suggests that buffer values increase noticeably with widths of 100 ft or more. This buffer should *not* be a maintained lawn area and should *not* contain lot lines or infrastructure. We recommend the buffer area be comprised of the existing vegetation or planted with Delaware native species of trees, shrubs, grasses or wildflowers.

Soil Disturbance and Phragmites

Soil disturbance within the project boundaries will likely result in the establishment of the non-native invasive grass – European reed (***Phragmites australis***), as well as other potentially invasive, non-native plant species. We recommend that, as a condition of the permit, the applicant revegetate the area using native plant species that are indigenous to the state of Delaware and are appropriate for the site. Our staff botanist, Bill McAvoy (William.mcavoy@delaware.gov) can provide guidance in selecting plant material. In addition, we also recommend that the applicant commit to a two-year monitoring and management plan

that would include the removal of non-native invasive plants and additional plantings of native species as necessary.

Tricolored Bat

A review of our database indicates that the tricolored bat (*Perimyotis subflavus*) may occur on or adjacent to the project site. Due to population declines largely caused by white-nose syndrome, a fungal disease known only to affect bats, this species is federally-listed as endangered under the U.S. Endangered Species Act (ESA). Section 7 consultation may be necessary. To determine the potential effect your project may have on the tricolored bat, visit the USFWS Information for Planning and Consultation (iPaC) tool to obtain an official species list and to use the final Range-wide Northern Long-eared Bat and Tricolored Bat Determination Key (Dkey).

Marsh Nesting Birds

Prior records indicate that the seaside sparrow (*Ammospiza maritimus*) and clapper rail (*Rallus longirostris*) nest in the low marsh habitat directly adjacent to the project area. Furthermore, such habitat may support other marsh nesting birds, such as the American oystercatcher (*Haematopus palliates*) and willet (*Tringa semipalmata*). We recommend a time of year restriction of **April 1st to July 31st** to avoid impacts to marsh nesting birds.

Fisheries

Fourspine Sickleback

A population of *Apeltes quadracus* (fourspine stickleback) is found within the Lewes-Rehoboth Canal. This species is dependent on calm, shallow, heavily vegetated waters for its habitat and for spawning. Measures should be taken to avoid impacts to submerged aquatic vegetation and to decrease downstream sedimentation during construction. ***If*** aquatic vegetation is prevalent in the project area, in-water work should not occur from **April 1st – May 30th** to minimize impacts to spawning activities.

American Eel

Previous scientific study documented larval ingress of eels at the Roosevelt Inlet. Therefore, **no** in-water work should occur from **March 1st - June 30th** to reduce the impact on this species.

Summer Flounder

Sampling conducted by our Division's fisheries staff revealed that Lewes-Rehoboth Canal supports a large number of juvenile migratory fish and is thus considered an important nursery area in the Inland Bays. Several species of particular commercial and recreational importance utilize the creek and could be impacted by this project. A primary species of concern for this project is Summer Flounder (*Paralichthys dentatus*) which utilize the canal as a nursery area. Although summer Flounder have been found in the Lewes-Rehoboth Canal, we have minimal concerns over young-of-the-year Summer Flounder being impacted by the in-water work involved with this project. The installation/construction does not involve dredging or pile driving and is planned to take place in a small area close to shore, over a short time period. If, for whatever reason, the scope or timeline of this project changes, the applicant should contact Fisheries at (302) 739-9914 for further guidance on the Summer Flounder TOYR.

Anadromous Species

Lewes-Rehobth Canal is utilized by American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), and striped bass (*Morone saxatilis*) for spawning, nursery, and adult habitats. Alewife and blueback herring, also known as 'river herring', are listed by the National Marine Fisheries Service as a Species of Concern. These species are important to both commercial and recreational fisheries and support a critical forage base for other fish, mammal, and bird species. The protection of spawning and nursery habitats and migratory corridors during the spawning season is important in maintaining these fisheries resources. We request a time of year restriction on in-water work activities from **March 15th – June 30th** to avoid impacts to these species during the spawning season.

Shellfish Harvest

After reviewing your proposed project. The placement of live oysters in the proposed area is in a prohibited shellfish harvest area. These oysters cannot be harvested for human consumption at any time. If you have more questions about those protocols, you can contact the Division of Watershed Stewardship's Shellfish Program at (302) 739-9939 and/or read the Shellfish Sanitation Regulations.

We are continually updating our records on Delaware's rare, threatened and endangered species, unique natural communities and other significant natural resources. If the start of the project is delayed more than a year past the date of this letter, please contact us again for the latest information.

Please feel free to contact me with any questions or if you require additional information.

Sincerely,

Matthew Young
Environmental Review Coordinator
Phone: (302) 735-8677
Email: matthew.young@delaware.gov
6180 Hay Point Landing Road
Smyrna, DE 19977

(See invoice on next page)

INVOICE - PAYMENT DUE

It is our policy to charge a fee for this environmental review service. This letter constitutes an invoice for $35.00 ($35.00/hour for a minimum of one hour). Please make your check payable to "Delaware Division of Fish and Wildlife" and submit to:

DE Division of Fish and Wildlife
97 Commerce Way, Suite 106
Dover, DE 19904
ATTN: DFW Fiscal

In order for us to properly process your payment, you must reference "JPP 2025 UDel DEEDS Lewes Living Shoreline**" on your check.**

cc: DFW Fiscal; Code to 72900

HCA
DELAWARE HISTORICAL & CULTURAL AFFAIRS

Delaware Division of Historical & Cultural Affairs
29 N. State St., Dover, Delaware 19901
Tel. (302) 736-7400 | Fax. (302) 739-5660
history.delaware.gov

February 3, 2025

Jack Puleo
Center for Applied Coastal Research
University of Delaware
301 DuPont Hall,
Newark, DE 19716

Subject: **Lewes Living Shoreline**
SHPO Project No. 2024.12.30.01

Dear Mr. Puleo:

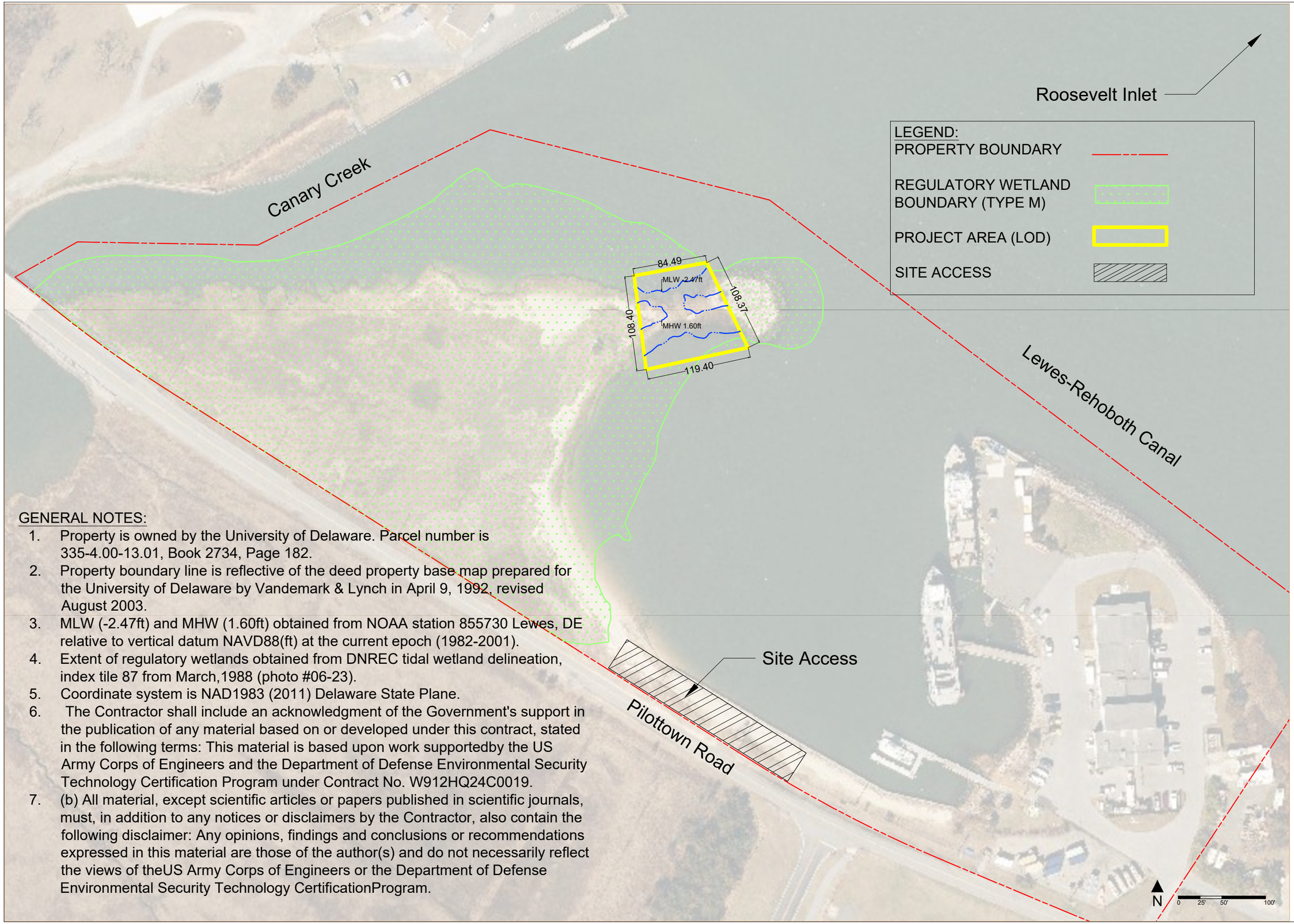
We understand from your letter that the University of Delaware, is receiving funds through the US Army Corps of Engineers (USACOE) Engineering Research and Development Center for the proposed undertaking at the boat basin at 700 Pilottown Road in Lewes. The applicant is proposing to install a mosaic living shoreline with oyster mats, shellfish mattresses, wave attenuation devices, and plantings. Because of the funding from the USACOE, the project is subject to compliance with Section 106 of the National Historic Preservation Act of 1966 (as amended).

There are no known archaeological sites or historic properties within the area of potential effect (APE). There are no known historic structures within a half-mile radius of the APE. Due to the limited nature of the proposed undertaking, there is no anticipated impact to above ground resources. There are three known archaeological sites within a half-mile radius of the APE. Due to the limited nature of the proposed undertaking and the distance to known archaeological sites, there is no anticipated impact to these properties. The APE has high potential for pre-Contact and early historic archaeological sites. However, historic maps and aerials show significant landform changes and there is low potential for intact archaeological sites. In addition, the proposed undertaking involves minimal ground disturbance and is unlikely to affect any intact archaeological sites.

Our Office finds there to be No Historic Properties Affected by the proposed undertaking. Please feel free to contact me if you have any questions at (302) 736-7431 or sarah.carr@delaware.gov.

Sincerely,

Sarah Carr, Archaeologist
Environmental Specialist
cc: Gwen Davis, Deputy SHPO



GENERAL NOTES:

1. Property is owned by the University of Delaware. Parcel number is 335-4.00-13.01, Book 2734, Page 182.
2. Property boundary line is reflective of the deed property base map prepared for the University of Delaware by Vandemark & Lynch in April 9, 1992, revised August 2003.
3. MLW (-2.47ft) and MHW (1.60ft) obtained from NOAA station 855730 Lewes, DE relative to vertical datum NAVD88(ft) at the current epoch (1982-2001).
4. Extent of regulatory wetlands obtained from DNREC tidal wetland delineation, index tile 87 from March,1988 (photo #06-23).
5. Coordinate system is NAD1983 (2011) Delaware State Plane.
6. The Contractor shall include an acknowledgment of the Government's support in the publication of any material based on or developed under this contract, stated in the following terms: This material is based upon work supportedby the US Army Corps of Engineers and the Department of Defense Environmental Security Technology Certification Program under Contract No. W912HQ24C0019.
7. (b) All material, except scientific articles or papers published in scientific journals, must, in addition to any notices or disclaimers by the Contractor, also contain the following disclaimer: Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of theUS Army Corps of Engineers or the Department of Defense Environmental Security Technology CertificationProgram.

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700 Pilottown Road, Lewes, Delaware 19958

Project Team:
DEEDS

SITE LOCATION NOTES

Prepared by: LM

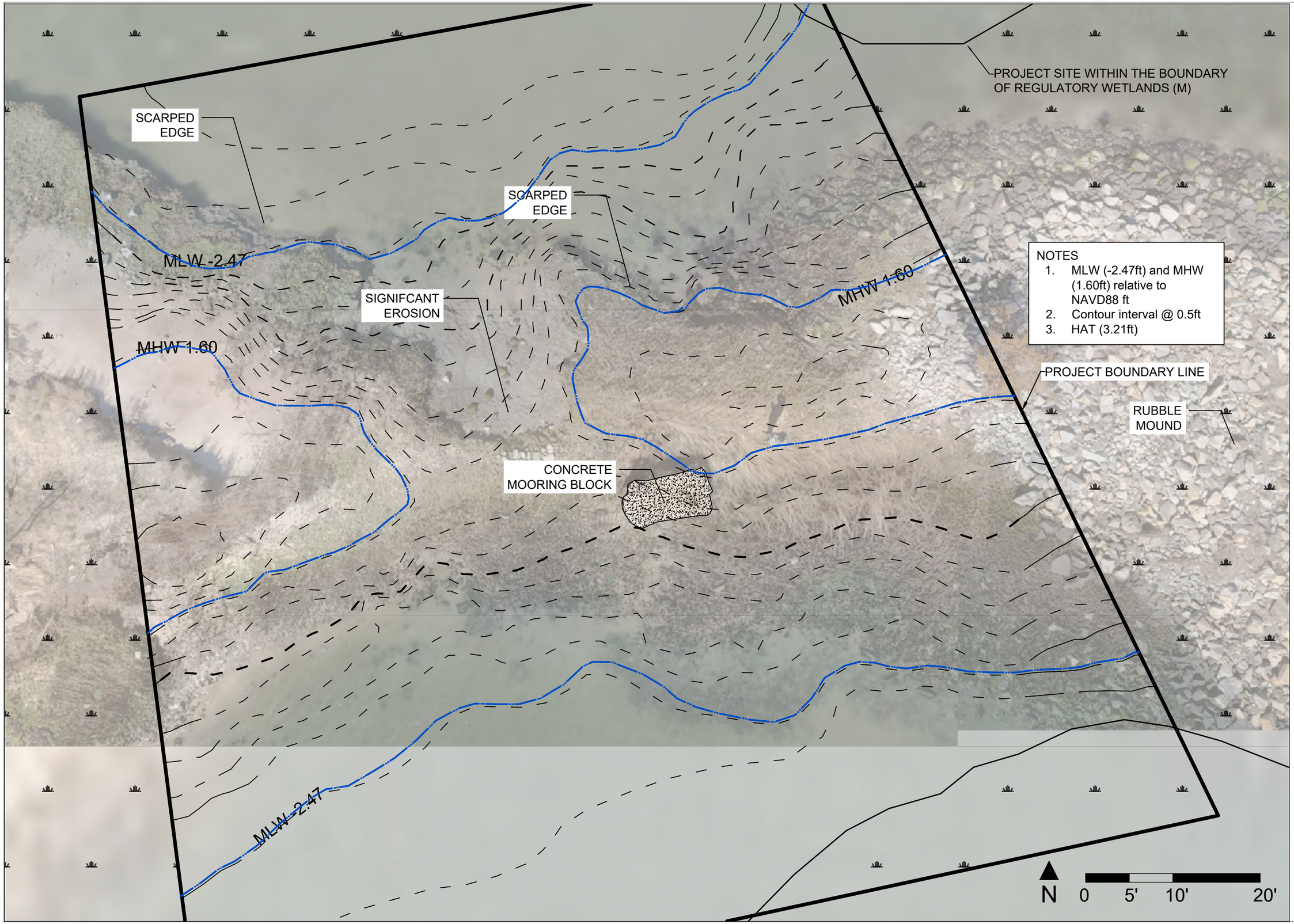
Date: 10/20/2024

Scale 1"= 100'

Sheet: 1 of 6

Sheet Title:

L - 01



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EXISTING CONDITIONS PLAN

Prepared by: LM

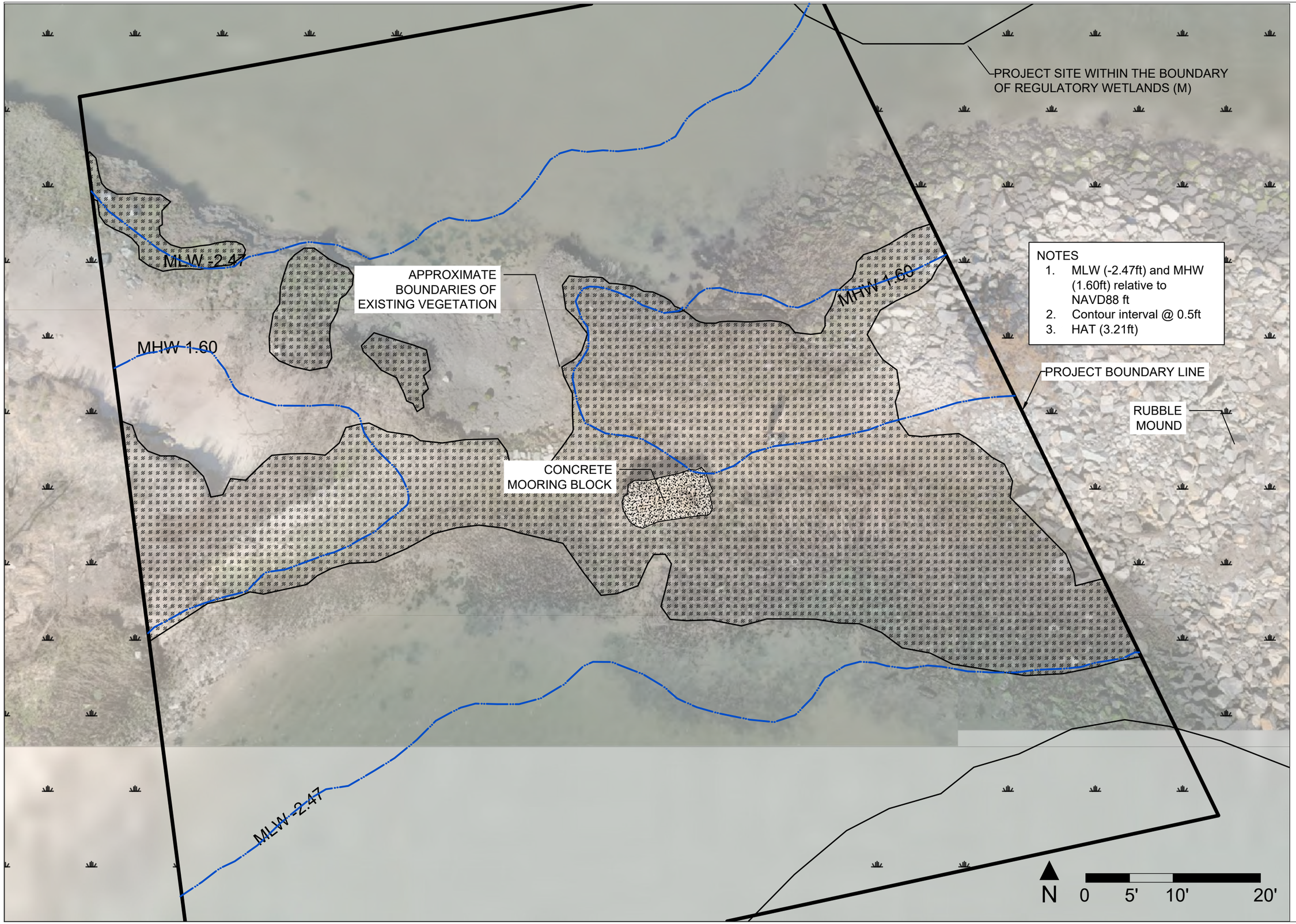
Date: 12/10/2024

Scale 1"= 10'

Sheet: 2 of 6

Sheet Title:

L - 02



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EXISTING VEGETATION

Prepared by: LM

Date: 12/10/2024

Scale 1"= 10'

Sheet: 3 of 6

Sheet Title:

L - 03

01. REEF BALL HABITAT SILL USING CONCRETE BAY BALL (32), MINI-BAY BALL (12), LO-PRO BALL (OYSTER(12) BALLS (67 TOTAL UNITS)~300SQFT

02. JUTE ROPE WRAPPED OYSTER SHELL MATTRESS ~

03. JUTE NET WRAPPED MIXED SHELL MATTRESS

04. SINGLE ROW OF SHELL BAGS STAKED AT BACK OF MATTRESS TREATMENT LINE

PROJECT BOUNDARY LINE

MLW 2.47

MHW 1.60

APPROXIMATE BOUNDARY LINE EXISTING VEGETATION

05. BESE ELEMENTS BIOPOLYMER PLANTED (TYP.)

06. BESE ELEMENTS BIOPOLYMER OYSTER MAT (TYP.)

07. STAKED ROPE TEST PLOT (TYP.)

MHW 1.60

MLW 2.47

N 0 5' 10' 20'

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SITE LAYOUT PLAN

Prepared by: LM

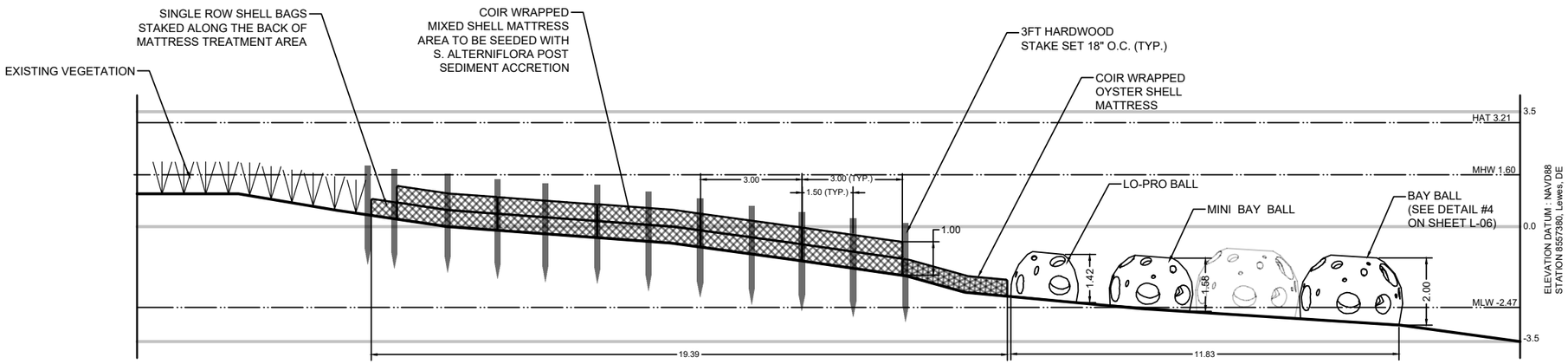
Date: 12/10/2024

Scale 1"= 10'

Sheet: 4 of 6

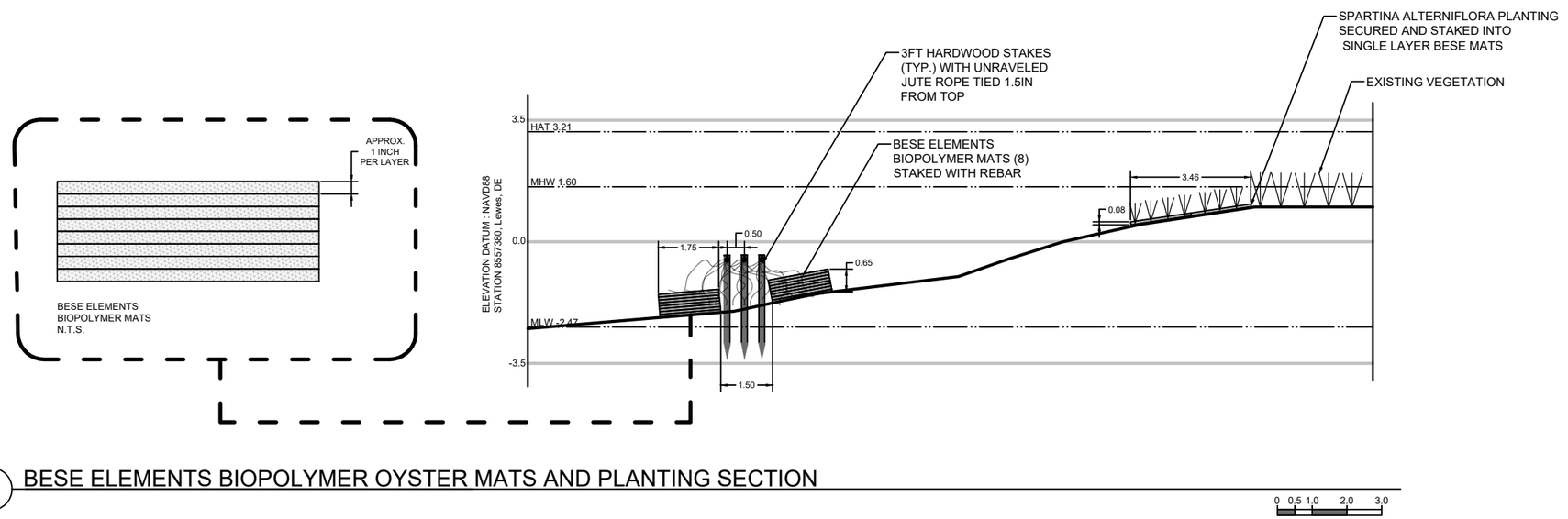
Sheet Title:

L - 04



1 SHELL MATTRESS TREATMENT AND WAVE ATTENUATION REEF BALL SECTION

0 0.5 1.0 2.0 3.0



2 BESE ELEMENTS BIOPOLYMER OYSTER MATS AND PLANTING SECTION

0 0.5 1.0 2.0 3.0

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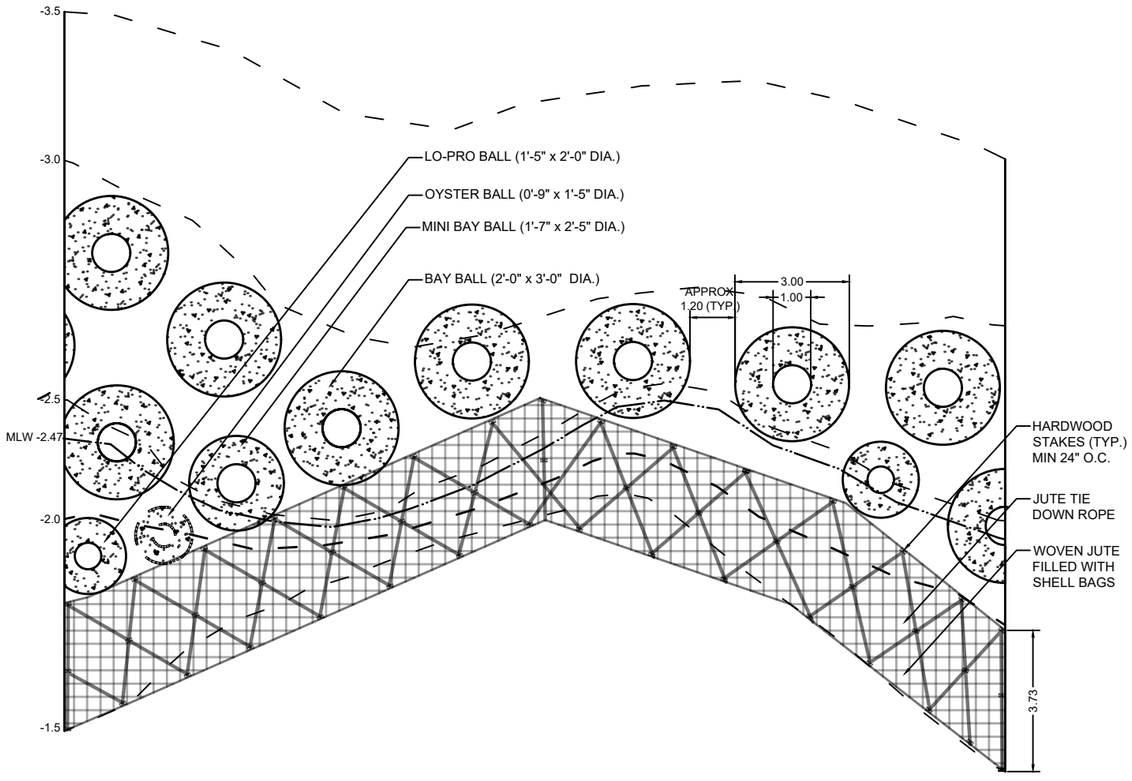
SECTION

Prepared by: LM
Date: 10/20/2024
Scale: 3" = 1'-0"
Sheet: 5 of 6
Sheet Title:

L - 05

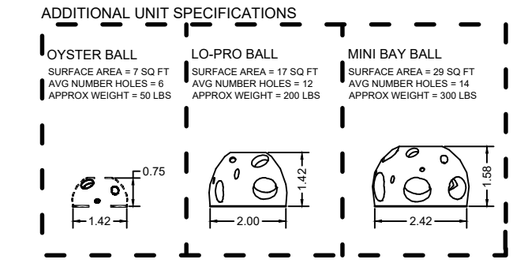


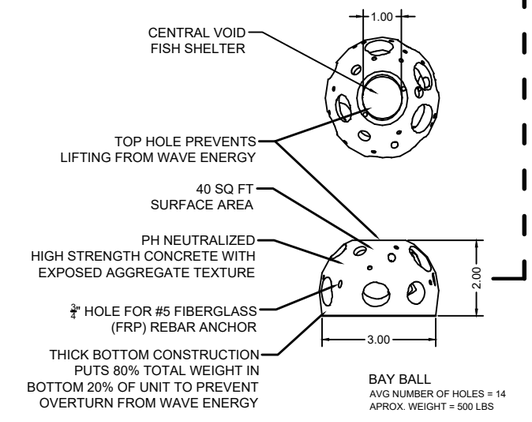
3 SHELL MATTRESS & WAVE ATTENUATION SILL HABITAT LAYOUT PLAN

0 0.5 1.0 2.0 3.0

ADDITIONAL UNIT SPECIFICATIONS

OYSTER BALL	LO-PRO BALL	MINI BAY BALL
SURFACE AREA = 7 SQ FT	SURFACE AREA = 17 SQ FT	SURFACE AREA = 29 SQ FT
AVG NUMBER HOLES = 6	AVG NUMBER HOLES = 12	AVG NUMBER HOLES = 14
APPROX WEIGHT = 50 LBS	APPROX WEIGHT = 200 LBS	APPROX WEIGHT = 300 LBS





BAY BALL
AVG NUMBER OF HOLES = 14
APROX. WEIGHT = 500 LBS

4 WAVE ATTENUATION SILL HABITAT BAY BALL DETAIL

0 0.5 1.0 2.0 3.0

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REEF BALL DETAILS

Prepared by: LM

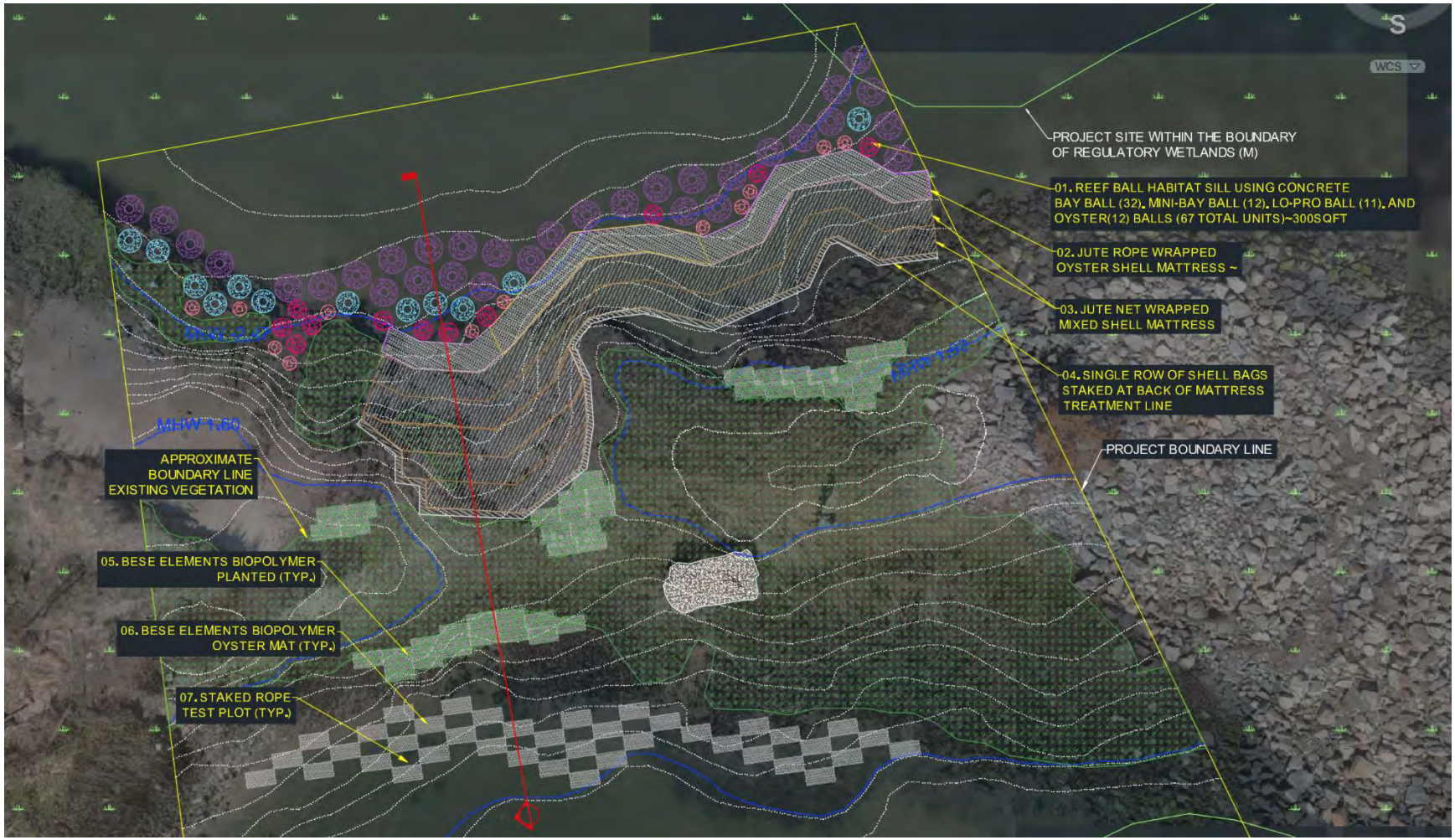
Date: 12/09/2024

Scale: 3"=1'-0'

Sheet: 6 of 6

Sheet Title:

L - 06


PROJECT SITE WITHIN THE BOUNDARY OF REGULATORY WETLANDS (M)
01. REEF BALL HABITAT SILL USING CONCRETE BAY BALL (32), MINI-BAY BALL (12), LO-PRO BALL (11), AND OYSTER(12) BALLS (67 TOTAL UNITS)~300SQFT
02. JUTE ROPE WRAPPED OYSTER SHELL MATTRESS ~
03. JUTE NET WRAPPED MIXED SHELL MATTRESS
04. SINGLE ROW OF SHELL BAGS STAKED AT BACK OF MATTRESS TREATMENT LINE
PROJECT BOUNDARY LINE
APPROXIMATE BOUNDARY LINE EXISTING VEGETATION
05. BESE ELEMENTS BIOPOLYMER PLANTED (TYP.)
06. BESE ELEMENTS BIOPOLYMER OYSTER MAT (TYP.)
07. STAKED ROPE TEST PLOT (TYP.)
MHW 1.80
MHW 1.80
WCS

Proposed Structure	ID No. on Plans	Dimensions channelward of MHWL (width x length)	Area (sq. ft.) channelward of MHWL	Volume (cubic yards) channelward of MHWL	Dimensions channelward of MLWL (width x length)	Area (sq. ft.) channelward of MLWL	Volume (cubic yards) channelward of MLWL
Reef Balls	01	5’ x 5’ 10’ x 3’ 12’ x 3’ 8’ x 12’	187 SQFT	7 CY	7’ x 92’	644 SQFT	36 CY
Shellfish Mattresses Jute Rope & Oyster Shells in Oyster Bags	02	3’ x 68’	204 SQFT	7.5 CY	8’ x 1’	8 SQFT	.3 CY
Shellfish Mattresses Jute Rope & Oyster & Mussel Shells in Oyster Bags	03	10’ x 63’	630 SQFT	23CY	0	0	0
Shell Bags	04	1’ x 74’	74 SQFT	2.7 CY	0	0	0
BESE-ELEMENTS with *Spartina alterniflora*	05	5’ x 74’	370 SQFT	14 CY	0	0	0
BESE-ELEMENTS with shells	06	3’ x 25’ 9’ x 10’	165 SQFT	6 CY	0	0	0

Management Triggers in Areas of Concern

Category of Concern	Monitoring Methods	Management Trigger	Expected Timeframe for Decision-Making	Potential Management Action
Plastic oyster bags	Visual inspection	Torn, ripped, large displacement	6-12 months	Replace bags
Non-plastic oyster bags	Visual inspection	Torn, ripped, biodegraded, large displacement	6-12 months	Replace non-plastic bags with plastic bags
Habitat sills	Visual and GPS surveying	Sills have toppled over	6-12 months	Right sills and attempt to stake through middle using oak and sill cap
Shellfish (i.e., oyster and ribbed mussel) recruitment	Evaluate recruitment to installed bags of recycled oyster shell on an annual and seasonal basis	Low/no recruitment of oysters or ribbed mussels at any given site; inability for shellbags to remain accessible by field staff after recruitment season and/or overwintering	Minimum one recruitment period (June-October)	Limitation and/or expansion of consideration of future installations that would potentially target shellfish recruitment
Plantings	Plant density	Plant density increases, or decreases	Minimum one growing period	Increase in plant density indicates approach is sufficient, return to plant more (increase density) Decrease in plant density indicates approach was insufficient. Use BESE elements seeded with shells to protect area

				instead
Oyster mattresses	Visual inspection	Jute insufficient to hold oyster shell in place, jute material deteriorates or tears	6-12 months	Replace jute with BESE elements or overtop with oyster bags
BESE elements	Visual inspection	Elements do not maintain position	6-12 months	Replace rebar staking with oak staking

BESE
ECOSYSTEM RESTORATION PRODUCTS

INNOVATING BIODEGRADABLE PRODUCTS, A CHALLENGING AND FAST-MOVING SCIENCE!

BESE aims to restore nature by using only biodegradable products. To ultimately leave only the natural system behind. Our goal: restored ecosystems and no pollution.

- How do we do this?
- What materials do we use?
- What is biodegradation?
- Answers to some frequently asked questions!

Biodegradability

What do we mean with biodegradability exactly? What is the expected time to fully degrade?

Biodegradability is a complex phenomenon when you think about it. Let us give you an example: place a wooden table on a forest floor, out in the rain, and it will rot away in a couple of years. However, the same wooden table may sit in a castle for 1000 years and still be strong. There is the complexity of biodegradability.

The rate of biodegradation strongly depends on environmental conditions.

Some of our products degrade faster than others. We always provide our best estimate based on field experience in our product sheets. All of our products have the following in common: they can either dissolve over time into naturally occurring ingredients or can ultimately be digested by microorganisms and broken down to carbon and water.

Please note that for some of our products full degradation may take one to several decades. Other products will go in months.

Certification

What certification is applicable to our products? Are the products compostable? Do the products contain harmful substances?

The compounds in our products have an OK compost industrial certificate/statement. This means that with certain temperatures, in a composting installation, the material will be eaten by microorganisms within six months and turned into natural harmless molecules. However, the required temperature for this type of biodegradation is generally much higher than you'll find in the natural world. Therefore, degradation in the real world will typically be slower.

In the certification we find proof that microorganisms can eat our products given certain environmental conditions. Additional to that, field tests are performed by scientists to show the actual process of degradation in field settings (Nitsch et al, 2021).

More specific information about biodegradability and non-toxicity is stated in a biodegradablily statement of the compounds that we use. This can be provided upon request.

Back to the future

So, are you done developing?

No! The R&D team are busy as ever.

Many people in this line of work for example know PHAs – a group of biopolymers produced by bacteria. Arguably the best marine-degradable biopolymers from which you could engineer some of the products that we use. To date, it is difficult to buy large enough quantities of good and stable quality PHA. And the PHA available isn't a waste product, while the use of waste products is such an important aspect of the BESE philosophy. This means we can't make PHA-based products yet.

Fortunately, innovations are moving quickly. Multiple scientists are now successfully making PHA from sewage waste (e.g. www.phario.eu). A true circular approach that we would LOVE to use in our products. This circulair PHA production is still experimentally and at small scale, but we are connected, investing and collaborating. It's a matter of a few years until we will be able to make circular PHA-based BESE-products.

Considerations

Do you recommend using biodegradable products in all types of regions, systems and conditions?

For all of our products it is not a one size fits all: you should apply them correctly and with sense. In warmer climates, degradation goes faster. For instance, if you are restoring mangroves, you may need years of support from a structure. A fast degrading material will not be the right solution there, it will simply weaken too fast. BESE-elements type 1 may offer the best solution. As a 1st rule of thumb: the lifespan of the BESE-product used should be long enough to allow ecosystem establishment, while being short enough to have fully degraded before the restored ecosystem may degrade again as part of its long-term ecosystem dynamics.

A second consideration is knowledge of the site conditions. BESE-elements are applicable in intermediate hydrodynamic conditions. They will reduce currents and waves to some extent but are not suitable for coasts that suffer from constant high wave energy. So make sure you know your site and manage the risk of storm damage and washing up to the beach adequately. As a 2nd rule of thumb: always start with a small pilot to see what happens during a year. If the BESE does not suffer, then try going larger. And if it fails before ecosystem establishment occurs, than clean up, despite it being a biodegradable product.

What happens if pieces of the product end up in the environment?

The material is heavier than water and won't float. There is some scientific evidence that they are not harmful to plankton life (Vasilakis, 2017). Finally, the certification shows that the materials are neither toxic nor otherwise chemically polluting. *But hey, let's do our best not to pollute the environment anyway!*

Wrapping up

Providing you with the current knowledge of biodegradable materials, should enable you to sensibly apply BESE-products, and of course we will be glad to help you with that.

We strive to use the best available materials and techniques. We adapt to changing scientific insights and improve continuously, to keep up with a fast-moving science. You can contact us any time for the latest updates and developments.

Do you think we can do better?

Please contact us and help us along! We are always open to improvement. Collaborations are key to speeding up knowledge for large scale ecosystem restoration techniques!

This Q&A and R&D are a produced by BESE in close collaboration with our partners from NIOZ, Rodenburg Biopolymers, ENEXIO Water Technologies and Technical University of Delft.

References

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BIODEGRADABILITY

Solanyl® C1104M (SP10247)

Document type – Biodegradability status

Solanyl® grades are biodegradable granulate based on renewable resources.

RODENBURG Biopolymers

Version 01 / Date 21-02-2014

NOTE

This information is believed to be accurate & refers to the laws, regulations & products at the date of issue. However, Rodenburg Biopolymers makes no express or implied representations or warranties with respect to the information contained herein. It is the responsibility of our customers to determine that their use of products is safe, lawful, & technically suitable for their applications. Because of possible changes in the laws & regulations, we cannot guarantee that the status of the products will remain unchanged.
For general product & processing information, please refer to our specialists. Our technical services department is available to discuss your requirements and advise on selection of products.

MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheets (MSDS) are available for all grades of resin products which Rodenburg Biopolymers produces. MSDS are provided to help customers satisfy their own handling, safety and disposal needs, and those that may be required by locally applicable health and safety regulations, such as OSHA (U.S.A) OR MAK (Germany).

CHEMICAL CONTROL LAW COMPLIANCE

Across the globe regulations exist for local environmental authorities to evaluate materials to assure the protection of human health & the environment from any un-reasonable risks associated with chemical substances. Components used in Rodenburg Biopolymers' resins as supplied from the factory gate comply with the EU EINECS-REACH chemical inventory. REACH is a regulation, adopted to improve the protection of human health & the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the chemicals industry.

NON-GMO (Genetically Modified Organisms)

Rodenburg Biopolymers, to the best of our knowledge, only uses components for the production of our Solanyl®, Optinyl® and FlourPlast® product range that are not coming from GMO plants.

OTHER PRODUCT INFORMATION

Various Solanyl® C grades like C1201, C2201, C8101 and C2101 are certified according Vinçotte OK Biobased.

STATUS SOLANYL® C1104M & C1102M GRADES

We confirm that **Solanyl® grades C1104M & C1102M** comply with a number of standards and regulations describing biodegradability around the globe and is as such a priori suitable for various biodegradable applications. As supplied from our factory, the product and as such the components used in the mentioned grades comply with various requirements related to biodegradability.

The most relevant criteria for biodegradability are described according to the European norm EN 13432 (2000) "Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging", the American standard ASTM D 6400-04 "Standard Specification for Compostable Plastics" and the international standard ISO 17088 (2008) "Specifications for compostable plastics".

Based on results from various compostability tests performed on Solanyl grades as laid down by OWS (Organic waste Systems in Ghent) in reports THRO-2 and THRO-3 it can be concluded that various aspects of EN 13432 are covered. More in particular, heavy metals, biodegradation and ecotoxicity are covering the requirements and do not need to be tested.

The grades C1104M and C1102M are based on a mix consisting of biodegradable components used in Solanyl's C1201, C2202, C8201, C1101, C2101 and C8101, which are certified according Vincotte OK Compost.

CERTIFICATES SOLANYL® C GRADES

Solanyl® C1201, C2201, C8201, C1101, C2101 and C8101 are certified according to EN13432 (industrial composting) Vinçotte OK Compost and has as such, presuming appropriate processing, potential to be used in industrial composting facilities. Other Solanyl® C grades comply with EN13432 (Aerobic biodegradability, ecotoxicity and environmental safety & heavy metal content). Various new certifications are set in place or pending.

Solanyl® C1201 and C2201 are certified by KIWA K77694 according to regulation BRL-K567.

Specifications for Reduced pH Reef Ball Concrete

Power Search **Searches all Reef Ball related web sites.**

The Reef Ball Foundation, working closely with concrete experts, has developed a typical mix design suitable to create artificial reef modules in complex molds with a minimal pH and to enhance the settlement and growth of typical marine species such as hard corals. Specific biological goals, such as oyster settlement, may require specialized designs. If you can not find local materials to match these specifications because of admixture or cement type availability, there are several acceptable substitutions, contact us for information. In general, this starting mix design has the highest amount of Portland Cement to help insure that you don't break your Reef Balls when handling them. However, Reef Ball usually don't need this much Portland cement when handled carefully, and there are additional biological benefits of using less cement because this can further reduce concrete pH. If you are reaching your goal of 95% or better of your modules not being broken you might consider reducing your cement proportions. Remember that best concrete practices are required for good pH neutralization; primarily the use of fresh cement, complete mixing, and good curing conditions (high humidity for at least 30 days)....without good practices all the microsilica in the world won't prevent a high pH.

Contact us if you have any questions about your mix design, to obtain approval for deviations or if you need a custom design for a specific project.

PART I - GENERAL

1.01 Section Includes

A. Concrete proportioning and products to be used to secure concrete, which when hardened will produce a required strength, permeability, and resistance to weathering in a reef environment.

1.04 References

A. ACI-211.191-Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
B. ASTM C 260- Standard Specifications for Air-Entraining Admixtures for Concrete.
C. ASTM-C 1116 Type III- Standard Specifications for Fiber Reinforced Concrete or Shotcrete.
D. ACI - 305R -91- Hot Weather Concreting.
E. ACI - 306R -88- Cold Weather Concreting.
F. ACI - 308- Standard Practice for Curing Concrete.
G. ASTM C 618-Fly Ash For Use As A Mineral Admixture in Portland Cement Concrete.
H. ASTM C 494-92- Standard Specifications for Chemical Admixtures for Concrete.
I. ASTM C 1202-91- Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
J. ASTM C 33- Concrete Aggregates.
K. ASTM C 94- Ready Mix Concrete.
L. ASTM C 150-Portland Cement.
M. ACI 304- Recommended Practice For Measuring, Mixing, Transporting and Placing concrete.
N. ASTM C 39 (Standard Specifications For Compressive Testing)
O. ASTM C-1240-93 (Standard Specifications for Silica Fume Concrete)

PART II PRODUCTS

2.01 Portland Cement: Shall be Type II and conform to ASTM C-150

2.02 Fly Ash: Shall meet requirements of ASTM C-618, Type F. And must be proven to be non-toxic as defined by the Army Corps of Engineers General Artificial Reef Permits. Fly Ash is not permitted in the State of Georgia and in most Atlantic States. (In October, 1991, The Atlantic States Marine Fisheries Commission adopted a resolution that opposes the use of fly ash in artificial reefs other than for experimental applications until the Army Corps of Engineers develop and adopt guidelines and standards for use.)

2.03 Water: Shall be potable and free from deleterious substances and shall not contain more that 1000 parts per million of chlorides or sulfates and shall not contain more than 5 parts per million of lead, copper or zinc salts and shall not contain more than 10 parts per million of phosphates.

2.04 Fine Aggregate: Shall be in compliance with ASTM C-33.

2.05 Coarse Aggregate: Shall be in compliance with ASTM C-33 #8 (pea gravel). (Up to 1 inch aggregate can be substituted with permission from the mold user.) Limestone aggregate is preferred if the finished modules are to be used in tropical waters.

2.06 Concrete Admixtures: Shall be in compliance with ASTM C-494.

2.07 Required Additives: The following additives shall be used in all concrete mix designs when producing the Reef Ball Development Group's product line:

A. High Range Water Reducer: Shall be ADVA Flow 120 or 140.

B. Silica Fume: Shall be Force 10,000 Densified in Concrete Ready Bags as manf. by W.R. Grace. (ASTM C-1240-93) or any of the permitted equivalent silica fume Brands as defined in the training manual Appendix K

C. Air-Entrainer: ONLY IF ADVA is not used: Shall be Darex II as manf. by W.R. Grace (ASTM C-260)

2.08 Optional Additives: The following additives may be used in concrete mix designs when producing Reef Ball Development's product line.

A. Fibers. Shall be either Microfibers as manf. by W.R. Grace, or Fibermesh Fibers (1 1/2 inches or longer) as manf. by Fibermesh. EitherNovember 1, 2007ators: Any Non- Calcium Chloride or Daracell as manf. by W.R. Grace may be used. (ASTM C-494 Type C or E)

C. Retarders: Shall be in compliance with ASTM-C-494-Type D as in Daratard 17 manf. by W.R. Grace

2.09 Prohibited Admixtures: All other admixtures are prohibited. Other admixtures can be submitted for approval by the Reef Ball Foundation Inc. Services Division by sending enough sample to produce five yards of concrete, the current MSDS, and chemical composition (which will be kept confidential by RBDG Ltd.) A testing fee of $2,500 must accompany the sample. Temporary approval will be granted or denied within 10 days based on chemical composition, but final approval may take up to 3 months since samples must be introduced in a controlled aquarium environment to assess impacts on marine and freshwater species.

PART III Concrete Proportioning:

A. General: The intent of the following proportions is to secure concrete of homogeneous structure which will have required strength and resistance to weathering.

B. Proportions:

	One Cubic Yard	**One Cubic Meter**
Cement:	600 lbs. (Min.)	356 kg
Aggregate:	1800 lbs.	1068 kg
Sand:	1160 lbs	688 kg

Water:	240 1bs. (Max.)	142 kg
Force 10K:	50 lbs	30 kg
Grace Microfibers	.25 bag	.3 bag
*Adva Flow 120 or Adva Flow 140	3.5-5 ounces per 100 lbs cement or 6-10 ounces per 100 lbs cement	1

*NOTE: Adjust Adva dosage as needed to obtain workable, placeable mix (170-250mm / 7-10 inch slump), and to achieve .40 w/c ratio.

Fibers: 0-3# (Max.) as needed to reduce micro cracking 1# (Min.) required if Silica Fume exceeds 50#

Accelerator: As needed to achieve de-molding no sooner than: 3-4 hours for heavy duty molds (All Polyform side balls) 6-7 hours for standard molds (Molds with any tether balls)

NOTE: Silica Fume or Force 10K shall be dosed at a 10# minimum in Bay Balls and Pallet Balls while Ultra & Reef Balls shall require a minimum of 25#. All molds must use at least 50# for floating deployments. All mold sizes must use at least 50# for use in tropical waters unless special curing procedures are followed.* This product is being specified not only for strength, but also to reduce pH to spur coral growth, to reduce calcium hydroxide, and to increase sulfate resistance. It is a non-toxic pozzalan.

* Special curing procedures for tropical waters without 50# of Silica Fume per yard should include storage in a fresh water or high humidity environment for a minimum of 60 days or less with higher temperatures, or until the surface pH of the modules is below 9.5 pH when placed in seawater.

NOTE: End of day concrete may be used, but follow these additional requirements.

-Do not use concrete that has a temperature of over 100 degrees Fahrenheit -The original mix must have been at least 3,500 PSI -50# of added microsilica or more is required unless microsilica at that dose was already in the starting mix -Add additional Portland if needed to achieve a .4 w/c ratio. Take into account water added on site -Advise mold user to allow extra time for curing to achieve minimum de-molding strength. -Mold or module user must be notified that EOD waste was used.

NOTE: Fly Ash, when permitted, may be used as a substitution for cement up to a maximum replacement of 15% and as an additional substitute for microsilica at 30% to 40% of cementitious material. (Call RBDG for details.)

Part IV Concrete Testing Requirements:

A. Compressive strengths shall be tested in accordance with ASTM C 39. Compressive strengths shall reach a minimum of the following table at the time of use of at least:

	Super/Ultra/Reef Ball	**Pallet Ball**	**Bay Ball and all smaller sizes**
Floating Deployment	8,500+	7,000+	6,000+
Barge Deployment	7,000+	5,500+	4,000+

To remove from mold	750+	750+	750+
To lift from base	1,500+	1,200+	1,000+

B. Permeability of concrete shall be tested in accordance with ASTM C 1202-91. Coulomb requirement shall be 2500 coulombs or less at 90 days. End of day waste shall be 3000 coulombs or less at 90 days.

THIS SPECIFICATION SHEET IS ONLY A SAMPLE. CONTACT RBDG FOR CUSTOM SPECIFICATIONS.

Minimum Standards for Reef Ball Foundation Authorized Contractors

1) All deployments made by authorized contractors must have at least 90% of modules upright and intact or they must supply free deployed replacement to purchaser. This is REGARDLESS of what the customer says is acceptable.

2) All new construction after Jan. 1, 1998 must use ADVA Flow superplastisizer rather than WRD-19, Reduce the amount of air entrainment by 35-50% so that entrainment remains at 6% +/- 2%. (This will not impact your costs).

2a) All new construction after July 2002 must have Attachment Adapter Plug system installed and at least 50% of the recommended number of attachment adapters for the particular sized Reef Ball must be usable.

3) All Reef Balls must be constructed with a "wavy" bottom formed by adding sand in the mold before inserting center bladder.

4) The rinsing of the outside layer of concrete is not optional to expose the surface texture due to the pH rise on the surface of the poorly set concrete. (If rinsing is impractical, use a non-oil based biodegradable mold-releasing compound instead of sugar water. Increase air entrainment to 8% and do not tap the concrete into the mold heavily to create as much "honeycombing" as you can.)

5) The following are **MINIMUM** guidelines for microsilica use, primarily for pH reduction. Again, these are **REGARDLESS** of what the customer says is acceptable.

Hard Corralled Waters (Florida border & south on East Coast, Hernando County and south on Gulf.) (Anywhere near the Flower Gardens of Texas, anywhere near Grey's Reef in SC)

Deployed less than 45 days from casting = 50 lbs/yard
Deployed > 45 days < 90 days from casting = 45 lbs/yard
Deployed > 91 days < 120 days from casting = 40 lbs/yard
Deployed > 121 days < 150 days from casting = 35 lbs/yard
Deployed > 151 days < 180 days from casting = 30 lbs/yard
Deployed > 181 days < 210 days from casting = 25 lbs/yard
Deployed > 211 days < 240 days from casting = 20 lbs/yard
Deployed > 240 from casting = 15 lbs/yard

Temperate / Cool Waters (North of above & all of West Coast)

Deployed less than 29 days from casting = 50 lbs/yard
Deployed > 30 days < 90 days from casting = 30 lbs/yard
Deployed > 91 days < 120 days from casting = 25 lbs/yard
Deployed > 121 days < 150 days from casting = 20 lbs/yard
Deployed > 151 days < 180 days from casting = 15 lbs/yard
Deployed > 181 days < 210 days from casting = 10 lbs/yard
Deployed > 211 days < 240 days from casting = 5 lbs/yard
Deployed > 240 from casting = not required

6) End of day waste still requires full 50 lbs/yard of Mircosilica regardless of location/time

7) All other proprietary standards, including an approved mix design must be upheld.

FIbermess Product Guide Specifications

SI Concrete Systems
4019 Industry Drive
Chattanooga, Tennessee 37416
Toll Free (800) 621-1273
Phone (423) 892-8080
Fax (423) 892-0157
Website www.siconcretesystems.com
E-mail fibermesh@sind.com

Specifier Notes: This product guide specification is written according to the Construction Specifications Institute (CSI) 3-Part Format as described in *The Project Resource Manual—CSI Manual of Practice.* The section must be carefully reviewed and edited by the Architect or Engineer to meet the requirements of the project and local building code. Coordinate this section with other specification sections and the Drawings. Delete all "Specifier Notes" when editing this section.

Section numbers are from *MasterFormat* 1995 Edition, with numbers from *MasterFormat* 2004 Edition in parentheses. Delete version not required.

SECTION 03240 (03 24 00)

SYNTHETIC FIBER REINFORCEMENT

Specifier Notes: This section covers SI Concrete Systems Fibermesh® 150 polypropylene fibers for use as concrete secondary reinforcement. Consult SI Concrete Systems for assistance in editing this section for the specific application.

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Polypropylene fibers used as concrete secondary reinforcement.

1.2 RELATED SECTIONS

Specifier Notes: Edit the following list of related sections as required for the project. List other sections with work directly related to this section.

A. Section 02750 (32 13 00) - Rigid Paving.

B. Section 03210 (03 21 00) - Reinforcing Steel.

C. Section 03300 (03 30 00) - Cast-in-Place Concrete.

D. Section 03370 (03 37 13) - Shotcrete.

E. Section 03500 (03 50 00) - Cementitious Decks and Toppings.

1.3 REFERENCES

Specifier Notes: List standards referenced in this section, complete with designations and titles. This article does not require compliance with standards, but is merely a listing of those used.

A. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

B. ASTM C 1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.

C. Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662-1.

D. UL Report File No. R8534-11.

1.4 SUBMITTALS

A. Comply with Section 01330 (01 33 00) - Submittal Procedures.

B. Product Data: Submit manufacturer's product data, including application rate and mixing instructions.

Specifier Notes: Delete samples if not required.

C. Samples: Submit manufacturer's sample of synthetic fiber reinforcement.

D. Manufacturer's Certification:
1. Submit manufacturer's certification that synthetic fiber reinforcement complies with specified requirements.
2. Submit evidence of manufacturer's ISO 9001:2000 certification.
3. Submit evidence of satisfactory performance history of synthetic fiber reinforcement.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
1. Synthetic fiber reinforcement manufactured in ISO 9001:2000 certified facility.
2. Minimum 10-year satisfactory performance history of specified synthetic fiber reinforcement.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver synthetic fiber reinforcement in manufacturer's original, unopened, undamaged containers and packaging, with labels clearly identifying product name, unique identification number, code approvals, directions for use, manufacturer, and weight of fibers.

B. Storage:
1. Store synthetic fiber reinforcement in clean, dry area indoors in accordance with manufacturer's instructions.
2. Keep packaging sealed until ready for use.

C. Handling: Protect synthetic fiber reinforcement during handling to prevent contamination.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. SI Concrete Systems, 4019 Industry Drive, Chattanooga, Tennessee 37416. Toll Free (800) 621-1273. Phone (423) 892-8080. Fax (423) 892-0157. Website www.siconcretesystems.com. E-mail fibermesh@sind.com.

2.2 SYNTHETIC FIBER REINFORCEMENT

A. Synthetic Fiber Reinforcement: Fibermesh 150.
1. Material: 100 percent virgin homopolymer polypropylene multifilament fibers, containing no reprocessed olefin materials.
2. Conformance: ASTM C 1116, Type III.
3. Fire Classifications:
a. UL Report File No. R8534-11.
b. Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662-1.

Specifier Notes: Specify graded or single-cut lengths.

4. Fiber Length: [Graded] [Single-cut lengths].
5. Alkali Resistance: Alkali proof.
6. Absorption: Nil.
7. Specific Gravity: 0.91.
8. Melt Point: 324 degrees F (162 degrees C).

PART 3 EXECUTION

3.1 MIXING

A. Add synthetic fiber reinforcement to concrete mixture in accordance with manufacturer's instructions.

B. Add synthetic fiber reinforcement into concrete mixer before, during, or after batching other concrete materials.

Specifier Notes: Lower application rates may be acceptable depending upon local building codes. Consult SI Concrete Systems for more information.

C. Application Rate: Add synthetic fiber reinforcement at standard application rate of 1.5 pounds per cubic yard (0.90 kg/m3) of concrete.

D. Mix synthetic fiber reinforcement in concrete mixer in accordance with mixing time and speed of ASTM C 94 to ensure uniform distribution and random orientation of fibers throughout concrete.

Force 10,000 Specifications (Microsilica)

Concrete Products
Technical Guide Specification
Microsilica Concrete
SECTION 03320
PART 1 - GENERAL
1.01 SUMMARY
A. This section specifies microsilica (silica fume) admixture for the reduction of concrete permeability to protect against intrusion by chlorides and other aggressive chemicals, and for the production of high-strength concrete.
B. Related Sections: Other specification sections which directly relate to the work of this Section include, but are not limited to, the following:
1. Section 03300 - Cast-In-Place Concrete.
2. Section 03365 - Post-Tensioned Concrete.
3. Section 03400 - Precast Concrete.
1.02 SUBMITTALS
A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each material.
B. Test and Performance Data: Submit independent test data substantiating the product's ability to reduce concrete permeability by chlorides and other aggressive chemicals.
1.03 QUALITY ASSURANCE
A. Manufacturer: Concrete admixture shall be manufactured by a firm with a minimum of 5 years experience in the production of similar products. Manufacturers proposed for use but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.
B. Materials: For each type of material required for the work of this Section, provide primary materials which are the products of one manufacturer.
C. Pre-Construction Conference: A pre-construction conference shall be held two weeks prior to commencement of field operations to install the specified product in order to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include concrete and admixture handling, placing, finishing, and curing.
D. Manufacturer's Representative: A representative of the manufacturer shall be present for project start-up during initial concrete placement. Engineer may waive requirement for manufacturer's representative if Contractor provides sufficient evidence that producer and finisher have adequate experience with admixtures required.
E. Trial Mix: Provide a minimum 4 cubic yard (3 m3) trial mix containing proposed concrete design mix placed at the job site in location acceptable to the Engineer. Engineer may waive requirement for trial mix if Contractor provides sufficient evidence that producer and finisher have adequate experience with low water cement ratio mixes.
1.04 PROJECT CONDITIONS
A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.
PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Provide Force 10,000® microsilica concrete admixtures by Grace Construction Products meeting specified requirements. For customer service in North America:

Call toll free: 877-4AD-MIX1 (877-423-6491)
Fax toll free: 877-4AD-MIX2 (877-423-6492)

2.02 MATERIALS

A. Microsilica Admixture: Provide Force 10,000 concrete admixture by Grace Construction Products complying with ASTM C 1240.

2.03 CONCRETE MIXES

A. Application Rate:

NTS This section may be used for concrete permeability requirements or high-strength concrete. Application rate (dosage rate) of microsilica may vary depending on individual project requirements. Application rates may be stated in dry pounds per cubic yard, percent of weight of cement, or as required to meet a performance criteria. Typical application rates for low permeability concrete varies from 30 to 60 lbs/cy. Specifier should use only one of the three sections which follow for A. Application Rate.

NTS Force 10,000 Sample Specification For Permeability Requirements

This sample specification may be used by the design engineer when specifying Force 10,000 microsilica for the reduction of concrete permeability to protect against intrusion by chlorides or other aggressive chemicals. Force 10,000 is a microsilica-based admixture manufactured by Grace Construction Products of W. R. Grace & Co.-Conn.

The high silicon dioxide content of microsilica combines with the excess calcium hydroxide in the concrete to form more calcium silicate hydrate “glue.” This chemical reaction plus its fine particle size allows Force 10,000 to fill in the voids between the cement grains and aggregate to deliver less permeable concrete. When chlorides migrate through the concrete and attack the steel reinforcing, corrosion occurs. By reducing the permeability of the concrete, chlorides take much longer to reach the steel which extends the service life of the structure considerably. Chlorides are typically present from deicing salts or from a marine environment. Structure applications of Force 10,000 include parking garages, bridge decks and overlays, reinforced pavements, and all structures in a marine environment. Structural concrete design criteria shall follow ACI 318, 357 and 201 guidelines. Parameters used in this sample specification, such as water/cementitious ratio and concrete cover over reinforcing steel, are taken from these guidelines and are conservative values.

There are two ways to specify microsilica concrete for permeability requirements: by prescription or by performance. The prescription method mandates the number of pounds of microsilica per cubic yard to be used while the performance method uses ASTM C 1202 test method to measure “coulombs.” Please use one method (prescription or performance) but not both. If the “performance method” is the preferred choice, use ASTM C1202 for mix design purposes only, not as a mix acceptance or rejection criteria during the construction phase. Since the chloride’s loading rate and final concrete quality are unknown factors, W. R. Grace cannot guarantee the longevity of the protection offered by Force 10,000. Quality concrete as recommended by ACI and the addition of Force 10,000 will slow the ingress of chlorides into the concrete. Neither quality concrete nor Force 10,000 will stop corrosion forever, but both will retard the onset of corrosion.

Prescription Method

1. Provide microsilica admixture Force 10,000 as manufactured by Grace Construction Products.
2. Microsilica shall be added at a rate of (50) pounds dry weight of microsilica per cubic yard [(30) kg/m3] of concrete.
3. Compressive strength shall be a minimum of (5,000) psi [35 MPa] at 28 days as measured using (4” x 8”) (100 mm x 200 mm) cylinder specimens.
4. A maximum water-to-cementitious ratio of 0.40 is required.
5. Microsilica may be counted as cementitious material in calculations.
6. Add microsilica as a liquid slurry or in dry densified form in 25 lb (11.4 kg) Concrete Ready BagsTM packaging.
7. Blended cements with interground microsilica will not be allowed.

Performance Method

1. Provide microsilica admixture Force 10,000 as manufactured by Grace Construction Products.
2. Microsilica shall have a minimum of (5,000) psi [35 MPa] at 28 days as measured using (4” x 8”) (100 mm x 200 mm) cylinders.
3. Permeability of microsilica concrete shall be tested by ASTM C 1202. Results of tests shall be expressed in electrical units of coulombs. Coulomb tests shall be made on two (4” x 8”) (100 mm x 200 mm) representative samples, moist cured for 56 days. Test cylinders shall be made according to ASTM C 31. Coulomb requirement shall be (_____) coulombs or less at 56 days. ASTM C 1202 testing shall be used as an indicator of concrete permeability

at mix design submittal only.
4. A maximum water-to-cementitious ratio of 0.40 is required.
5. Microsilica may be counted as cementitious material in calculations.
6. Add microsilica as a liquid slurry or in dry densified form in 25 lb (11.4 kg) Concrete Ready Bags packaging.
7. Blended cements with interground microsilica will not be allowed.

NTS: Force 10,000 Sample Specification For High-Strength Concrete Requirements

This sample specification may be used by the design engineer when specifying Force 10,000 microsilica for the production of high-strength concrete. The design engineer should fill in the compressive strength required. Force 10,000 is a microsilica-based admixture manufactured by Grace Construction Products of W. R. Grace & Co.-Conn. The high silicon dioxide content of microsilica combines with the excess calcium hydroxide in the concrete to form more calcium silicate hydrate "glue." This produces a stronger, tighter bonding paste structure. Additionally, the extreme fineness of the microsilica enables it a less permeable paste. These two factors contribute to providing higher strength, more durable concrete.

Structural applications for high strength Force 10,000 concrete are broad, but include usage in structural columns, beams and girders. Structural concrete design criteria shall follow ACI 318, 357 and 201 guidelines. Parameters used in this sample specification, such as water-to-cementitious ratio are taken from these guidelines and are conservative values. This sample specification is based on the performance method, whereby the compressive strength of the concrete is mandated by the design engineer.

High-Strength Concrete Requirements
1. Provide microsilica admixture Force 10,000 as manufactured by Grace Construction Products.
2. Microsilica high-strength concrete shall have a minimum of (____) psi [(___) MPa] at 28 days.
3. Test cylinders shall be 4" x 8" (100 mm x 200 mm).
4. A maximum water-to-cementitious ratio of 0.40 is required.
5. Microsilica may be counted as cementitious material in calculations.
6. Add microsilica as a liquid slurry or in dry densified form in 25 lb. (11.4 kg) Concrete Ready Bags packaging.
7. Blended cements with interground microsilica will not be allowed.

B. Concrete Cover Over Reinforcement: Minimum concrete cover over reinforcement shall be (____) inches [(____) mm].

NTS: Follow ACI 318 recommendations for concrete cover over reinforcement. For deicing salt and marine environments, ACI 318-89, section R7.7.5, requires 2 inches (50 mm) for walls and slabs and 2-1/2 inches (64 mm) for other members. For marine environments, ACI 357 recommends 2-1/2 inches (64 mm).

C. Air Entrainment: For freeze-thaw durability comply with ACI 318 freezing and thawing exposure requirements, as determined by ASTM C 173 or ASTM C 281.

D. Water-to-Cementitious Ratio: Provide 0.40 maximum. Microsilica, fly ash, blast furnace slag and cement are considered cementitious materials. The water content of Force 10,000 slurry shall be included as mix design water.

E. Recommended Cementitious Content for Workability:

Maximum Aggregate		Minimum Cementitious
3/8"	(10 mm)	700 pounds/cu.yd. (415 kg/m3)
1/2"	(13 mm)	680 pounds/cu.yd. (400 kg/m3)
3/4"	(20 mm)	650 pounds/cu.yd. (385 kg/m3)
1"	(25 mm)	630 pounds/cu.yd. (375 kg/m3)

F. Compressive Strength: Minimum 28 day compressive strength for microsilica concrete shall be (5,000) psi [(35) MPa] unless stated otherwise in Section 2.03 A. Application Rate.

G. Concrete Slump for Flatwork: 5 to 8 inches (125 to 200 mm). Concrete slump may be 2 inches (50 mm) over normal concrete slumps as microsilica concrete can be sticky and has a surface that is harder to close than normal concrete.

H. Concrete Admixtures: High-range water reducers are mandatory to control slump, mixing, cementitious ratio and proper distribution of the microsilica, and shall be plant added. Additional water reducers may be added at the job site when required.

I. Additional Concrete Admixtures: Additional concrete admixtures conforming to ASTM C 494 or equivalent CSA 266 standards may be used as required including the following:
1. Type A: Water-reducing admixture, WRDA® series or Daracem®-55 by Grace Construction Products.
2. Type D: Water-reducing and retarding admixture, Daratard®-17 by Grace

Construction Products.
3. Type F or G: Water-reducing, high-range admixture, WRDA-19, Daracem-100 by Grace Construction Products. This type of admixture must be included in all Force 10,000 concrete.
4. Type C: Accelerating admixture, PolarSet® by Grace Construction Products.
5. Grace MicroFibers® for flatwork, at 1 pound per cubic yard (600 grams/m3) addition rate.
6. DCI® or DCI-S Corrosion Inhibitor by Grace Construction Products may also be used if required at rate recommended by manufacturer.
J. Special Mixing Requirements for Densified Microsilica: Densified microsilica requires enhanced mixing to ensure full dispersion. The following mix requirements shall be adhered to:
1. For all types of mixing equipment, mix times shall be increased by 40% over the minimum mix time required to achieve mix uniformity as defined by ASTM C 94.
2. For truck-mixed and central mixed concrete, maximum allowable batch size shall be 80% of the maximum as called out by ASTM C 94.
PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine conditions of substrates and other conditions under which work is to be performed and notify Owner, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
3.02 CONCRETE PLACEMENT, FINISHING AND CURING
A. Concrete Finishing and Curing: Microsilica concrete typically exhibits little or no bleeding. To reduce plastic or drying shrinkage cracks, comply with ACI 302 “Guide for Concrete Floor and Slab Construction”, ACI 308 “Standard Practice for Curing Concrete”, ACI 306 “Standard Practice for Cold Weather Concreting”, and ACI 305 “Hot Weather Concreting.”
1. Underfinish microsilica concrete by limiting finishing operation to screeding, bull-float, and broom finish. Curing shall be initiated within one hour of concrete placement.
2. The use of wind breaks, sun shades, and fog misting are recommended to minimize the rate of evaporation at the concrete surface.
3. Light fog misting above the concrete to keep the environment above the concrete surface at high humidity is recommended during the placing and finish operations.

4. Fog misting is required when the rate of evaporation at the concrete surface exceeds 0.1 pound per square foot per hour as determined by ACI 308 Section 1.2.1. Fogging shall continue after the finishing operation until prewetted burlap or other approved curing material is placed over the concrete. When fog misting is not available or possible, an evaporation retarder shall be applied before and after bull-floating and during final finish to protect the concrete.
5. Wet curing is the preferred method for curing. Use prewetted burlap to cover all flatwork and keep wet for a minimum of seven days or until the time necessary to attain 70 percent of the specified compressive strength, as recommended by ACI 308 Section 3.1.3.
3.03 PROTECTION
A. Protect completed work from damage and construction operations throughout finishing and curing operations.

Reef Ball Foundation, Inc.
890 Hill Street
Athens, GA 30606 USA

Board Of Directors
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