GREAT BAY LIVING SHORELINE PROJECT

MOODY POINT – NEWMARKET, NEW HAMPSHIRE
CONCEPTUAL EROSION MITIGATION
AND LIVING SHORELINE

CONCEPT DESIGN REPORT

Prepared by:
Moody Point Project Team

Prepared for:
Great Bay Living Shoreline Project Grant
Great Bay National Estuarine Research Reserve
New Hampshire Department of Environmental Services – Coastal Program
University of New Hampshire

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GREAT BAY LIVING SHORELINE PROJECT GRANT PROGRAM

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Great Bay National Estuarine Research Reserve

New Hampshire Department of Environmental Protection – Coastal Program

University of New Hampshire

Piscataqua Region Estuaries Partnership

Strafford Regional Planning Commission

Town of Durham, New Hampshire

Great Bay Stewards

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INTRODUCTION

The Great Bay Living Shoreline Project (GBLSP) is a collaboration supported by the National Fish and Wildlife Foundation, the Town of Durham, New Hampshire Department of Environmental Services Coastal Program, University of New Hampshire, Great Bay National Estuarine Research Reserve, Great Bay Stewards and the Strafford Regional Planning Commission. The goals of the project are to build professional capacity to advance living shoreline designs in the state and to develop viable living shoreline projects to a conceptual level to showcase the varied living shoreline practices. The GBLSP issued a Call for Applications and assembled 24 participants comprised of professional engineers, ecologists, restoration practitioners, landscape designers, and marine construction professionals. The participants were assigned to one of four coastal sites within New Hampshire's Great Bay region. The sites had been identified by GBLS as having shoreline conditions which would likely benefit from a living shoreline and coordinated with the landowners for permissions for inclusion in the project. See **Table 1**. The project teams began in August 2021 and concluded with conceptual designs in April 2022.

TABLE 1: GREAT BAY LIVING SHORELINE PROJECT SITES

SITE – LANDOWNER	LOCATION	GENERAL SHORELINE CHARACTERISTICS
Moody Point – Homeowner's Association	Great Bay Newmarket, NH	Diverse habitat; salt marsh and coastal bank erosion and use impacts
Spur Road – Private Residential	Bellamy River, Dover, NH	Salt marsh shoreline erosion
Schanda Park – Town of Newmarket	Lamprey River, Newmarket, NH	Boat ramp and shoreline armoring
Chapman's Landing – NH Fish and Game	Squamscott River, Stratham, NH	Boat launch; salt marsh erosion

The report herein is the conceptual design deliverable for the Moody Point project team. The project team conducted two site visits in the Fall of 2021 to establish the project limits, observe the conditions, and collect data including limited topographic survey at set transect locations to capture representative conditions across the project limits. Additional site observations were completed by one or more project team members in October 2021 during a Nor'easter storm and in March 2022 for collection of supplemental data. The following provides an overview of the conditions observed at the site; design parameters; conceptual design; and additional considerations for final design, permitting and construction.

SITE DESCRIPTION

The Moody Point site is located in Newmarket, NH on the Great Bay. It is owned by the Moody Point Community Association (MPCA) and is part of the Moody Point on Great Bay – a 167-acre residential community with approximately 1 mile of shoreline and 100 homes within five residential clusters on 35 acres. The community includes conservation land, meadows, woodlands, private walking trails, a community gathering building, and water access via a fixed pier and seasonal floating dock. See **Figure 1**. The pier and dock are located with the community "Screen House" building and deck at the headland. Non-motorized watercraft are stored at the top of the bank adjacent to the pier access. See **Figures 2 through 4**.

Figure 1: Moody Point on Great Bay (Looking Northwest)

Figure 2: MPCA Pier and Headland Shoreline (13 September 2021)

Figure 3: Watercraft Storage (26 October 2021)

Figure 4: Screen House and Deck (26 October 2021)

The property supports a variety of ecological habitats, including fringe and meadow salt marsh along its entire shoreline. Near the headland, there is a bedrock outcrop along the shore (east of the fixed pier) and significant coastal bank erosion that has compromised the root system of trees and exposed areas of bedrock. To either side of the headland, the salt marsh exhibits signs of stress due to tree shading, erosion from upland run-off and wave action, ice rafting damage, and areas of wrack build-up. See **Figures 5 through 8**. More detailed descriptions of the site characteristics are provided in the following sections.

Figure 5: Tree Shading (13 September 2021)

Figure 6: Coastal Bank Erosion, Exposed Tree Roots and Bedrock (16 March 2021)

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Figure 7: Bedrock Outcrop along Shoreline, East of the Fixed Pier (13 September 2021)

Figure 8: Wrack Buildup on the Marsh, West of the Fixed Pier (22 October 2021)

Current and Historic Salt Marsh

In 2019, a salt marsh monitoring program of MPCA's shoreline began through the Landowner Technical Assistance Program operated by New Hampshire Department of Environmental Services and the University of New Hampshire Cooperative Extension. As part of the program, salt marsh erosion pins were set at 25 locations along the marsh edge. During the first year of monitoring, the salt marsh loss ranged from no loss to 5.1 inches of loss with an average loss of 1.0 inch. During the second year of monitoring, four erosion pins were no longer present, five locations had up to 2.2 inches of salt marsh loss and the remining locations had an apparent increase in salt marsh. However, much of the marsh edge was observed to be undercut at the start of the program and the apparent increase in salt marsh may have resulted from marsh collapse as the marsh retreats. See the **Appendices** for additional information.

A review of historic aerial imagery available on-line and through NH GRANIT provided limited assessment of the salt marsh changes over time. While areas of fragmented salt marsh were discernible, the image resolutions did into allow for definitive evaluation of salt marsh regression over time. As a rudimentary comparison, the approximate interpreted salt marsh area in 1974 was overlaid on the 2017 aerial image. It suggests that salt marsh regression has occurred with the greatest retreat on the western and northernmost limits of the MPCA shoreline. See **Figure 9**.

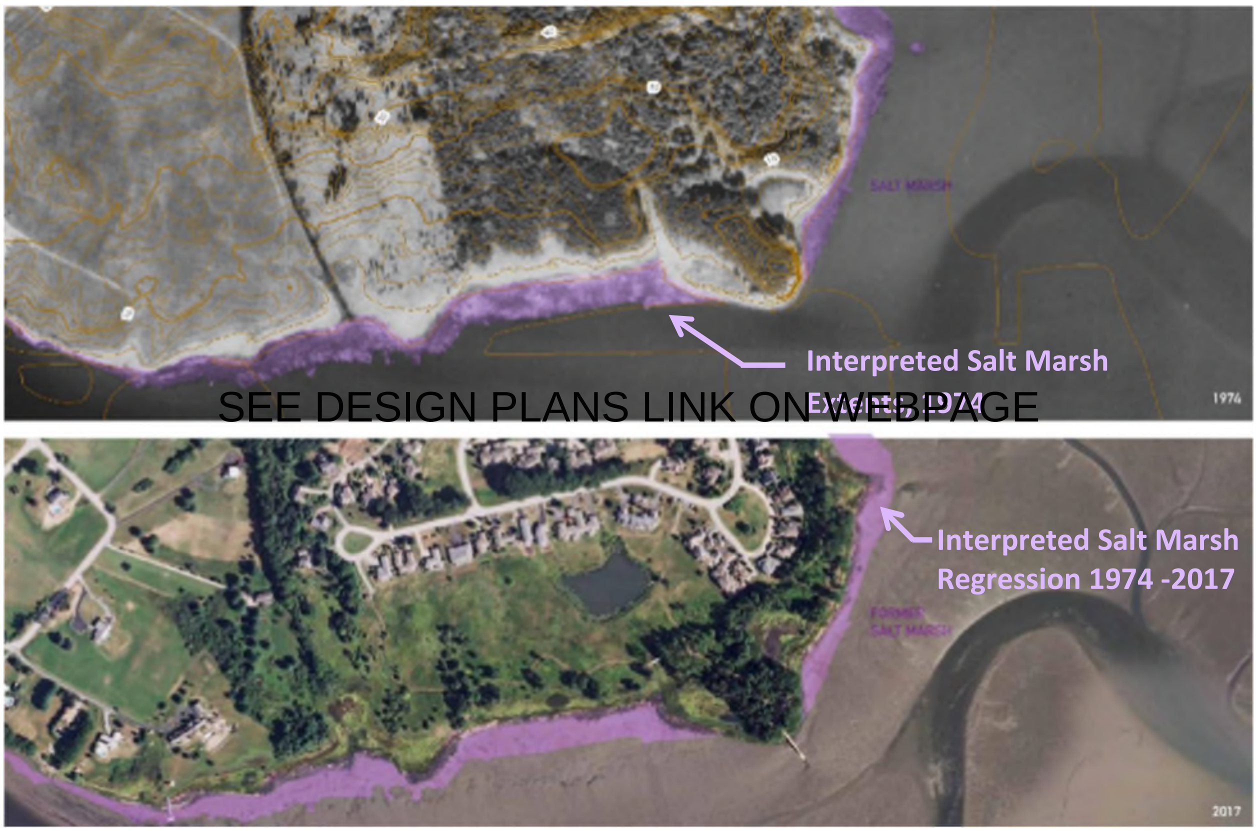

Figure 9: Approximate Estimate of Salt Marsh Regression 1974 to 2017. (Images Source: NH GRANIT)

Remnant Agricultural Berm

To both sides of the headland, approximately 2-foot high, manmade earthen berms extend along the existing salt marsh. The berm along the western shore begins just beyond the existing kayak storage area and runs approximately 425 feet northwest, ending just before the “Fire Pond” outlet. The berm on the east side of the headland runs approximately 150 feet northeast along a perched tidal pond and terminates at a bedrock outcrop. See **Figure 10**. In aerial imagery, there appears to be several man-made ditches on the landward side of the western berm. They run along straight axes, parallel to the berm, and are spaced at regular intervals, suggesting these anthropogenic berms were developed for agricultural use. The berms restrict tidal connectivity with the landward side of the marsh and have created a perched wetlands - the lack of frequent flooding and poor drainage has resulted in standing water or pool development and poor vegetative cover. Recent studies have shown “impacts from berms may impair salt marsh function and resilience to invasive plants and sea level rise” (Mora, Burdick; 2013)[1].

Figure 10: Anthropogenic Berms, Likely Former Agricultural Berms. (Images Source: Google Earth Pro, 10/10/2020, Newmarket, NH, 43° 4'2.16"N, 70°54'23.12"W elevation 1,497 ft [Accessed 30 November 2020])

The berms have created favorable conditions (high salinity and poor drainage) for Iva frutescens or marsh-elder, a multi-stemmed woody shrub that is a threatened species in New Hampshire. Stands of marsh-elder have become established along the entirety of both berms. The marsh-elder is known for erosion control and has created a thick tangle of stems along both berms that trap floating debris as it approaches, compounding the lack of tidal flooding and encouraging wrack build-up. Areas of exposed roots, bare soil, and thick mats of wrack were observed along the seaward side of the berms. The wrack build-up smothers vegetation, which leads to bare soil that is easily washed away by tidal influences and storm events, suggesting that the combined effects of the berms and marsh-elder colonies are substantially contributing to large sections of marsh calving. See **Figures 11 through 13**.

[1] Mora, J.W., and D.M. Burdick. 2013. The impact of man-made earthen barriers on the physical structure of New England tidal marshes (USA). Wetlands Ecology and Management 21:387-389. link.springer.com/article/10.1007/s11273-013-9309-3

Figure 11: Berm with Wrack Build-up along the Western Salt Marsh (Looking West from Approximate Limit of Kayak Storage Area, 22 October 2021)

Figure 12: Lack of Vegetation at Wrack Line (22 October 2021)

Figure 13: Marsh Calving (13 September 2021)

Shoreline Bank Erosion

As part of the GBLSP, four coastal bank erosion pins were set in September 2021: one on each side of the fixed pier approximately near the apparent high tide line, one near the west end of the Screenhouse deck and one just beyond the east end of the Screenhouse deck. At each location, a section of reinforcing steel bar was set horizontally into the bank. One pin was set flush with the face of bank. The other three pins encountered resistance, possible bedrock, and were set with an extension of the reinforcing steel bar protruding from the bank. The length of the extensions was recorded. In March 2022, the erosion pins were located and found to be covered by leaves. Each location had evidence of slope collapse above the pin and the bar extension was either the same or less than it was when the bar was initially set in September. (See the **Appendices**.) Based on this reduction in bar extension and the observations, erosion of the bank is occurring above the pin elevations. This is supported by the significant undercutting present at the easternmost pin set beyond the Screenhouse Deck. See **Figure 14**.

Figure 14: Example of Slope Erosion above the Coastal Bank Pin (Pin Location 4, Beyond the West End of the Screenhouse Deck, 16 March 2022)

State-Listed Rare Plant Species

The New Hampshire Natural Heritage Bureau (NHB) provides a review of proposed projects for potential rare species within the project limits. Reviews are requested during the regulatory permitting stage of a project. Because the GBLSP is a conceptual design, it is premature to request an NHB review. However, MPCA completed an NHB review for a separate project at the Screenhouse. The NHB review noted records for the following rare plant species along the shoreline:

- Eastern grasswort (*Lilaeopsis chinensis*)

- Marsh elder (*Iva frutescens*)
- Perennial saltmarsh American-aster (*Symphyotrichum tenuifolium var. tenuifolium*)
- Prolific yellow-flowered knotweed (*Polygonum ramosissimum ssp. prolificum*)
- Tundra alkaligrass (*Puccinellia pumila*)

Of these, only marsh elder (also referred to by the common name high-tide bush) was observed during site visits in the Fall of 2021. An NHB review specific to the living shoreline project described herein must be requested as part of future permitting efforts. Any potential impacts to state-listed plants must be approved by NHB and NHDES prior to commencing any field work.

Water Levels

A temporary tide gauge was deployed at the waterside of the existing floating dock to record site-specific water levels. Data was collected from mid-September to mid-November 2021. A disruption in the data towards the end of October occurred and is thought to coincide with the seasonal removal of the float. As such, the first approximately 30 days of data were processed. The data was calibrated to the North American Vertical Datum 1988 (NAVD88) through survey of the water surface during the project's site survey in the Fall of 2021. The estimated tidal range between Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW) at Moody Point was determined to be 7.1 ft. See **Table 2** for additional water levels and vertical datums. See the **Appendices** for a sample of the collected data and processing.

TABLE 2: MOODY POINT TIDAL WATER LEVELS AND VERTICAL DATUMS
SEPTEMBER 2021-OCTOBER 2021

Vertical Datum and Water Levels	Water Level (ft NAVD88)
Highest Observed Tide (HOT)*	7.64
FEMA Base Flood Elevation (BFE)	6.5
Mean Higher High Water (MHHW)	3.93
Mean High Water (MHW)	3.63
Mean Tide Line (MTL)	0.39
North American Vertical Datum 1988 (NAVD88)	0.00
National Geodetic Vertical Datum 1929 (NGVD29)	-0.73
Mean Low Water (MLW)	-2.85
Mean Lower Low Water (MLLW)**	-3.17

**The nearest long-term tide gauge is maintained by NOAA and tide station #8419870, Seavey Island ME. At this station, MHHW is observed at 4.18 (ft NAVD88), totaling 0.25 ft above the measured MHHW line at Moody Point. Additionally, the NOAA tidal station identifies a Highest Observed Tide (HOT) of 7.89 (ft NAVD88). Assuming that an extreme tide condition can fully penetrate Great Bay to Moody Point, an estimated HOT at the Project site would be 0.25 ft below the open ocean HOT, totaling 7.64 ft (NAVD88).*

***The tidal gauge was not continuously below water. Therefore, data for MLLW were distorted. MLLW reported in the table is based on MLW per the data less 0.32 feet consistent with the difference between MLW and MLLW for NOAA STA Seavey Island, ME.*

Wind and Wave Environment

A preliminary metocean data wave analysis was completed for the project site for prevailing wind-wave conditions and coastal storm conditions up to a 100-year recurrence interval flood. Statistical analysis was completed of wind records for the Pease International Airport located across the Great Bay from the Moody Point site. For the site exposure, Northeast, East and Southeast winds were used to develop wind speeds and prevailing directions for estimating wave characteristics.

Living Shorelines are typically designed in consideration of marsh survivability relative to wave climatology, including empirical correlations to wave height. The H_{20} significant wave height (representing 80% of the waves affecting the shoreline) is often used as a benchmark for the maximum allowable wave-induced bottom stresses. A preliminary estimate of the H_{20} significant wave height is provided, representing the prevailing wind-wave conditions. In addition, wave characteristics for the 1, 5, and 100-year recurrence interval coastal flood events are provided. See **Table 3** and the **Appendices** for additional information.

TABLE 3: MOODY POINT PRELIMINARY WIND-WAVE CONDITION ANALYSIS

Fetch Direction	Recurrence Interval Condition	Design Fetch (ft)	Wind Speed (mph)	Input Wind Duration (minutes)	Wave Height (H1/3) (ft)	Wave Period (s)
NE	Prevailing*	17,424	11	2	0.5	1.3
E	Prevailing*	19,008	10	2	0.5	1.3
SE	Prevailing*	20,064	10	2	0.5	1.4
NE	1YR	17,424	18	2	0.9	1.6
E	1YR	19,008	16	2	0.8	1.6
SE	1YR	20,064	16	2	0.8	1.6
NE	5YR	17,424	34	2	1.8	2.0
E	5YR	19,008	32	2	1.7	2.1
SE	5YR	20,064	32	2	1.8	2.1
NE	100YR	17,424	52	2	2.9	2.4
E	100YR	19,008	52	2	3.0	2.5
SE	100YR	20,064	52	2	3.1	2.5

* Representing the significant wave height of 80% of total waves

The wave characteristics summarized in **Table 3** do not consider future conditions associated with climate change, including potential sea level rise. Additional analyses are recommended for final design to refine the design wave characteristics, including: 1) detailed bathy-topo analysis; 2) comprehensive prevailing wave analysis; 3) numerical wave modeling using the SWAN model; and 4) consideration of climate change impacts.

Projected Sea Level Rise

While the service life of a constructed living shoreline and erosion mitigation measures is dependent on various factors including the severity of coastal storm events and how soon after construction a storm occurs, a service life of 25 years provides a basis for establishing design parameters for the living shoreline. Considering a 25-year design life for the conceptual shoreline recommendations, a projected sea level rise of 1.6 feet was established using the New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections (University of New Hampshire, 3-24-2020). The SLR value assumes a medium tolerance for flood risk. See the **Appendices** for additional information.

Great Bay Tidal Wetland Habitat Elevations

The site-specific water levels estimated with the temporary tidal gauge described above were used to determine plant community elevations in combination with observation and survey of the types of plants existing in the Fall of 2021. High marsh was observed and surveyed to exist from an estimated Elevation +4.50 feet NAVD 88 to approximately above Elevation +2.9 feet NAVD88. The upper limit of the low marsh vegetated zone was observed to occur at or near Elevation +2.9 feet NAVD88. The lower limit of the low marsh zone was estimated based on observation of the existing vegetation elevations, tidal marsh elevations at Wagon Hill in Durham, NH, and reports of observations in other salt marshes in Southern New England indicating that the low marsh lower bound lies between 0 to 3 feet above MTL. Using an average value of 1.5 feet above MTL and the site-specific tidal water levels places the lower limit of the low marsh at Elevation +1.90 ft NAVD 88. However, field observation and survey of the low marsh plants revealed that the marsh extends lower than this elevation to Elevation -0.2 feet NAVD 88.

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CONCEPTUAL PROJECT GOALS AND LIMITS

In developing the GBLSP conceptual design for MPCA, consideration was given to MPCA's concerns and community uses along the shoreline and the ecological benefits of enhancing and promoting favorable living shoreline conditions for sustainability and resiliency. The following provides a summary of the project team's understanding of the goals and how the goals shaped the GBLSP limits.

MPCA Goals

MPCA's conservation committee chairs and representative members met with the project team and provided insight into their issues with the shoreline; how their community recreates on the walking trails and accesses the water via the pier and floating dock; and use limitations set by the land deed. Based on the project team's understanding, MPCA's goals include:

- Address the coastal bank (bluff) and shoreline erosion, particularly surrounding the community space of the Screenhouse and pier.
- Protect the upland community space that extends from the Screenhouse to the pier.
- Improve ease of water access from the watercraft storage area to the pier for a demographic of over 55-years old users.
- Improve water access at low tide between the pier and the floating dock. The gangway is narrow and too steep at low tide.
- Incorporate a water viewing or sitting space along the shore.
- Provide phased approach to distribute costs over a 2-to-3-year period.

- Provide solutions that are permittable by the regulatory agencies.
- Provide solutions thar preserve the community's assets and have clear benefits that the MPCA homeowners can understand for voting on the financial expenditures.

Ecological Goals

After evaluating the existing site conditions and learning from MPCA representatives about their observations and concerns, the project team identified the following ecological goals:

- Mitigate erosion of the fringing salt marsh.
- Restore or expand the fringing marsh, especially near the pier.
- Mitigate erosion of the coastal bank (bluff) and shoreline above the salt marsh.
- Promote aggregation of healthy salt marsh and encourage its migration as a proactive measure to enhance resiliency for increased climate change related weather and potential sea level rise.
- Mitigate use impacts of the community upland space and enhance the ecological value of existing infrastructure.

Project Limits

In light of the MPCA goals and the project team's ecological goals, the conceptual project limits were set with a focus on the community space at the headland and the shoreline immediately adjacent to the space. These limits allow for improvements of the community space (upland and shore) and protection of those improvements and investments. Because of the varied challenges and conditions within this approximate 600 linear feet of shore, the project was categorized into four main focus areas based on geological, ecological, and use considerations. See below and **Figure 15**.

- Central Upland – the upland area defined by the Screenhouse, watercraft storage areas and access to the pier
- Water Access – the fixed pier and seasonal gangway and floating dock
- Central Shore – the coastal bank and shore centered around the pier
- West Shore – the salt marsh located west of the fixed pier and along the back side of the watercraft storage area

Figure 15: Conceptual Project Limits

CONCEPTUAL MITIGATION AREAS AND CHALLENGES

Each of the four project areas have unique characteristics that present challenges in balancing the project goals. The following sections provide an overview of the more prominent challenges.

Central Upland

The Central Upland is the social hub of the community space along the shoreline. It consists of the community Screenhouse building and deck, open area, access to the fixed pier, and the watercraft storage area. The soil between the Screenhouse and the shore is compacted, largely unvegetated, and without defined walking paths. (See **Figure 3**.) Because the area slopes down towards the shore, concentrated storm water runoff is likely contributing to the erosion of the coastal bank. It was noted that there are no gutters on the Screenhouse.

Approximately 70-75 kayaks and other non-motorized watercraft are stored in the area to the west of the Screenhouse and nearest the marsh. Some of the watercraft are on racks, some on the ground. (See **Figure 4**.) Residents maneuver their kayaks, canoes, etc. over the uneven terrain towards the pier, carry them down four steps to the pier and then along the pier and down the gangway to the float. Depending on the tide, the gangway becomes steep. (See Water Access.) Launching of kayaks or other watercraft through the marsh or anyplace other than the float is prohibited.

Water Access

During meetings with MPCA, challenges with the gangway were highlighted. Its narrow width makes it difficult to carry watercraft on the gangway to/from the float. This is exasperated at low tide by the steep angle of the gangway. See **Figure 16**. Based on limited field measurements, the gangway slope at a MLLW water level is estimated at 1 (vertical) to 2.5 (horizontal). At an extreme low tide, it is steeper at approximately 1 (vertical) to 2.2 (horizontal). While the steepness of the gangway is limited to the time of the low tide conditions, it is steeper than best practices of a maximum 1 (vertical) to 3 (horizontal) slope.

Figure 16: Existing Gangway Slope nearing the Low Tide Conditions (13 September 2021)

Central Shore

The Central Shore consists of a small fringing salt marsh, sparsely vegetated border/spray zone, and a steep bank. The pier extends from the upland over the central shore and into Great Bay. The fringing marsh in this area is narrow with areas of salt-marsh patches interspersed with exposed bedrock, gravel, and sand. The marsh is significantly impaired by wrack accumulation; deep channels bifurcating the marsh; and disturbances from wave action, seasonal ice movement and unmanaged stormwater runoff from the central upland. The steep bluff immediately adjacent to the fringing marsh also shows evidence of active erosion in the form of undercutting and exposed soil and tree roots. See **Figure 17**. It is noted that a mud flat extends from the existing salt marsh to approximately the low tide elevation, and therefore, the seaward limit of the salt marsh does not experience tidal interaction at low tide.

Figure 17: Coastal Shore to the East of the Pier (26 October 2021)

The access to the fixed pier is flanked by areas of severe erosion that threaten the stability of the central shoreline. Steep slopes with areas of bare, eroded soil are evident. Roots of large trees are exposed, and trees lean significantly seaward, creating a potential hazard and suggesting additional erosion and/or bank failure is likely. The erosion continues along the central shoreline, including areas of exposed bedrock very near the foundation columns of the deck at the Screenhouse. See **Figure 18**.

Figure 18: Coastal Bank to the East of the Pier (26 October 2021)

West Shore

The West Shore consists of a fringing marsh, anthropogenic berm, and perched wetland on the back (landside) of the berm. Evidence of marsh erosion was observed, including undercut sections of marsh, fragmented sections of marsh along the seaward toe of the berm, and rafted pieces of marsh that calved off and were carried waterward by the tide. See **Figure 19**. Similar to the Central Shore, a mud flat extends from the existing salt marsh to approximately the low tide elevation, and therefore, the seaward limit of the salt marsh does not experience tidal interaction at low tide. However, the vitality of the marsh is impaired by the wrack buildup along the berm. The wrack material smothers marsh vegetation, causing die-off which leads to bare soil, a weakening of the marsh platform, and its subsequent erosion. In addition, the berm is a barrier to tidal circulation and has created the perched wetland. The perched wetland lacks water flushing and has poor vegetative cover.

Figure 19: West Shore with Sections of Rafted Marsh (9 September 2021)

Overwinter storage of the seasonal float along the shoreline immediately to the west of the pier is likely intensifying the saltmarsh die-off from tree shading and bank runoff in this area. See **Figures 20**. The area of the float storage corresponds to the compromised salt marsh area in **Figure 19**.

Figure 20: Float Storage on the Shoreline (16 March 2022)

CONCEPTUAL MITIGATION DESIGN

A conceptual design for each of the project areas was developed by considering their unique characteristics and challenges and how they contribute to the combined project goals. To better inform the conceptual design approaches, an assessment of the site under a No-Action approach was completed. The following provides a summary of the No-Action assessment and the conceptual mitigation designs.

No-Action Assessment

If no action is taken within the project limits, it is anticipated that the current issues will continue to advance and MPCA's use of the area will be impacted as follows:

Coastal Upland	degradation of the slope and kayak storage area, widened area of vegetation loss.
Coastal Shore	advanced coastal bank erosion, loss of more trees, destabilization around the pier interface with the upland, encroachment of bank erosion on the watercraft storage area, potential destabilization of the Screenhouse deck if foundations along the top of the bank are not founded on sound bedrock, calving and marsh collapse, advanced loss of salt marsh due to bank impediment for marsh migration.
West Shore	calving and marsh collapse, marsh rafting and loss of shoreline; limited salt marsh migration due to the berm impediment, potential for invasive species to vegetate the perched marsh potential risk of increased inflow of salt water at the Fire Pond outlet without the salt marsh present to buffer tidal water.
All Areas	loss of salt marsh wildlife, loss of coastal plant diversity, loss of salt marsh beautification of the shoreline.

The impacts of No-Action will likely be compounded by the effects of climate change. Water levels associated with potential sea level rise will likely alter the existing exposure conditions and effects on the shore and marsh. Deeper water from SLR will increase the elevation and inland reach of tidal water levels and storm surges. The deeper water will allow for the development of larger waves and for wave impacts to affect the shoreline at a higher elevation. Thus, the existing tidal and wave impacts along the fringe marsh and coastal bank are anticipated to be exacerbated by SLR.

Without mitigating measures to promote conditions favorable for marsh growth and landward migration, the fringing marsh along the West Shore is anticipated to continue to erode from the conditions created by the berm and could eventually drown under the higher water levels associated with SLR. Gradual swamping of the perched wetland, landward of the anthropogenic berm, is anticipated with SLR. However, given the poor vegetative cover, the area may lack favorable conditions for salt marsh development.

Two visualization tools were used to create graphics depicting the potential landward reach of SLR and potential salt marsh migration.

NH Coastal Viewer is an online mapping tool of coastal resources and hazards-related spatial data. It provides an initial screening tool developed and managed by NH GRANIT in partnership with NHDES Coastal Program. **Figure 21** compares MHHW water level for a 2014 Baseline condition, MHHW +1’ SLR, and MHHW +2’ SLR. **Figure 22** depicts potential salt marsh landward migration for 2050 as compared to 2014 conditions. See the **Appendices** for full-sized versions of the mapped images.

Figure 21: NH Coastal Viewer Screening Maps of MHHW Extents under Sea Level Rise Scenarios

2014 Baseline Marsh | 2050 Predicted Marsh Migration

Figure 22: NH Coastal Viewer Screening Maps of Salt Marsh Landward Migration

Sea Level Affecting Marshes Model (SLAMM), initially developed by the Environmental Protection Agency (EPA) in the 1980s, simulates the dominant processes involved with wetland conversion due to sea level rise. It incorporates parameters including LiDAR elevation data, mapped wetland classifications, sea level rise, tide range, accretion, and erosion rates. The SLAMM results for the +1.6-foot SLR scenario shows the development of transitional marsh along the much of the shore. The fringing high marsh ("Irregularly Flooded Marsh") around the headland converts to low marsh ("Regularly Flooded Marsh") but is limited by the steep coastal bank. See **Figure 23**.

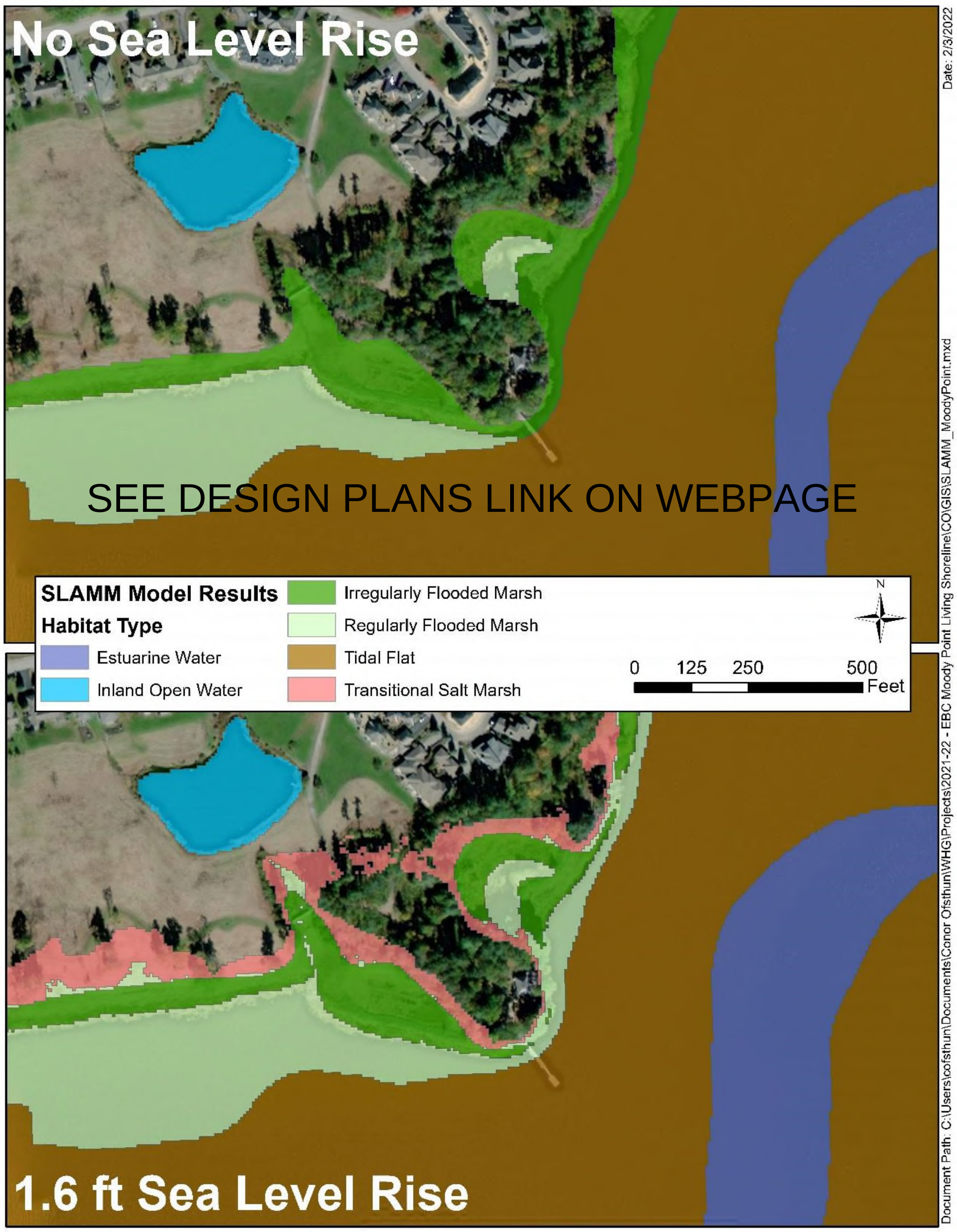

Figure 23: NH Coastal Viewer Screening Maps of Salt Marsh Landward Migration

Both of the visualization tools suggest a landward migration of the salt marsh. With that comes an increased reach of tidal waters and the potential realization of the above listed anticipated impacts to the shore and coastal bank. Improving the current salt marsh conditions and addressing the coastal bank erosion are measures to integrate potential mitigation and resilience. Summary of the conceptual design for each of the project areas is presented below.

Central Upland Conceptual Design

The upland portion of the design is important in that it addresses runoff from storm water and offers conceptual solutions to some of the residents' concerns about how the space is used. It should be considered a Phase 2 project as installing it before addressing the erosion issues of the central and west shores (or at least the central portion around the dock) would be counterproductive. The upland area will need to serve as the access point for the marsh related work. Therefore, any new work in the upland areas would be destroyed during the marsh construction work. It is both fiscally responsible and practical to complete the marsh construction work prior to implementing the upland design.

The upland conceptual design is built upon a base plan consisting of spot field measurements and available topographical resources for mapping. A specific survey of the upland site was not completed at this time and should part of the final design process.

Objectives of the Central Upland Conceptual Design include:

- Addressing the runoff from the road/path and the Screenhouse to reduce coastal bank erosion.
- Creating an easier kayak/watercraft experience for the residents without compromising the marsh.

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Solutions provided by the Central Upland Conceptual Design are summarized below and are depicted in the **Appendices** and **Figure 24:**

- Incorporation of gutters at the Screenhouse with connection to rain barrels. This water can then be used for potted plants on the deck or for supplementary watering of small areas. (Note: When the weather is dry, the rain barrels will not be refilled, so there should be a second watering plan in place.) Any excess water would be drained via a perforated pipe.
- Grade the area between the Screenhouse and shore by relocating soil from the higher areas towards the west (where the kayaks are stored), adding some supplemental soil to create a low, vegetated berm to help contain the new, more level graded area. The entire area would then require an additional 6 inches +/- of soil in which to plant because the existing ground is compacted and full of roots.
- Plant native plants between the Screenhouse and the shore. Plants would be of varieties that do not grow too tall so that they will not obstruct the water views. Plantings on the new berm would be woodier in nature so as to encourage birds and blend with the natural landscape.
- Add a 16' to 22' ribbon of crushed stone along the western side on which to store kayaks and to help with drainage.

Figure 24: Central Upland Conceptual Design

The Central Upland Conceptual Design accomplishes the following:

- It allows for removal of stairs to the dock and creates easier access to the pier. Flex-MSE (a geomodular wall system) or similar product could be used if necessary for stabilization or it could be tied into the central shore renovation portion of the project.
- It allows plants, mulch, and crushed stone to absorb and filter runoff and contains it to the upland area.
- It provides the residents the opportunity to have an easier experience with their kayaks as it requires less lifting and maneuvering. A conceptual design for a kayak rack that would hold a number of kayaks while making them accessible has been included in the design but should be vetted through a contractor before proceeding.

- Between the berm and the plantings in front of the Screenhouse, there is the opportunity to build a habitat that is welcoming to birds and wildlife as well as being an attractive place for the residents to meet and socialize, whether or not they are spending time on the water.
- It allows for a space behind the proposed kayak racks that could support a table or benches for passive enjoyment of the environment or picnic lunch while looking out over the water.

Also incorporated into the conceptual design:

- A 5 foot wide, mulched path around the perimeter of the area with stone steps where necessary to encourage and facilitate access to the pier and the water views.
- A buried perforated pipe to conduct excess water from the gutters/rain barrels towards the crushed stone kayak area where it can filter out.
- A porous paver “pad” near the entrance to the Screenhouse for use by emergency vehicles or an occasional vehicle for operational purposes.

Water Access Conceptual Design

To mitigate the challenges with the gangway width and slope, the gangway could be replaced with a wider and longer gangway. Based on the pier deck elevation, a 45-foot-long gangway would provide an approximate 1 (vertical) to 3.2 (horizontal) slope at extreme low tide. A gangway with a clear width should be adequate for carrying kayaks and similar watercraft without interference from the handrail or gangway framing. In order to have proper placement of the gangway on the float, the float would need to be relocated father waterward approximately 11.5 feet. See **Figure 25**. The proposed gangway replacement and float relocation would require approval from regulatory agencies. However, a cursory review of mapped eel grass and the proximity of the navigation channel did not identify potential conflicts. See the **Appendices** for additional information.

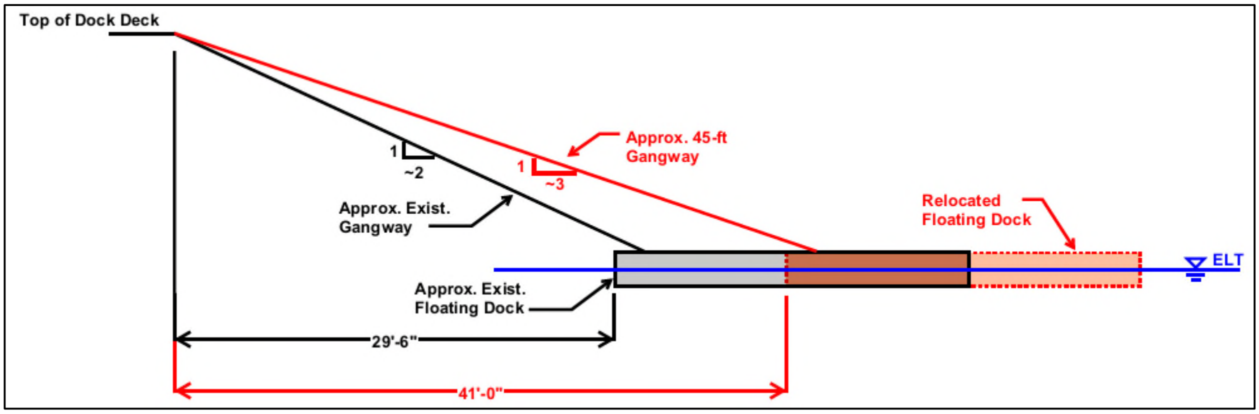

Figure 25: Comparison of Approximate Existing Gangway Slope and a Proposed 45-foot Long Gangway at Extreme Low Tidal Conditions.

MPCA indicated that they would like to explore the potential for an alternative water access. The land deed for the property established a Pier and Deck Area in which the community has the "*right to build such improvements within the "pier and deck" area… as are permissible and in compliance with all Federal, State and Town of Newmarket requirements*." Based on review of the site plan associated with the deed, the "pier and deck" area appears to encompass the shoreline from the east side of the Screenhouse toward the west beyond the pier and current watercraft storage area. See **Figures 26 and 27**. While the deed may allow for another water access location, the area within the "pier and deck" area is within an environmentally sensitive region. Before advancing with and alternative water access, preliminary discussions with NH DES is advised.

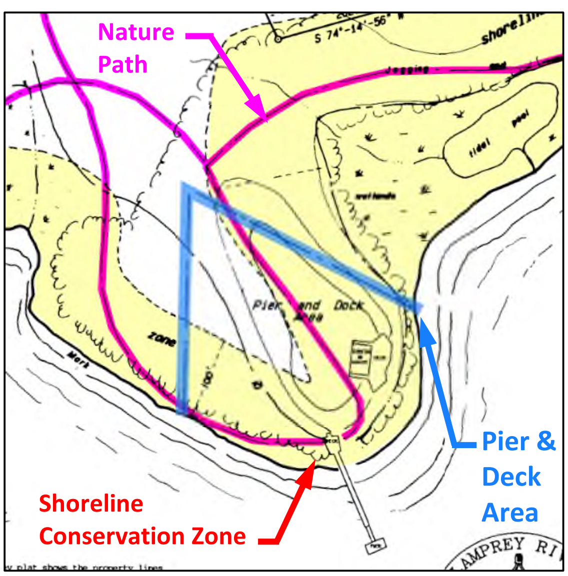

Figure 26: Excerpt, *Moody Point Site Plan Screen House Deck & Pier*, Plan No., A-1769, Sheet 2 0f 3, Frederick E. Drew Associates, Jan, 1990.

Figure 27: Google Earth Pro Imagery with Approximate Pier and Deck Area Overlay

Central Shore Conceptual Design

The Central Shore Conceptual design incorporates restoration and bioengineering components aimed at advantageous use of natural based structures. The approach is based in the principals of geomorphic and interactive watershed and climate processes. These include variable weather patterns, land use, recreation activities, tidal elevation availability and current bank soil loss rates. The conceptual bioengineering and geomorphic stabilization features include the implementation of structures such as:

- Individual and multiple large wood habitat pieces (e.g., bank stabilization and wave/tidal energy dissipation)
- Bank roughening structure (e.g., Large Woody Debris - LWD, Engineered Log Jams - ELJ, root wads, and bio-stabilization)
- Brush Mattresses (e.g., structure to increase aggradation and increase between ELJ's)
- Vertical Aggradation Structures (e.g., utilized in the highest energy areas to dissipate tidal energy)
- Post Assisted Wicker Weaves (e.g., promote mid energy level dissipation and aggradation)
- Individual and multiple large wood habitat pieces (e.g., streambank energy dissipation)
- Fabric Encapsulated Soil Lifts (provide time for vegetation to gain root mass and root density)

The fabric encapsulated soil solution on either side of the dock is a basic technology solution to minimize further bank erosion and marsh degradation. The solution proposes coir fiber fabric wrapping soil, stacked in a staircase-like formation to dissipate tidal and wave energy to promote and maintain the shoreline position. The substrate would subsequently be planted with native vegetation.

This proposed solution is intended to be a living shoreline. The living shoreline approach is anticipated to provide erosion protection while providing habitat value and permitting feasibility.

A similar planting scheme to that described for the West Shore will be implemented in the Central Shore fringing marsh. See the **Appendices** for more details provided by the Conceptual Plan set. A Living Shoreline Planting Schedule is included in the Conceptual Drawing Set on Sheet C-006.

West Shore Conceptual Design

The West Shore Conceptual Design focused on the two distinct shoreline features – the fringing marsh and the anthropogenic berm. Conceptual design solutions are described below:

- Fringing Marsh: Amend the existing fringing marsh vegetation where it has been disturbed by erosion and/or wrack accumulation (wrack to be manually removed prior to planting), or by potential disturbance from the construction efforts described herein. Plant species were selected to match conditions on site and in similar settings around Great Bay. Planting elevation ranges correspond to tidal elevations determined during the data-gathering phase of this project.

  Planting in the fringing low marsh should be from elevations 0.0 feet to + 2.8 feet NAVD 88, and should consist of the single species, Spartina alterniflora. High marsh plant species should be installed between elevations +2.8 feet and +4.5 feet NAVD 88 and should consist of the species Spartina patens, Distichlis spicata, and Juncus gerardii. The marsh border, at elevations between +4.5 feet and +6.3 feet NAVD 88, should be amended with Iva frutescens (to be transplanted prior to disturbance from the west shore berm), Juniperus horizontalis, and Panicum virgatum. See the **Appendices** for Conceptual Plan set. A Living Shoreline Planting Schedule on Sheet C-006 includes plant species, elevations, and proposed spacing

- Antrhopogenic Berm: Breach the anthropogenic berm, creating a direct and clear channel for tidal penetration from Great Bay to the low marsh behind the anthropogenic berm. An alternative or additional approach requiring further study is an enhanced runnel from the western tidal creek (Fire Pond outfall) through pounding or digging, deepening the runnel by up to 1-2 ft. This may promote tidal exchange behind the anthropogenic berm, bringing nutrients and sediment to the low marsh.

CONCEPTUAL OPINION OF CONSTRUCTION COSTS

An Opinion of Probable Construction Costs (OPCC) has been prepared that is commensurate to the conceptual design level. The OPCC summarized in **Table 4** should be considered as "order of magnitude" and used for general planning purposes only. The OPCC is based on the limited data, conditions and assumptions described in this report and approximate quantity evaluations that are not intended to be sufficiently accurate to develop construction bids. Actual construction costs may and could be significantly more, or less, than indicated.

TABLE 4: MOODY POINT OPINION OF CONCEPTUAL CONSTRUCTION COSTS*

Conceptual Design	Conceptual Construction Cost Range	
Central Upland	$60,000 to $80,000	Does not include kayak storage stands, picnic tables, rain barrels or Screenhouse gutters
Water Access	$20,000 to $30,000	New gangway, pierhead connection, relocation of the float's existing bottom anchors. Assumes installation is included by MPCA's existing seasonal installation Does not include disposal of existing gangway.
Central and West Shores	$1,000/linear foot to $3,000/linear foot	Costs are highly dependent on final design detailing, project phasing, and the bid environment at the time of the project.

* This Opinion of Construction Costs is for general planning purposes. Actual cost may vary depending on the final design, when the work is completed, labor and material costs and the construction bid environment. Actual costs may vary and could be significantly more, or less, than shown.

Construction Phasing

The conceptual designs for the four focus areas of the project provide both immediate benefits and proactive measures to reduce potential unfavorable impacts to MPCA's shoreline and use of the community space. Being proactive now to manage shoreline erosion and marsh degradation holds long term benefits in mitigating the encroachment of tides on habitat, open space, and property. Considering the financial investment for such a capital improvement plan, a phased approach to the project is recommended. Project phasing that addresses the most seaward components first and works inland provides a logical sequence that minimizes the potential for later phases of construction to damage the first phases of the work. A three-year phased approach provides a practical implementation sequence for the conceptual designs.

Phase 1: West Shore improvements and components of the Central Upland that would require construction access along the shore. Examples of Central Upland components to include are preparation for the berm at the watercraft storage area and a temporary grading condition along the top of bank and west side of the pier to transition from the current finished grades to the final grades under Phase 3.

Phase 2: Central Shore improvements and components of the Central Upland that would require construction access along the shore. An example of a Central Upland component to include is a temporary grading condition along the top of bank and east side of the pier to transition from the current finished grades to the final grades under Phase 3.

Phase 3: Central Upland improvements and finish grade transitions to the West Shore and Central Shore improvements.

The Water Access improvements are not contingent on any phase of the work. They can be completed at any time upon final design and regulatory approval.

ADDITIONAL CONSIDERATIONS

With the conceptual phase of this project, the following provides additional considerations for MPCA as the project is advanced and refined.

North Shore

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The North Shore of the site was characterized as a transition from the fringing salt marsh and steep headland of the Central Shore to a low elevation, marsh platform. Observations during site visits found evidence of coastal bank erosion with undercutting and salt marsh erosion through calving. Causes of marsh erosion are likely a combination of the similar factors affecting the West Shore and Central Shore: wave damage and removal of marsh sediment; ice damage; wrack accumulation leading to vegetation die-off; and tree shading leading to vegetation die-off. Further north, the agricultural berm acts as a barrier between the inland marsh area and Great Bay, similar to the conditions of the West Shore.

Along the North Shore, the Screenhouse and deck are located at the top of the coastal bank within the area of erosion and undercutting with exposed bedrock. (See **Figures 28 and 29**.) The foundation of the deck appeared to be fronted by the exposed bedrock, however, an assessment of the deck foundation was not included in the project. Given that improvement solutions along this section of shoreline would require a deck foundation assessment, bedrock quality and stability evaluation and further study that was beyond the scope of the GBLS project, the North Shore was excluded from the living shoreline conceptual design project. However, the concept solutions provided for the West and Central Shores may form a part of the engineered solutions for the North Shore as related to the agricultural berm and shore erosion.

Figure 28: North Shore, Along Screenhouse Deck (Looking West, 16 March 2022)

Figure 29: North Shore, East of Screenhouse Deck (Looking West, 22 October 2021)

Regulatory Permitting

Any activities proposed in or within a prescribed distance (200 feet) of a coastal wetland requires prior review and approval from the New Hampshire Wetlands Bureau under New Hampshire Revised Statutes Chapter 482-A: Fill and Dredge in Wetlands. Activities directly affecting coastal wetlands or waters (Waters of the United States) also require approval from the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act. In addition, the Town of Newmarket takes jurisdiction over a Wetlands Protection Overlay District consisting of all wetlands within town boundaries. Impacts to such wetlands require a permit from the Town of Newmarket Planning Board.

The New Hampshire Wetlands Rules contain sections intended to facilitate ecological restoration and coastal resilience projects. The following chapters are relevant to this project:

- Env-Wt 514 Bank Stabilization
- Env-Wt 525 Restoration/Enhancement Activities
- Env-Wt 600 Coastal Lands & Tidal Waters/Wetlands

As part of the New Hampshire Wetlands permit application, a New Hampshire Natural Heritage Bureau review for potential rare species within the project limits is required. Based on NHB reviews completed for other MPCA projects along the shoreline, it is anticipated that state-listed plant species will be identified. The potential impacts to these plant species as well as the hydraulic alteration posed by the conceptual opening(s) in the West Shore berm will require coordination with NHB and NHDES and may alter the project approach and/or require further assessment and potential compensatory mitigation.

The U.S. Army Corps of Engineers has promulgated General Permits that facilitate review and permitting of minimal impact projects concurrent with the NHDES permit application review. The General Permits include the following:

- GP 9. Shoreline and Bank Stabilization Projects
- GP 10. Aquatic Habitat Restoration, Establishment, & Enhancement Activities

Recognizing that the construction of a living shoreline is a “green” ecological restoration, as opposed to a hard development, the Town of Newmarket may also treat this living shoreline project favorably.

Each of these regulatory agencies should be contacted prior to completion of the designs put forward in this document. Pre-application meetings with the agencies provide the opportunity to understand potential permitting constraints before design finalization.

Monitoring and Maintenance

The shoreline will continue to respond to the multitude of environmental and use factors that affect it, including the changes that the conceptual design solutions will introduce. While the final designs will be founded in best practices and engineering, more natured-based and green coastal solutions are relatively newer approaches in New Hampshire. With the “living” nature to these solutions, they are subject to stressors and monitoring and maintenance are important components to their success. For this project, the metrics vary between the upland and shoreline. The following provides suggested aspects for a monitoring program.

Upland Monitoring: Monitoring of the upland portion of the project is more subjective than the other parts of this project but should include the following:

- Visual assessment of the plants over 2-3 full growing seasons to confirm they are establishing well and/or to identify were to replace plants.
- Visual assessment of the designed area, in particular after a heavy rain or major weather event, to identify puddling or erosion that might impact the efficacy of the design and to address such issues promptly.
- Monitoring (by the landowners on an internal level) to ensure that the separate use areas (walking path, kayak storage area, etc.) are used as they are designated on the plan.

Shoreline Monitoring: Large wood and planted vegetation are being incorporated into shoreline protection and restoration projects that are of a more natural design and utilize natural materials, such as rocks and logs, and vegetation, rather than riprap and bulkheads. Shoreline protection constructed with large wood aggradation structures serve to meet the goal of vegetation stabilization, wave attenuation and provide a vegetated terrace component for various tidal water surface elevations. In addition to shoreline protection, the large wood also provides ecosystem services (e.g., habitat provision for fish and invertebrates, improved water clarity, etc.). Living shoreline-type projects that include wood as part of their design should be monitored to determine when or if maintenance implementation or adaptability decisions are needed.

Measurements of both shoreline loss/gain (the change in shoreline position) and shoreline profile/elevation change will allow documentation of how well the large wood is abating erosion on the adjacent shoreline, and/or enhancing accretion and stable vegetation of the shoreline. Measurements of the density of marsh plants or other shoreline plant habitat can determine the effects the breakwater structures may be having on nearby plant communities.

Each structure has a specific objective and target metrics used during analysis to assess project effectiveness and risk aversion. Effectiveness monitoring at the impact sites is evaluated temporally on a rotating schedule. Years 0, 1, 3 and 5 for all quantitative core monitoring and Years 2 and 4 for qualitative conditional metrics. Based on the interaction with natural events and proximity to recreational access, observations should occur to determine if there are any critical elements changing along the shoreline that could have adverse effect.

Three project goals can be measured using a few metrics to evaluate whether the prescribed living shoreline is achieving its intentions.

- Shoreline stabilization – wood, coir fabric, planting
- Wave Attenuation & Water Quality
- Vegetation/Habitat/Biodiversity (Optional)

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The monitoring table provides a simplified and quick reference organizing the different metrics that should be considered including quantitative vs. qualitative methods.

TABLE 5: MOODY POINT POTENTIAL MONITORING - SHORELINE

Metric		Quantitative Method Years 0, 1, 3 and 5	Qualitative Methods Years 2 and 4
1	**Upland Erosion from Runoff**	Objective photographs capturing • Gain/Loss of soil and runnels • Vegetation changes • Surface runoff (runnels)	Photographs taken from monumented locations to track erosion, upland erosion, bank recession
2	**Shoreline Profile**	• Survey longitudinal shoreline profile from monument to shoreline edge of each structure along established transects • Sediment depth and location for aggradation/degradation calculations	Photographs from monumented locations of the shoreline at established transects to track • Sediment probing to refusal • Nearshore conditions • Overall profile changes
3	**Shoreline Elevation Change**	Survey transect cross-sections to loss of soil, lack of native vegetation, shoreline rafting	Photographs taken from monumented locations to track erosion or bank recession of the upland and nearshore

TABLE 5 CONTINUED: MOODY POINT POTENTIAL MONITORING - SHORELINE

Metric		Quantitative Method Years 0, 1, 3 and 5	Qualitative Methods Years 2 and 4
4	**Large Woody Structures**	Survey to identify vertical and/or lateral movement	Photographs capturing location and orientation of structures to assess movement
5	**Wave Energy (Dissipation)**	Rod measurements during wind/wave events for wave attenuation measurements	Photographs of • wrack and sediment volume captured in the structures • surface changes
6	**Density & Percent Cover**	Transects/Vegetation plots of the shoreline to upland composition	Photographs taken from monumented location(s) of study plot(s)
7	**Wetland Herbaceous cover**	Transects/Vegetation plots	Photographs taken from monumented location(s)
8	**Invasive Vegetation**	Plots of non-vegetated areas	Photographs of transects capturing succession
9	**Habitat Use**	Birds, benthic, fish	Study plots, photographs of use evolution

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Next Steps

The conceptual designs summarized in this report provide a groundwork for MPCA to develop engineered solutions to the current use and environmental impacts affecting the shoreline centered around the community's water-related activities and passive recreation. Revision of the conceptual solutions may be warranted as the project advances with a more comprehensive collection of site data (topographic and near shore survey, North Shore evaluation, exposed bedrock assessment, comprehensive prevailing wave analysis, numerical wave modeling, etc.). It is recommended that MPCA's design consultant consider the site as part of the complete shoreline and upland system with an understanding of influences and affects that each part has on the other. In addition to addressing the current environmental conditions, solutions should be developed with a level of tolerance for changing conditions such as storm intensity, sea level rise, and groundwater rise.

The MPCA'a shoreline is a beautiful asset for its community, the environment and Great Bay. It provides ecological diversity, wildlife habitat and the personal benefits of the outdoors. The shoreline improvement project offers the opportunity for MPCA to protect the community assets and enhance the resiliency of the shoreline for its continued enjoyment and vitality as the conservation land for which it was established.

APPENDICES

SEE DESIGN PLANS LINK ON WEBPAGE

SALT MARSH EROSION PINS

SEE DESIGN PLANS LINK ON WEBPAGE

UNH "Moore Erosion Study" Shared with GBLS Project for Moody Point

Salt Marsh Erosion Pin Data November 2019 through October 2021

pin #	Pin Length 2019 (cm)	Pin Length 2020 (cm)	Pin Length 2021 (cm)	Erosion (in) 2019 - 2020	Erosion (in) 2020 - 2021	Erosion Rate (in yr-1) 2019 - 2020	Erosion Rate (in yr-1) 2020 - 2021
1	2.54	2.54	2.5	0	-0.04	0.0	0.0
2	10.795	10.795	12	0	1.21	0.0	1.3
3	7.3025	7.62	6.5	0.3175	-1.12	0.3	-1.2
4	4.7625	5.3975	4.5	0.635	-0.90	0.6	-1.0
5	4.445	5.715	0	1.27		1.3	
6	12.7	12.7	12.5	0	-0.20	0.0	-0.2
7	5.08	6.35	6.3	1.27	-0.05	1.3	-0.1
8	7.62	8.89	8.3	1.27	-0.59	1.3	-0.6
9	5.08	8.5725	5	3.4925	-3.57	3.5	-3.8
10	10.16	11.43	4.5	1.27	-6.93	1.3	-7.4
11	5.08	6.35	6.5	1.27	0.15	1.3	0.2
12	7.62	8.89	9	1.27	0.11	1.3	0.1
13	17.78	19.05	19.3	1.27	0.25	1.3	0.3
14	7.62	8.255	7.8	0.635	-0.46	0.6	-0.5
15	7.62	9.525	8	1.905	-1.53	1.9	-1.6
16	7.62	7.62	7	0	-0.62	0.0	-0.7
17	7.62	8.255	7.2	0.635	-1.06	0.6	-1.1
18	5.08	5.715	7.8	0.635	2.09	0.6	2.2
19	10.16	10.16	9.4	0	-0.76	0.0	-0.8
20	7.62	8.255		0.635		0.6	
21	7.62	7.9375	2.5	0.3175	-5.44	0.3	-5.8
22	54.61	54.61		0		0.0	
23	5.08	10.16	7.3	5.08	-2.86	5.1	-3.0
24	7.62	7.62	0	0	-7.62	0.0	-8.1
25	7.62		7	-7.62	7.00		

average, all pins 1.0 -1.5

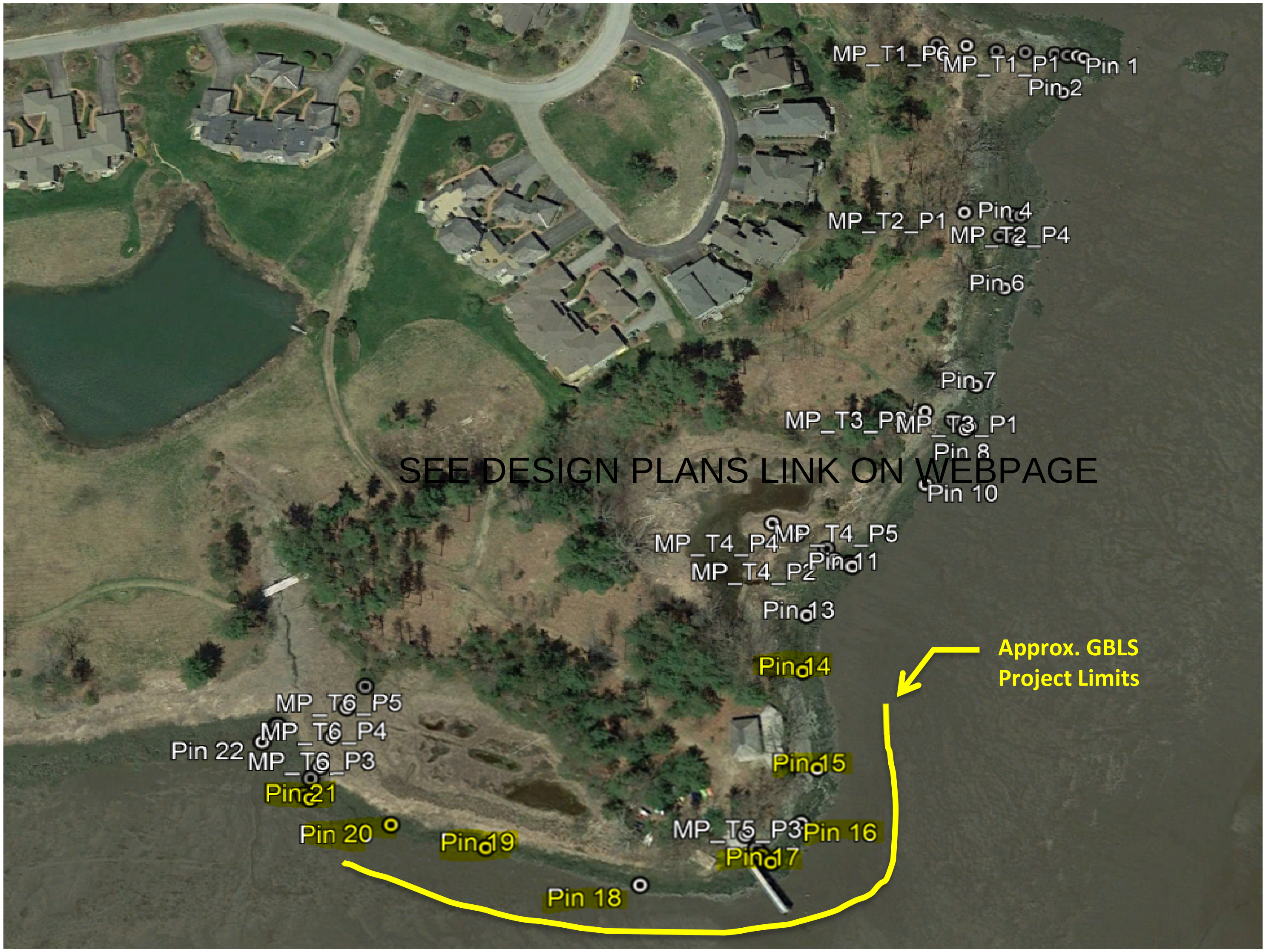
average pins north of dock within GBLS limits (pins 14-17) 0.8 -1.0

average pins west of dock within GBLS limits (pins 18-21) 0.4 -1.5

Pins within approx. limits of the GBLS project (2022). See next page.

UNH "Moore Erosion Study" Shared with GBLS Project for Moody Point

Salt Marsh Erosion Pin Locations with respect to GBLS Project



Coastal Bank Erosion Pins

SEE DESIGN PLANS LINK ON WEBPAGE

<u>Coastal Bank Erosion Pin No. 1</u>:

Location: west side of pier, approx. at apparent High Tide Line and aligned with large tree. Set flush with slope on 13 September 2020.

COASTAL BANK EROSION PIN NO. 2:

Location: east side of pier, near tree with exposed roots on rock. Set with 2.5” of bar protruding from slope on 13 September 2020.

<u>COASTAL BANK EROSION PIN NO. 3</u>:
Location: east of the pier, approx. aligned with deck timber post at top of bank. Set with 2.3" protruding from slope on 13 September 2020.

COASTAL BANK EROSION PIN NO. 4:
Location: east of east end of screenhouse deck, aligned with small pine trees. Set with 3” protruding from slope on 13 September 2020.

Just west of this tree


Screenhouse
Deck
Coastal Bank
Erosion Pin 4
Coastal Bank
Erosion Pin 3
aligns with deck
SEE DESIGN PLANS LINK ON WEBPAGE
Coastal Bank
Erosion Pin 2
East of Pier
Coastal Bank
Erosion Pin 1
West of Pier

Moody Point - Coastal Bank Erosion Pins Set as Part of GBLS Project

Data Collection Table

Coastal Bank Erosion Pin No.	2021 Sept 13	2022 March 16					
	Pin Exposed Length (in)	**Pin Exposed Length (in)**	**Comment**	**Pin Exposed Length (in)**	**Comment**	**Pin Exposed Length (in)**	**Comment**
1	0	0	Pin buried due to slope collapse above. Covered in leaves.				
2	2.5	0	Pin buried due to slope collapse above. Covered in leaves.				
3	2.3	1.10	Evidence of slope collapse. Covered in leaves. Pin NOT reset.				
4	3	1.22	Evidence of slope collapse. Significant undercutting of bank. Covered in leaves. Pin NOT reset.				

Moody Point - Summary of Coastal Bank Erosion Pins Set as Part of GBLS Project

Toe Pin Location	Date	Days Since Previous Reading	Pin Exposed Length (in)	Change Since Previous Reading (in)	Rate of Change Since Previous Reading *	
					in/day	in/year
1	9/13/2021		0.00			
	3/16/2022	184	0.00	0.00	0.00	0.00
2	9/13/2021		2.50			
	3/16/2022	184	0.00	-2.50	-0.01	-4.96
3	9/13/2021		2.30			
	3/16/2022	184	1.10	-1.20	-0.01	-2.38
4	9/13/2021		3.00			
	3/16/2022	184	1.22	-1.78	-0.01	-3.53

* A negative value indicates that the pin was less exposed during the more recent reading. This can occur when the bank above the pin sloughs and accumulates at the pin.

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SITE SPECIFIC WATER DATA

SEE DESIGN PLANS LINK ON WEBPAGE

THE GREAT BAY
LIVING SHORELINE PROJECT

Moody Point Water Levels

Unit	US Survey Feet	P=rho*g*h	h=P/(rho*g)	
Horizontal Datum	NH State Plane	h =	depth	m
Vertical Datum	NAVD88	rho =	1023.6	kg/m3
Survey Date: October 22, 2021		g =	9.80665	m/s2
		P =	Pressure from kg/(m*s2)	
		1 psi =	6894.76	Pascal (kg/m*s2)

Data Collection Period

Pressure transducer was set near the end of the floating dock at mid-afternoon on 13 September 2021.
It was removed at mid-morning on 21 November 2021.
Based on the data, it appears that the transducer was moved on 13 September 2021 around 3:50 PM. This corresponds to the initial set-up relocation. The data collected at that time is excluded from the data processing. It also appears that the transducer was moved on 22 October 2021 based on a change in the data. This likely corresponds to the seasonal removal of the float. Data collected one week before this date through the end of the installation have been excluded from the data processing.

Estimated Mudline at Transducer Location

During site visit on 22 October 2021, topographic survey was completed, including a reading at the transducer location to correlate the collected data to the vertical datum.

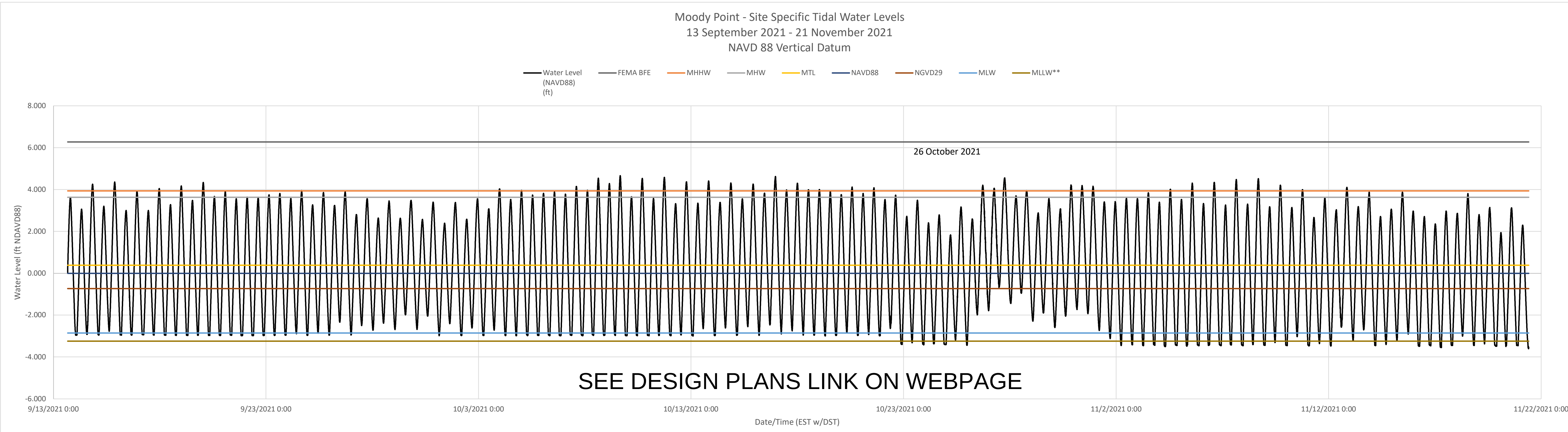
Water Surface Elevation =	-1.144400	ft NAVD88	(22 Oct'21 topo survey at 1050 EST)
Water Depth =	2.280519	ft	(22 Oct' 21 collected data at 1050 EST)
Difference =	3.424919		
Mudline EL =	-3.42	ft NAVD 88	
Max Water Depth =	8.089	ft	(collected data)
Min Water Depth =	-0.178	ft	(collected data)

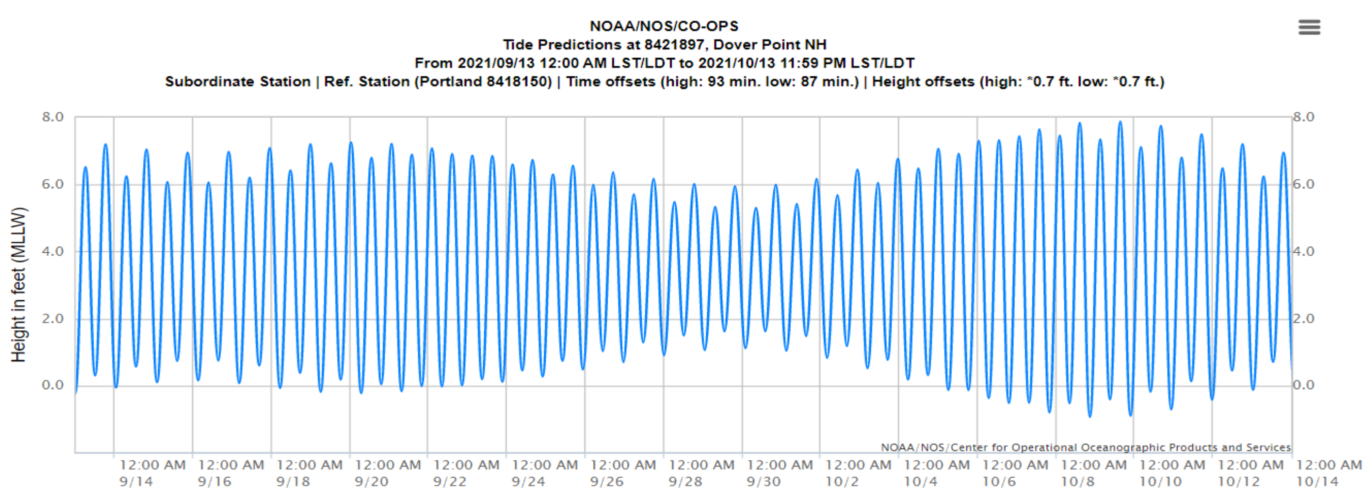
Sample of Collected Data

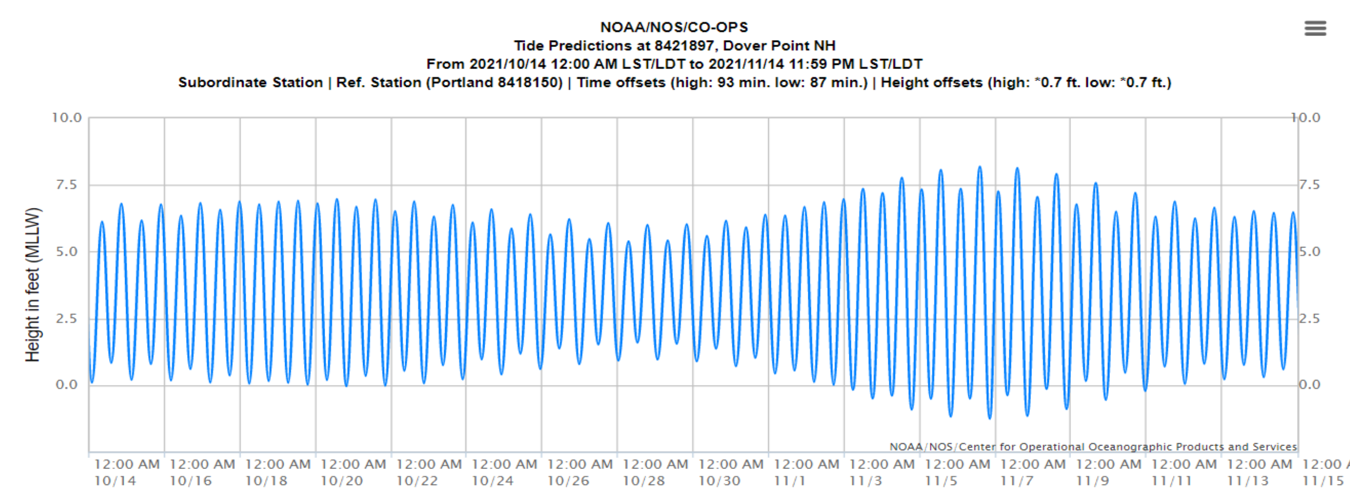
Date Time, GMT-04:00	Barometer (Pascal)	Water Pressure (Pascal)	Air to Water Pressure Difference (Pascal)	Water Depth (m)	Water Depth (m)	Water Depth (ft)	Water Level (NAVD88) (ft)
9/13/2021 15:00	101228.8663	101246.7927	17.9264	10.08626378	0.001785838	0.006	-3.419
9/13/2021 15:05	101217.8347	101250.2401	32.4054	10.08660721	0.003228245	0.011	-3.414
9/13/2021 15:10	101243.3453	101228.8663	-14.479	10.08447794	-0.001442406	-0.005	-3.430
9/13/2021 15:15	101232.3137	101208.182	-24.1317	10.08241736	-0.002404014	-0.008	-3.433
9/13/2021 15:20	101221.2821	101190.9451	-30.337	10.08070021	-0.003022189	-0.010	-3.435
9/13/2021 15:25	101175.7767	101201.2873	25.5106	10.0817305	0.002541381	0.008	-3.417
9/13/2021 15:30	101204.0452	101195.7715	-8.2737	10.08118102	-0.000824231	-0.003	-3.428
9/13/2021 15:35	101195.082	101183.3609	-11.7211	10.07994467	-0.001167663	-0.004	-3.429
9/13/2021 15:40	101186.1188	101173.7082	-12.4106	10.07898306	-0.001236351	-0.004	-3.429
9/13/2021 15:45	101183.3609	101190.9451	7.5842	10.08070021	0.000755542	0.002	-3.422
9/13/2021 15:50	101206.8031	101201.2873	-5.5158	10.0817305	-0.000549487	-0.002	-3.427
9/13/2021 15:51	*0*	*101223.3505*	*101223.3505*	*10.08392845*	*10.08392845*	*33.084*	*29.659*
9/13/2021 15:51	*0*	*111491.7166*	*111491.7166*	*11.10686899*	*11.10686899*	*36.440*	*33.015*
9/13/2021 15:55	101212.3189	111812.3229	10600.004	11.13880798	1.055978501	3.464	0.040
9/13/2021 16:00	101188.8767	112179.1242	10990.2475	11.17534894	1.094854783	3.592	0.167
9/13/2021 16:05	101210.2505	112567.2991	11357.0486	11.21401914	1.13139572	3.712	0.287

Comparison of Moody Point Water Data with NOAA Station Dover Point Tide Predictions

The tidal water level plot of the collected data has similar trends as the predicted tide plots, except around the time of the 26 October 2021 Nor'easter storm. This is a reasonable deviation because the tide predictions are not adjusted for weather.



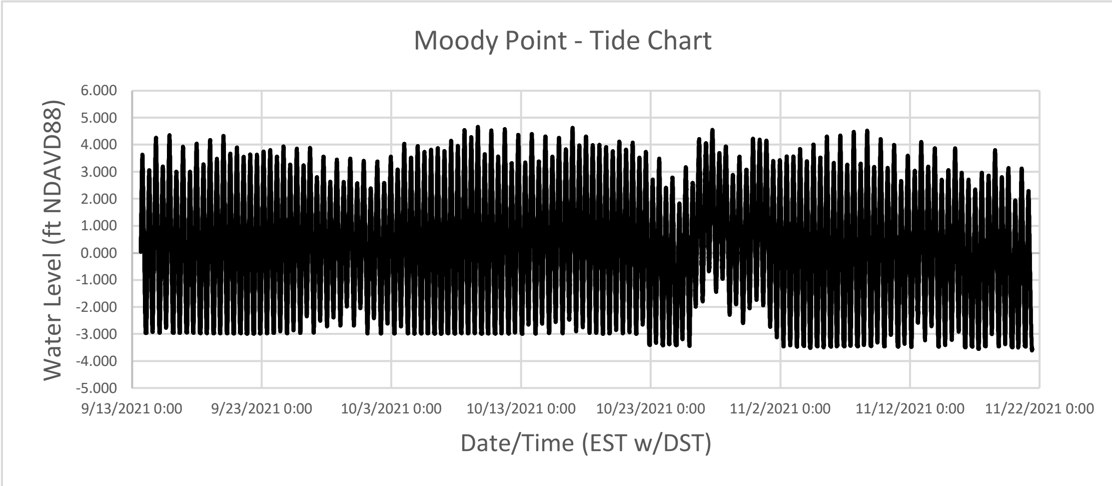




THE GREAT BAY
LIVING SHORELINE PROJECT

Calculate Moody Point Water Level Datums

Use Data from September 14, 2021 at 00:00 to October 11, 2021 at 2355



Date	Water Levels (ft, NAVD88)			
	MHHW	MHW	MLW	MLLW
14-Sep		3.065	-2.949	-2.949
14-Sep	4.256	4.256	-2.915	
15-Sep		3.199	-2.949	-2.949
15-Sep	4.358	4.358	-2.766	
16-Sep		3.004	-2.944	
16-Sep	3.928	3.928	-2.951	-2.951
17-Sep		3.004	-2.921	
17-Sep	4.048	4.048	-2.940	-2.940
18-Sep	3.276	3.276	-2.947	
18-Sep			-2.957	-2.957
19-Sep	4.171	4.171	-2.959	
19-Sep		3.483	-2.962	-2.962
20-Sep	4.335	4.335	-2.949	
20-Sep		3.673	-2.972	-2.972
21-Sep	3.899	3.899	-2.959	
21-Sep		3.560	-2.974	-2.974
22-Sep	3.639	3.639	-2.975	
22-Sep		3.630	-2.976	-2.976
23-Sep		3.748	-2.964	-2.964
23-Sep	3.813	3.813	-2.956	
24-Sep		3.562	-2.889	
24-Sep	3.944	3.944	-2.958	-2.958
25-Sep		3.270	-2.860	
25-Sep	3.854	3.854	-2.950	-2.950
26-Sep		3.243	-2.332	
26-Sep	3.885	3.885	-2.940	-2.940
27-Sep		2.806	-2.468	-2.468
27-Sep	3.557	3.557		
28-Sep		2.641	-2.720	-2.720
28-Sep	3.458	3.458	-2.382	
29-Sep		2.631	-2.686	-2.686

Date	Water Levels (ft, NAVD88)			
	MHHW	MHW	MLW	MLLW
29-Sep	3.486	3.486	-1.987	
30-Sep		2.576	-2.677	-2.677
30-Sep	3.403	3.403	-2.044	
1-Oct		2.391	-2.980	-2.980
1-Oct	3.386	3.386	-2.405	
2-Oct		2.587	-2.973	-2.973
2-Oct	3.556	3.556	-2.615	
3-Oct		3.081	-2.972	-2.972
3-Oct	4.032	4.032	-2.716	
4-Oct	3.528	3.528	-2.980	-2.980
4-Oct			-2.979	
5-Oct	3.957	3.957	-2.976	-2.976
5-Oct		3.739	-2.969	
6-Oct		3.823	-2.973	
6-Oct	3.879	3.879	-2.985	-2.985
7-Oct		3.779	-2.963	
7-Oct	4.148	4.148	-2.976	-2.976
8-Oct		3.960	-2.967	-2.967
8-Oct	4.540	4.540	-2.966	
9-Oct		4.285	-2.964	
9-Oct	4.664	4.664	-2.974	-2.974
10-Oct		3.656	-2.980	-2.980
10-Oct	4.578	4.578	-2.960	
11-Oct		3.576	-2.971	-2.971
11-Oct	4.578	4.578		

See next sheet for averages of each tidal water levels.

THE GREAT BAY
LIVING SHORELINE PROJECT

Calculate Moody Point Water Level Datums Cont'd

Average the daily recorded water level to estimate the site-specific tidal range with respect to NAVD88 datum.

Mean Higher High Water, MHHW =	3.934	ft	
Mean High Water, MHW =	3.632	ft	
Mean Tide Level, MTL =	0.390	ft	(calc'd as the average of MHW and MLW)
Mean Low Water, MLW =	-2.852	ft	
Mean Lower Low Water, MLLW =	-2.919	ft	Note: the mudline at the transducer location approximately corresponded to the low tide elevation. As such, the transducer may have surfaced during lowest tides and not captured the lowest tidal range. Therefore, adjust MLLW by the same difference between MLW and MLLW for the nearest NOAA long-term gauge at Seavey Island (STA No. 8419870). MLLW = -0.32' MLW. Set Moody Point MLLW at -0.32' to MLW.
MLLW adjustment =	-0.32	ft	
Estimated MLLW =	-3.239	ft	
North American Vertical Datum 1988,=	0	ft	NAVD88 (Reference Vertical Datum)
National Geodetic Vertical Datum 1929 =	-0.728	ft	Based on NOAA STA Seavey Island, ME
FEMA Base Flood Elevation =	6.5	ft	FIS 33015CV001B, January 29, 2021 See attached.

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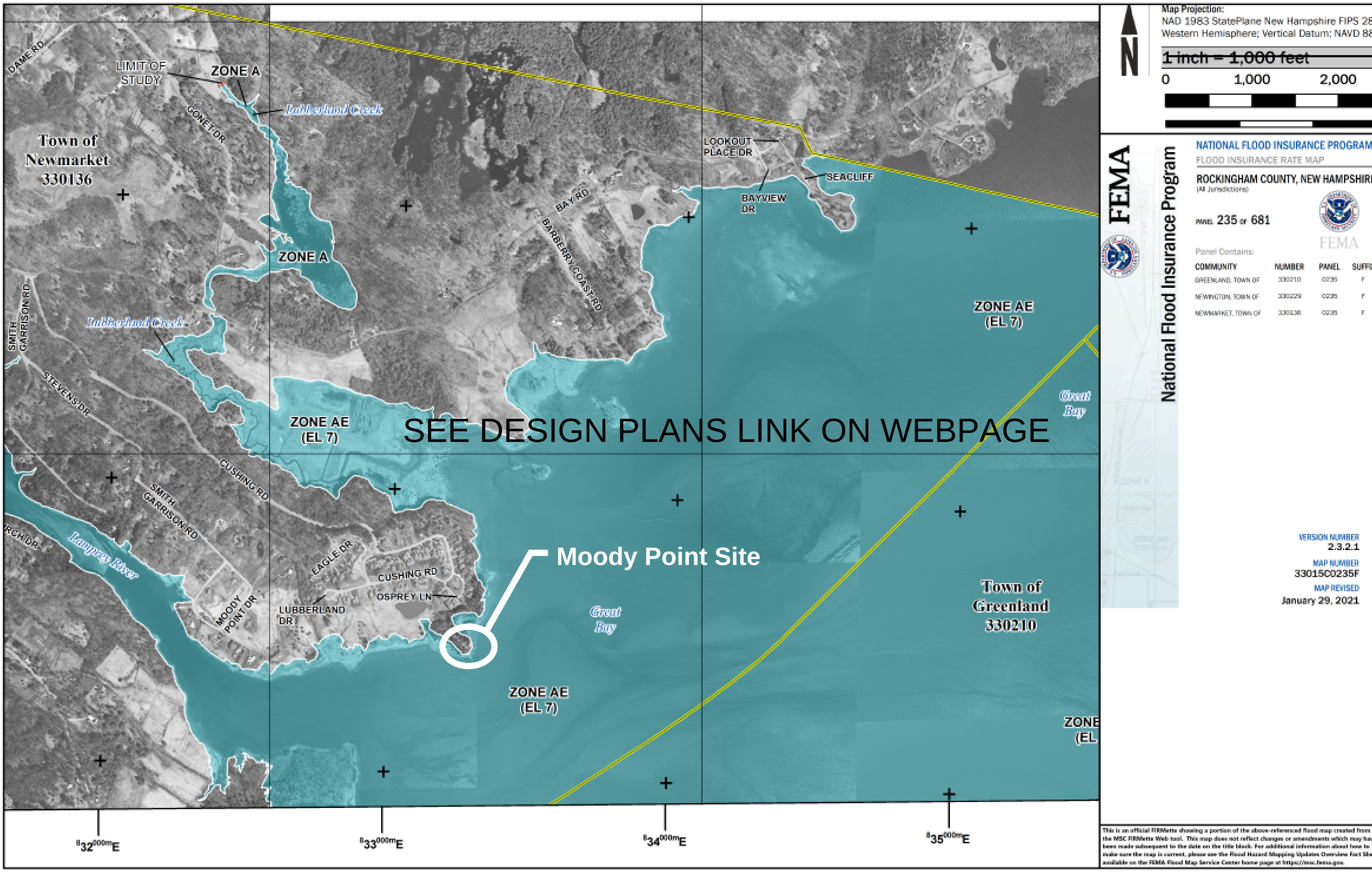
FIRMETTE Created of FEMA FIRM 33015CO235F dated January 29, 2021



reduced

Excerpt of FEMA FIS 33015CV001B dated January 29, 2021

TABLE 5 – SUMMARY OF STILLWATER ELEVATIONS

SEE DESIGN PLANS LINK ON WEBPAGE

Flooding Source and Location	Elevation (feet NGVD[1], NAVD[2])			
	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
ADAMS POND				
At Derry	326.0[1]	327.1[1]	327.3[1]	328.1[1]
ATLANTIC OCEAN				
Entire shoreline from New Castle to Seabrook	7.24[2]	7.98[2]	8.36[2]	9.43[2]
Isles of Shoals, entire shoreline	7.24[2]	7.98[2]	8.36[2]	9.43[2]
BEAVER LAKE				
At Derry	287.9[1]	289.3[1]	289.6[1]	294.0[1]
COUNTRY POND				
Entire shoreline within Kingston	*	*	120.8[1]	*
GREAT BAY				
Entire shoreline of the Squamscott River within the Exeter corporate limits to a point approximately 970 feet downstream of Chestnut Hill Avenue	6.4[2]	6.9[2]	7.2[2]	7.7[2]
Entire shoreline within Greenland and Newington, and the entire shoreline of Great Bay and Lamprey River downstream of MacCallen Dam in Newmarket	5.7[2]	6.3[2]	6.5[2]	7.1[2]
Entire shoreline of the Squamscott River within Newfields, and the entire shoreline with Stratham	6.2[2]	6.8[2]	7.0[2]	7.5[2]

[1] National Geodetic Vertical Datum of 1929

[2] North American Vertical Datum of 1988

*Data not available

PRELIMINARY METOCEAN AND WAVE ANALYSIS

SEE DESIGN PLANS LINK ON WEBPAGE

Prepared for

THE GREAT BAY LIVING SHORELINE PROJECT

INTERNAL MEMORANDUM

To: Cheryl Coviello, PE GZA

From: Michael E. Gardner, GZA
Daniel C. Stapleton, PE GZA

Date: March 23, 2022

Project No.: 09.P000092.22

Re: Preliminary Metocean and Wave Analysis
Moody Point Shoreline
Newmarket, New Hampshire

GZA GeoEnvironmental, Inc. (GZA) performed a preliminary metocean data wave analysis for the shoreline at Moody Point in Newmarket, NH. The analysis includes prevailing wind-wave conditions as well as coastal storm conditions up to a 100-year recurrence interval flood.

The project location is presented in **Figures 1** and **2**. The project site is located along the southwestern shoreline of Moody Point, within Great Bay and is hydraulically connected to the Gulf of Maine and Atlantic Ocean through the Piscataqua River. Great Bay is a sheltered bay and waves affecting Moody Point are wind-waves generated within the Bay.

The site consists of a coastal bank with marsh and beach. We understand that the project shoreline is experiencing erosion and also that a Living Shoreline approach is being considered as a shoreline stabilization method.

This memorandum summarizes the results of GZA's preliminary metocean and wave analysis and presents preliminary recommendations for design wave heights and periods associated with prevailing winds, as well as a 1, 5 and 100-year recurrence interval coastal flood event under current sea level conditions. Additional water levels and recurrence interval events can be provided if requested. Living Shorelines are typically designed in consideration of marsh survivability relative to wave climatology, including empirical correlations to wave height. The H_{20} significant wave height (representing 80% of the waves affecting the shoreline) are often used as a benchmark for the maximum allowable wave-induced bottom stresses. A preliminary estimate of the H_{20} significant wave height is provided, representing the prevailing wind-wave conditions.

The water levels presented here reference NAVD88 (feet) datum.

Additional analyses are recommended for final design to refine the design wave characteristics, including: 1) detailed bathy-topo analysis; 2) comprehensive prevailing wave analysis; and 3) numerical wave modeling using the SWAN model.

This preliminary analysis has not considered future conditions associated with climate change including potential relative sea level rise.

METHODOLOGY

For this preliminary study, GZA completed:

1. A brief metocean data analysis to characterize prevailing and extreme event conditions (wind, water levels and waves) associated with the prevailing winds 1 through 100-year recurrence interval flood event using available data sources including:

   a. the effective FEMA Flood Insurance Study (FIS) (**Attachment 4**);
   b. the NOAA tide station at Seavey Island, ME;
   c. GZA's statistical analysis of observed wind data from the Pease International Airport; and
   d. ASCE 7-16 3-second wind speeds.

2. GZA performed simplified analytical calculations to predict the following wave characteristics associated with the prevailing (H_{20}), 1, 5 and 100-year recurrence wind conditions. The airport directional and all-direction wind data (GZA statistical analysis) was used for the wave analyses.

COASTAL SETTING

The project site is located within the southwestern portion of Great Bay, a sheltered waterbody which is hydraulically connected to the Gulf of Maine and to the Atlantic Ocean by the Piscataqua River. **Attachment 1** presents the NOAA nautical chart for the site vicinity as well as the tidal datums for the nearest NOAA tidal gauge, Seavey Island, ME. The coastal setting of the site consists of sheltered bays and channels bordered by topographic points. The NOAA chart, as well as aerial photographs (**Attachment 1** - Google Earth) indicate shallow water conditions along the site shoreline.

The predominant coastal storm type in the project area is an extratropical low-pressure storm (Nor'easter) that generally occurs between September and April.

WATER LEVELS

Tidal datums are available for the current tidal epoch at the NOAA Seavey Island Tidal Station and are presented relative to NAVD88 in **Attachment 1**. The 100-year recurrence interval (1%AEP) flood stillwater elevation is AE 7 feet NAVD88 (see **Attachment 3**).

WIND SPEEDS

GZA has developed wind speeds for the project area for purposes of estimating wave characteristics, based on statistical analysis of observed 1 and 2-minute duration, sustained wind speeds at 10-meter elevation from Pease International Airport. Wind speeds are presented in **Attachment 2** and **Table 1**. For wave calculation, with the exception of the prevailing winds, the adjusted design wind speeds were assumed to be all-directional winds.

For comparison, ASCE 7 winds (representing an ASCE Exposure C terrain scenario - roughly open terrain) were reviewed. The ASCE 7-16 3-second gusts were adjusted for time averaging (duration required for the wave to be fetch-limited over the transects evaluated. The ASCE 7-16 3-second gust wind speed at 10 meters for the 100-year recurrence interval wind event is 95 mph, transformed to a 2-minute sustained wind speed is approximately 61 mph, about 10 mph greater than the statistical trend of the all-direction airport wind data.

WAVE CHARACTERISTICS

Wave characteristics were evaluated over multiple transects extending out from the site to the regions of greatest fetch exposure (see **Attachment 3**). These fetch lengths were simplified to three representative design transects (from the NE, E and SE respectively).

Wind-generated waves were developed using GZA calculation spreadsheets based on methods presented in the USACE Coastal Engineering Manual. Calculation input and results are summarized on **Table 1**.

Based on an assumed Rayleigh wave distribution, larger waves within the spectrum are estimated as:

- $H_{1/10}$ = 1.27 x H_s
- $H_{1/100}$ = 1.67 x H_s

The FEMA flood hazard zone classification of AE indicates wave heights equal to or less than 3 feet associated with the 100-year recurrence interval flood. The 100-year recurrence interval wind-generated waves presented in **Table 1** are approximately 3 feet. The FEMA Flood Insurance Study (FIS) does not include coastal transects within the Bay or provide details as to the wave development.

SEE DESIGN PLANS LINK ON WEBPAGE

Tables

SEE DESIGN PLANS LINK ON WEBPAGE

Fetch Direction	Recurrence Interval Condition	Design Fetch (ft)	Wind Speed (mph)	Input Wind Duration (minutes)	Wave Height ($H_{1/3}$)	Wave Period (T_p)
NE	Prevailing*	17,424	11	2	0.5	1.3
E	Prevailing*	19,008	10	2	0.5	1.3
SE	Prevailing*	20,064	10	2	0.5	1.4
NE	1YR	17,424	18	2	0.9	1.6
E	1YR	19,008	16	2	0.8	1.6
SE	1YR	20,064	16	2	0.8	1.6
NE	5YR	17,424	34	2	1.8	2.0
E	5YR	19,008	32	2	1.7	2.1
SE	5YR	20,064	32	2	1.8	2.1
NE	100YR	17,424	52	2	2.9	2.4
E	100YR	19,008	52	2	3.0	2.5
SE	100YR	20,064	52	2	3.1	2.5

* Representing the significant wave height of 80% of total waves (H_{20})

Table 1 - GZA Wind and Wave Characteristics Over Transects

SEE DESIGN PLANS LINK ON WEBPAGE

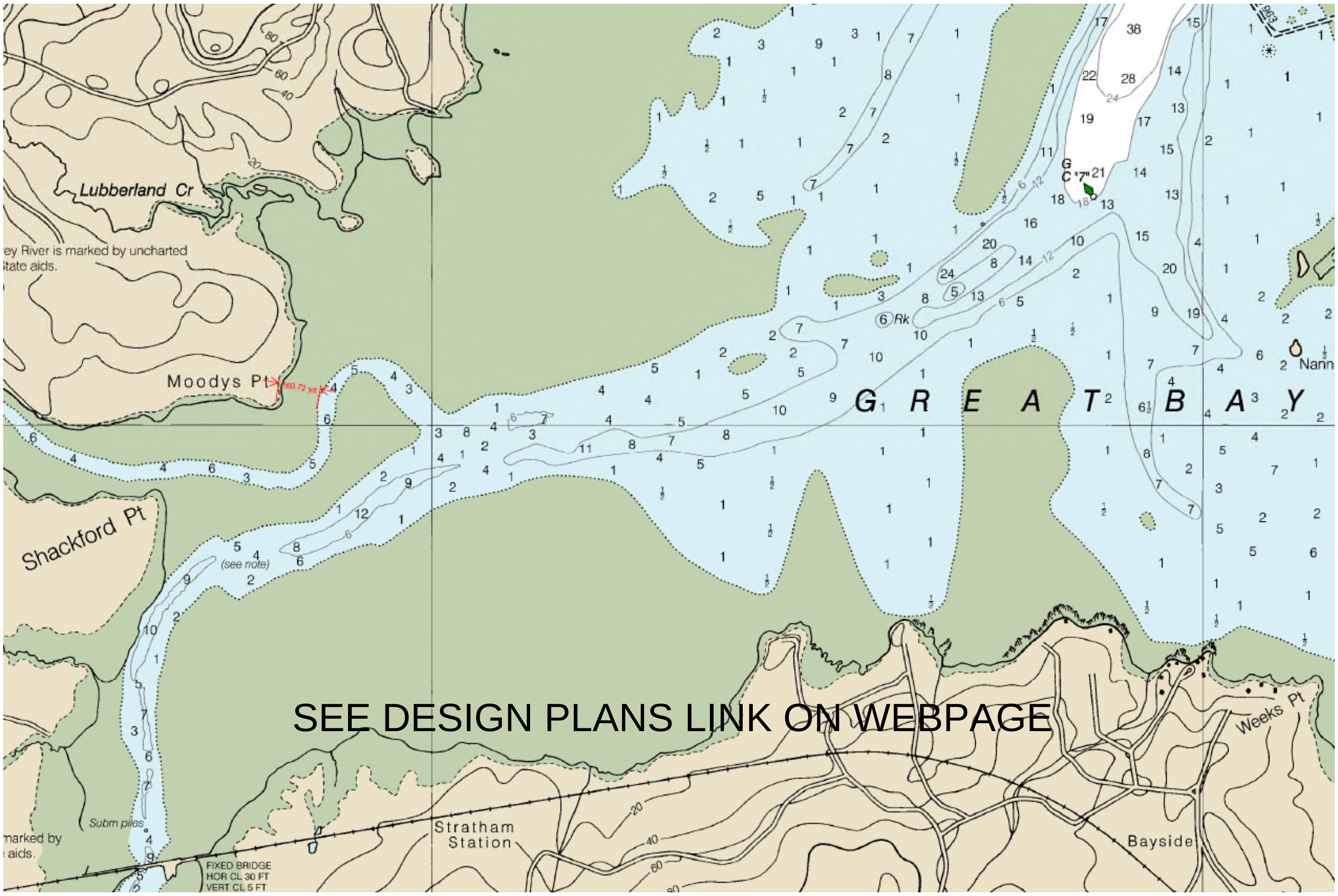
Figures

Figure 1: Site Locus

Figure 2: Site Location

Attachment 1

SEE DESIGN PLANS LINK ON WEBPAGE



Soundings in Feet at Mean Lower Low Water (MLLW)

Note: MLLW = -4.71 feet NAVD88

Google Earth Image of Site Vicinity (same image as NOAA Nautical Chart shown above)

Elevations on NAVD88

Station: 8419870, Seavey Island, ME
Status: Accepted (Dec 6 2021)
Units: Feet
Control Station: 8418150 Portland, ME
T.M.: 0
Epoch: 1983-2001
Datum: NAVD88

Datum	Value	Description
MHHW	4.18	Mean Higher-High Water
MHW	3.76	Mean High Water
MTL	-0.32	Mean Tide Level
MSL	-0.25	Mean Sea Level
DTL	-0.26	Mean Diurnal Tide Level
MLW	-4.39	Mean Low Water
MLLW	-4.71	Mean Lower-Low Water
NAVD88	0.00	North American Vertical Datum of 1988
STND	-6.98	Station Datum
GT	8.89	Great Diurnal Range
MN	8.16	Mean Range of Tide
DHQ	0.42	Mean Diurnal High Water Inequality
DLQ	0.31	Mean Diurnal Low Water Inequality
HWI	3.92	Greenwich High Water Interval (in hours)
LWI	10.04	Greenwich Low Water Interval (in hours)
Max Tide	7.89	Highest Observed Tide
Max Tide Date & Time	02/07/1978 10:42	Highest Observed Tide Date & Time
Min Tide	-7.98	Lowest Observed Tide
Min Tide Date & Time	11/30/1955 00:00	Lowest Observed Tide Date & Time
HAT	5.87	Highest Astronomical Tide
HAT Date & Time	11/15/2016 16:18	HAT Date and Time
LAT	-6.51	Lowest Astronomical Tide
LAT Date & Time	01/14/2036 23:00	LAT Date and Time

Tidal Datum Analysis Periods
07/01/2020 - 06/30/2021

NOAA Seavey Island (Portsmouth, NH) Tide Station Datums

Attachment 2

SEE DESIGN PLANS LINK ON WEBPAGE

PSM Wind Data Summary

Hourly wind data at the Pease International Tradeport was downloaded from the National Centers for Environmental Information (NCEI). The record covers 1956 through present, a total of 64 years, from dataset by NCDC.

USAF-WBAN ID	Station Name	Lat (deg)	Long (deg)	Elevation (ft)	Period of Record
726055 04743	Pease International Tradeport	43.083	-70.817	30.5	2006 through 2019
726055 99999	Pease International Tradeport	43.083	-70.817	31.0	1956 through 2005

GZA Evaluation (Updated 08/2019):

GZA compiled and analyzed wind data from the Pease International Tradeport (PSM). GZA conducted statistical analysis of the wind data representing both the prevailing and extreme conditions. The data source is: NOAA's National Centers for Environmental Information (formerly the National Climatic Data Center (NCDC), data accessible at https://www.ncdc.noaa.gov/). The available wind record at Pease International Tradeport (PSM) includes a 64-year record (between 1956 and 2019) of hourly wind data of speed and direction (10-meter, 1 and 2-minute averaging duration).

The wind information includes:

- Prevailing Winds: The **prevailing wind** is the wind that blows most frequently across a particular region. Specifically, it is the dominant, non-storm wind that blows most frequently across a particular region. GZA's prevailing wind figure indicates the 1 and 2-minute, 10-meter sustained wind speed cumulative non-exceedance probability (in percent and miles per hour) of the complete wind dataset, analyzed by 22.5-degree directional bins and cumulatively for all directions. Directions are presented as clockwise from true north and indicate the direction from which the winds blow.

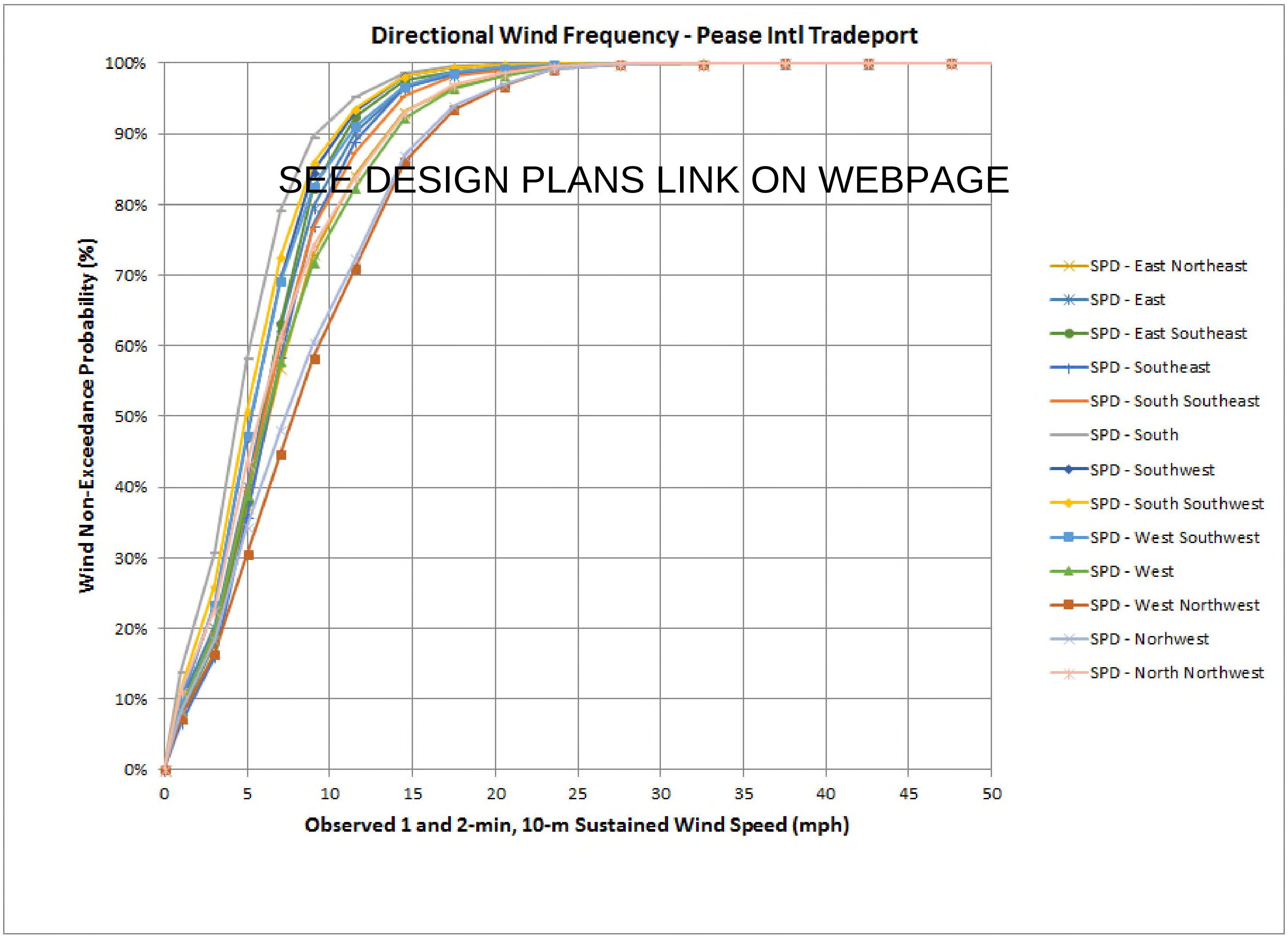
- Wind Roses: A wind rose is a graphic tool that presents a succinct view of how wind speed and direction are typically distributed at a particular location. Presented in a circular format, the wind rose shows the frequency of winds blowing from differing directions over a specified period. The length of each "spoke" around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each concentric circle represents a different frequency, emanating from zero at the center to increasing frequencies at the outer circles. Wind roses typically use 16 cardinal directions, such as north (N), NNE, NE, etc., although they may be subdivided into as many as 32 directions. In terms of angle measurement in degrees, North corresponds to 0°/360°, East to 90°, South to 180° and West to 270°. The information presented includes: 1) the entire wind data set; 2) seasonally-binned wind data (i.e., spring, summer, fall, winter); and 3) intensity-binned wind data (six categories of magnitude from winds 0-10 mph to winds greater than 50 mph). The results presented include the 1 and 2-minute, 10-meter sustained wind speed in mph.

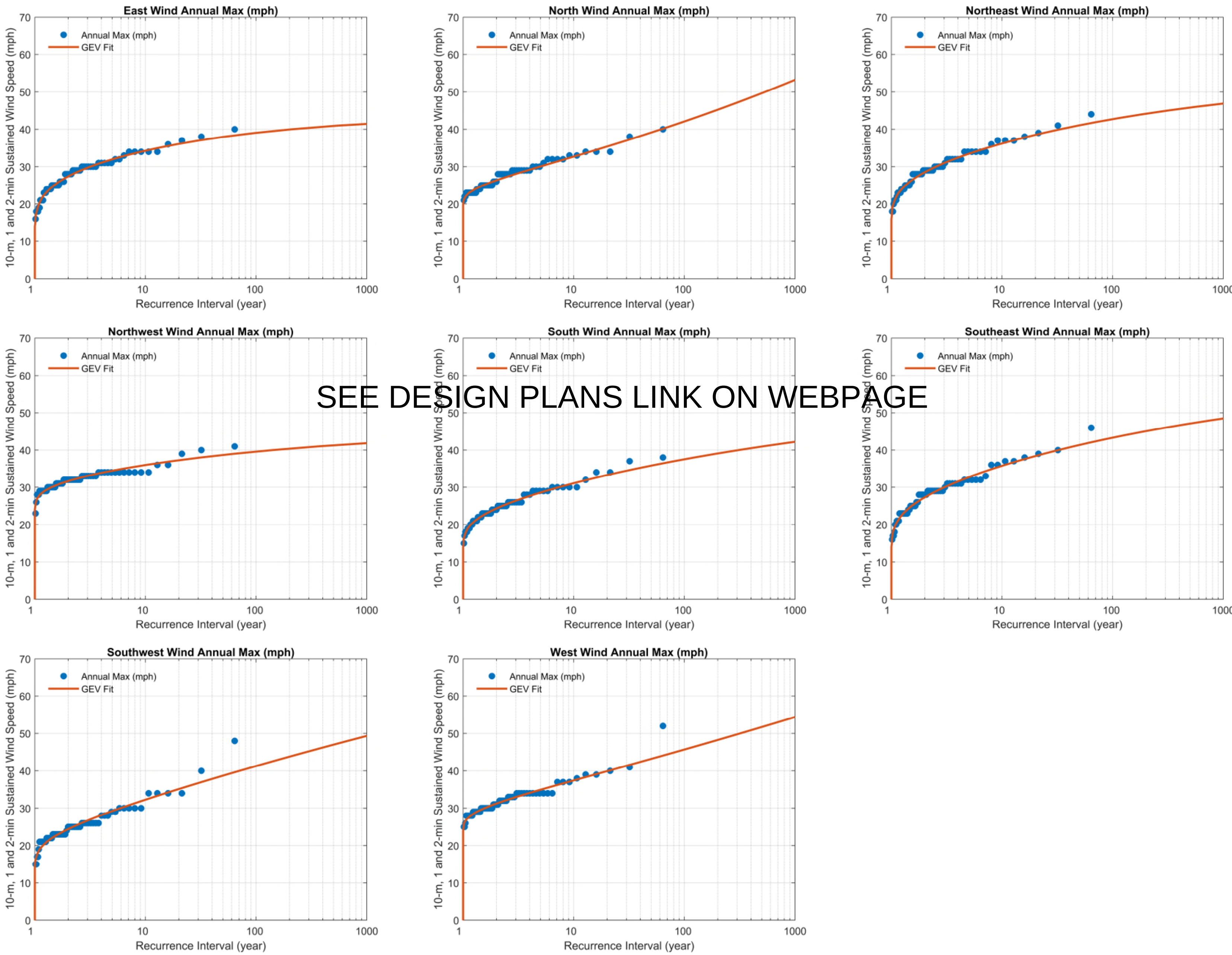
- Extreme Winds: Extreme Winds include those wind events that exceed typical prevailing winds and are typically associated with tropical depressions and cyclones, extratropical cyclones such as Nor'easters and convective and non-convective events including tornados and thunderstorms. GZA performed statistical analysis of the observed

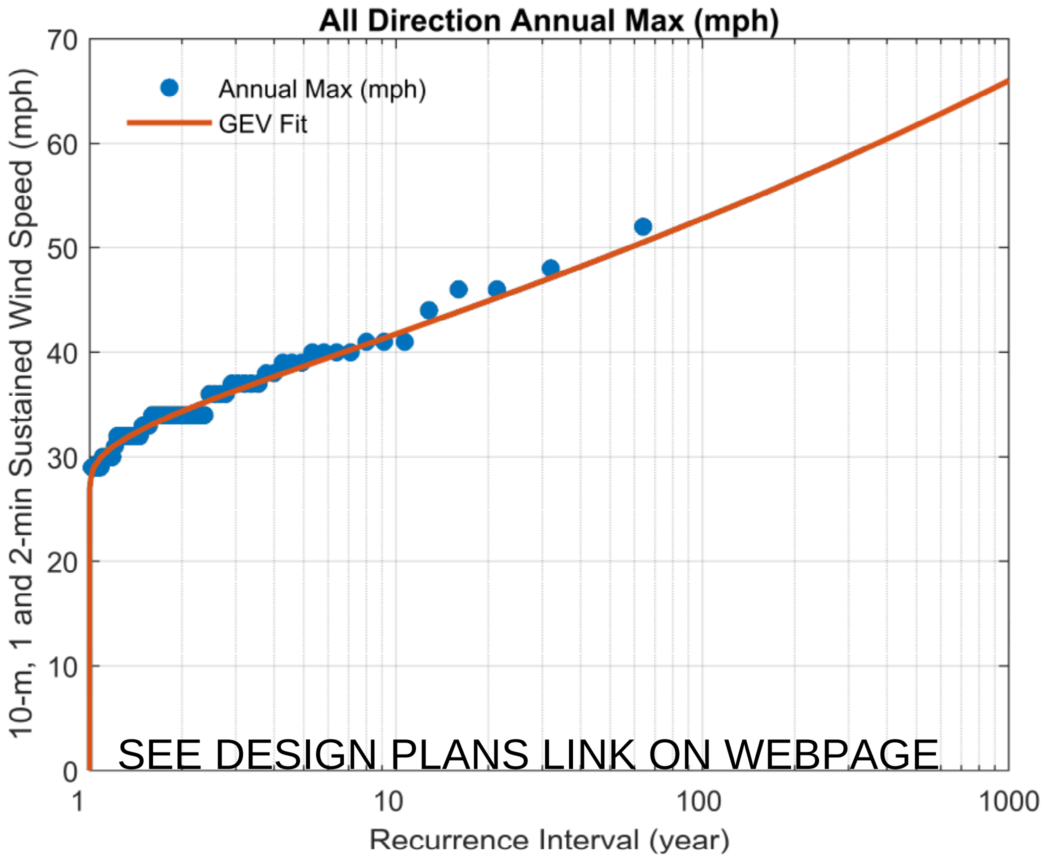
1 and 2-minute, 10-meter sustained monthly maximum wind data extracted from the data set, using the Generalized Extreme Value (GEV) distribution and the MathWorks© software (MATLAB). The three cases covered by the GEV distribution are often referred to as the Types I, II, and III. Each type corresponds to the limiting distribution of block maxima from a different class of underlying distributions. Statistical analyses were performed for the complete wind dataset for all-direction and for eight directional 45-degree data bins (i.e., North, Northeast, East, Southeast, South Southwest, West, and Northwest). GZA's Extreme Wind Frequency results include the Best Fit of the 1 and 2-minute, 10-meter sustained wind speed annual exceedance probability (in terms of recurrence interval in years and wind speed in miles per hour). Directions are presented as clockwise from true north and indicate the direction from which the winds blow.

Limitations

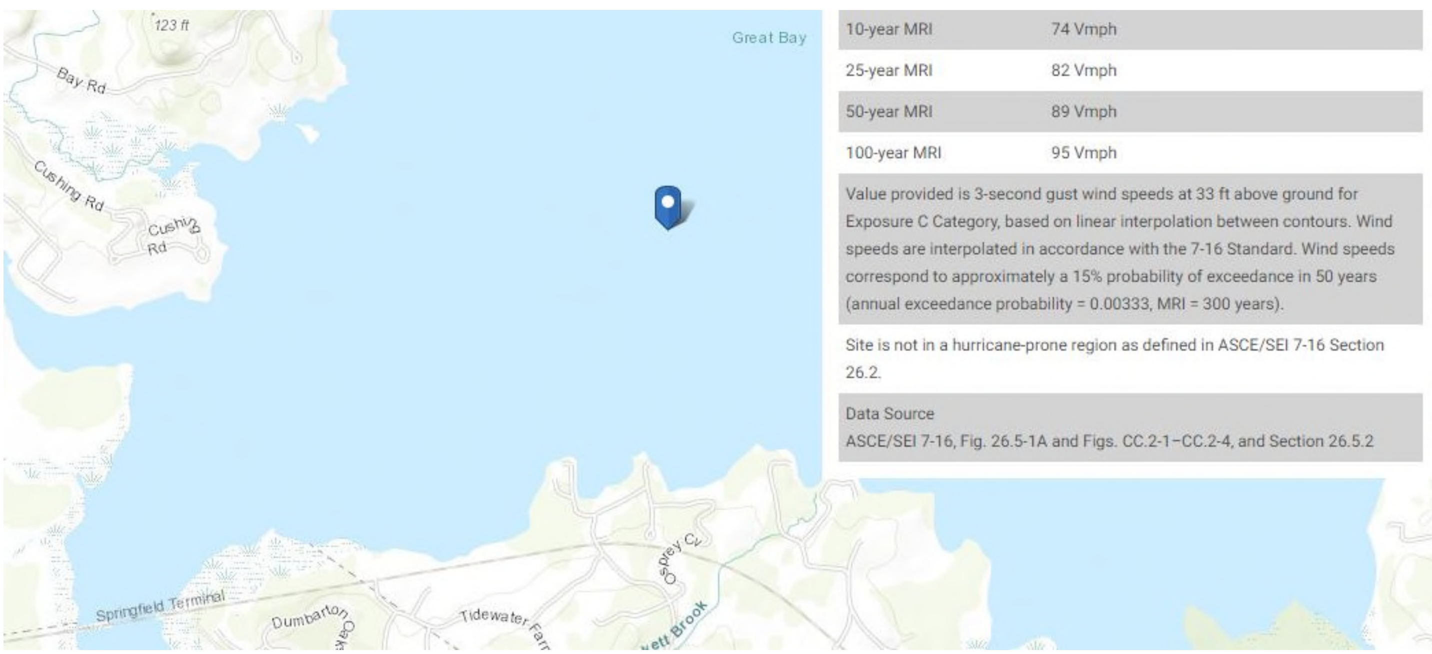
The period of record does not include certain significant wind events (e.g., the Hurricane of '38), which inclusion may significantly influence the statistical analysis. Wind speed recommendations presented in ASCE 7-10 and 7-16 should be reviewed and compared for consistency. The limited data set analyzed in the directional wind analysis may result in significant analysis uncertainty. The selection of wind speeds for design is based on available data and engineering judgement.




East Wind Annual Max (mph)
North Wind Annual Max (mph)
Northeast Wind Annual Max (mph)
Northwest Wind Annual Max (mph)
South Wind Annual Max (mph)
Southeast Wind Annual Max (mph)
Southwest Wind Annual Max (mph)
West Wind Annual Max (mph)
Annual Max (mph)
GEV Fit
10-m, 1 and 2-min Sustained Wind Speed (mph)
Recurrence Interval (year)
0
10
20
30
40
50
60
70
1
10
100
1000



ASCE 7-16 Winds



10-year MRI	74 Vmph
25-year MRI	82 Vmph
50-year MRI	89 Vmph
100-year MRI	95 Vmph

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (annual exceedance probability = 0.00333, MRI = 300 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

Data Source
ASCE/SEI 7-16, Fig. 26.5-1A and Figs. CC.2-1–CC.2-4, and Section 26.5.2

Attachment 3

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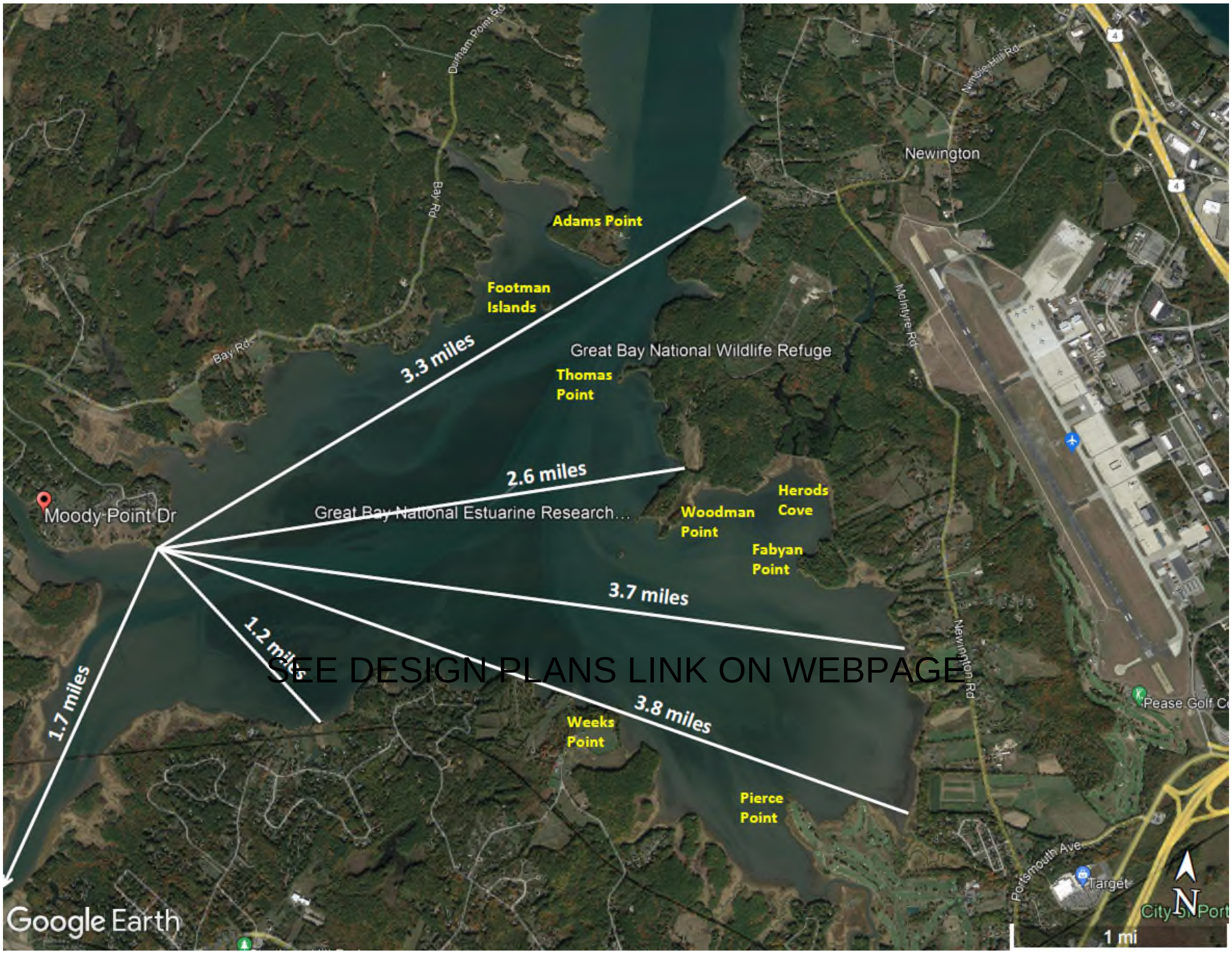

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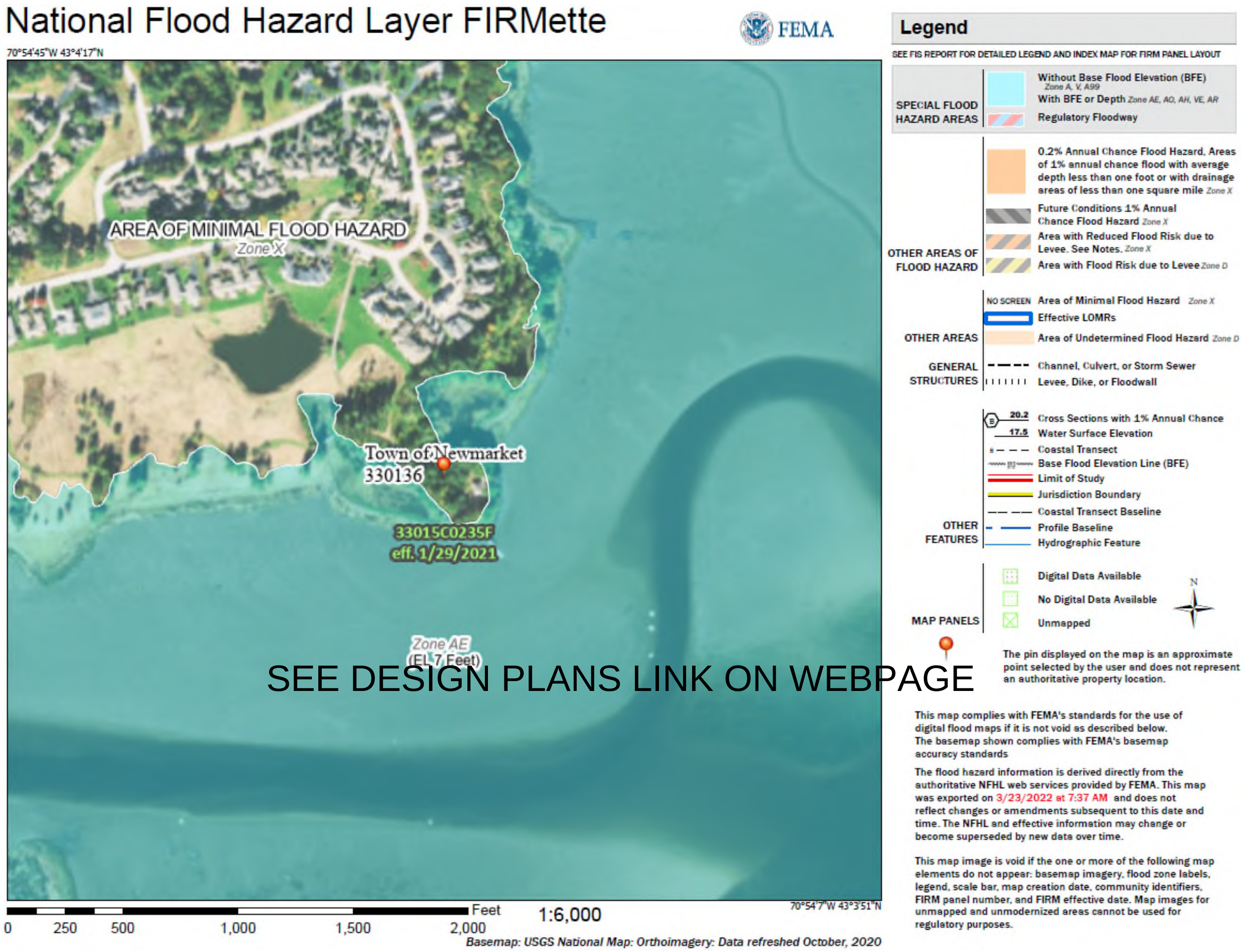
Attachment 4

SEE DESIGN PLANS LINK ON WEBPAGE



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PROJECTED SEA LEVEL RISE

SEE DESIGN PLANS LINK ON WEBPAGE

Excerpt from New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections (3-24-2020)

Great Bay Living Shoreline Project - Moody Point Site
Design SLR
4 January 2022

STEP 2 TABLE. FRAMEWORK FOR DETERMINING PROJECT TOLERANCE FOR FLOOD RISK.

		HIGH TOLERANCE FOR FLOOD RISK	**MEDIUM** TOLERANCE FOR FLOOD RISK	**LOW** TOLERANCE FOR FLOOD RISK	**VERY LOW** TOLERANCE FOR FLOOD RISK
DESCRIPTION		Decision makers have a High tolerance for flood risk to the project	Decision makers have a Medium tolerance for flood risk to the project	Decision makers have a Low tolerance for flood risk to the project	Decision makers have a Very Low tolerance for flood risk to the project
POSSIBLE PROJECT CHARACTERISTICS *Tolerance for flood risk will depend on the mix and importance of these project characteristics.*		Low value or cost	Medium value or cost	High value or cost	Very high value or cost
		Easy or likely to adapt	Moderately easy or somewhat likely to adapt	Difficult or unlikely to adapt	Very difficult or very unlikely to adapt
		Little to no implications for public function and/or safety	Moderate implications for public function and/or safety	Substantial implications for public function and/or safety	Critical implications for public function and/or safety
		Low sensitivity to inundation	Moderate sensitivity to inundation	High sensitivity to inundation	Very high sensitivity to inundation
PROJECT EXAMPLES	**PLANNING**	SEE DESIGN PLANS LINK ON WEBPAGE Updating a local master plan Developing a capital improvement plan			
	REGULATORY	Updating a floodplain zoning ordinance Updating a subdivision site plan regulation Updating state alteration of terrain rules			
	SITE-SPECIFIC	Designing a walking path; Siting a temporary or accessory structure; Upgrading a minor storage facility	Replacing a local culvert; Constructing a residential, commercial, or industrial building	Maintaining a school; Siting a community center or recreational facility; Upgrading a wastewater treatment plant	Renovating a hospital or police/fire station; Siting an emergency shelter or response center; Repairing a power station
CORRESPONDING ASCE 24-14[14,15] FLOOD DESIGN CLASS		1	2	3	4
RECOMMENDED COASTAL FLOOD RISK PROJECTIONS		Lower magnitude, Higher probability	⟵	⟶	Higher magnitude, Lower probability

Excerpt from New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections (3-24-2020)

Great Bay Living Shoreline Project - Moody Point Site
Design SLR
4 January 2022

STEP 3 TABLE A. RECOMMENDED DECADAL RSLR ESTIMATES (IN FEET ABOVE 2000 LEVELS) BASED ON RCP 4.5, PROJECT TIMEFRAME, AND TOLERANCE FOR FLOOD RISK.

TIMEFRAME	HIGH TOLERANCE FOR FLOOD RISK	MEDIUM TOLERANCE FOR FLOOD RISK	LOW TOLERANCE FOR FLOOD RISK	VERY LOW TOLERANCE FOR FLOOD RISK
	Plan for the following RSLR estimate (ft)* *compared to sea level in the year 2000*			
	Lower magnitude, Higher probability	⟵	⟶	Higher magnitude, Lower probability
2030	0.7	0.9	1.0	1.1
2040	1.0	1.2	1.5	1.6
2050	1.3	1.6	2.0	2.3
2060	1.6	2.1	2.6	3.0
2070	2.0	2.5	3.3	3.7
2080	2.3	3.0	3.9	4.5
2090	2.6	3.4	4.6	5.3
2100	2.9	3.8	5.3	6.2
2110	3.3	4.4	6.1	7.3
2120	3.6	4.9	7.0	8.3
2130	3.9	5.4	7.9	9.3
2140	4.3	5.9	8.9	10.5
2150	4.6	6.4	9.9	11.7

SEE DESIGN PLANS LINK ON WEBPAGE

*The colors (blue, red, purple, green) in Step 3 Table A correspond with the colors of the graph depicted in Figure 2 (see also Figure 4.5 in *Part I: Science*[17]). The RSLR estimates for High tolerance for flood risk projects correspond with K14, upper end of "likely" estimates for RCP4.5 (83% chance RSLR will not exceed this value). The RSLR estimates for Medium tolerance for flood risk projects correspond with K14, 1-in-20 chance estimates for RCP 4.5. The RSLR estimates for Low tolerance for flood risk projects correspond with K14, 1-in-100 chance estimates for RCP 4.5. The RSLR estimates for Very Low tolerance for flood risk projects correspond with K14, 1-in-200 chance estimates for RCP4.5. For K14, 1-in-1000 chance estimates, see Table 4.2 in *Part I: Science*.[17] Note that while the Bayesian probabilities associated with RSLR projections are useful, they have some limitations as described in Box 4.3 in *Part I: Science*.[17]

Excerpt from ASCE 24-14 Flood Resistant Design and Construction

Great Bay Living Shoreline
Project - Moody Point Site
Design SLR
4 January 2022

Table 1-1 Flood Design Class of Buildings and Structures

Use or Occupancy of Buildings and Structures	Flood Design Class
Buildings and structures that normally are unoccupied and pose minimal risk to the public or minimal disruption to the community should they be damaged or fail due to flooding. Flood Design Class 1 includes (1) temporary structures that are in place for less than 180 days, (2) accessory storage buildings and minor storage facilities (does not include commercial storage facilities), (3) small structures used for parking of vehicles, and (4) certain agricultural structures.[a]	1
Buildings and structures that pose a moderate risk to the public or moderate disruption to the community should they be damaged or fail due to flooding, except those listed as Flood Design Classes 1, 3, and 4. Flood Design Class 2 includes the vast majority of buildings and structures that are not specifically assigned another Flood Design Class, including most residential, commercial, and industrial buildings.	2
Buildings and structures that pose a high risk to the public or significant disruption to the community should they be damaged, be unable to perform their intended functions after flooding, or fail due to flooding. Flood Design Class 3 includes (1) buildings and structures in which a large number of persons may assemble in one place, such as theaters, lecture halls, concert halls, and religious institutions with large areas used for worship; (2) museums; (3) community centers and other recreational facilities; (4) athletic facilities with seating for spectators; (5) elementary schools, secondary schools, and buildings with college or adult education classrooms; (6) jails, correctional facilities, and detention facilities; (7) healthcare facilities not having surgery or emergency treatment capabilities; (8) care facilities where residents have limited mobility or ability, including nursing homes but not including care facilities for five or fewer persons; (9) preschool and child care facilities not located in one- and two-family dwellings; (10) buildings and structures associated with power generating stations, water and sewage treatment plants, telecommunication facilities, and other utilities which, if their operations were interrupted by a flood, would cause significant disruption in day-to-day life or significant economic losses in a community; and (11) buildings and other structures not included in Flood Design Class 4 (including but not limited to facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.[b]	3
Buildings and structures that contain essential facilities and services necessary for emergency response and recovery, or that pose a substantial risk to the community at large in the event of failure, disruption of function, or damage by flooding. Flood Design Class 4 includes (1) hospitals and health care facilities having surgery or emergency treatment facilities; (2) fire, rescue, ambulance, and police stations and emergency vehicle garages; (3) designated emergency shelters; (4) designated emergency preparedness, communication, and operation centers and other facilities required for emergency response; (5) power generating stations and other public utility facilities required in emergencies; (6) critical aviation facilities such as control towers, air traffic control centers, and hangars for aircraft used in emergency response; (7) ancillary structures such as communication towers, electrical substations, fuel or water storage tanks, or other structures necessary to allow continued functioning of a Flood Design Class 4 facility during and after an emergency; and (8) buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.[b]	4

[a] Certain agricultural structures may be exempt from some of the provisions of this standard; see Section C1.4.3.

SEE DESIGN PLANS LINK ON WEBPAGE

[b] Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for assignment to a lower Flood Design Class if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.3 of *Minimum Design Loads for Buildings and Other Structures* that a release of the substances is commensurate with the risk associated with that Flood Design Class.

vertical loads, including uplift and lateral loads in accordance with the load combinations specified in Section 1.6.2.

Stringers or beams shall be attached to the substructure or directly to piles, columns, piers, and walls with bolted or welded connections such that a continuous load path is maintained.

Washers shall be used under all nuts and bolt heads bearing directly on wood. All nuts, bolts, and washers shall be corrosion resistant. Notches at the tops of timber posts and piles shall not exceed 50% of the cross section of the post or pile.

Adequate anchorage shall be provided for storage tanks, sealed conduits and pipes, lined pits, sumps, and all other similar structures that are subject to flotation or lateral movement during the design flood.

1.6 LOADS IN FLOOD HAZARD AREAS

1.6.1 General Design of structures within flood hazard areas shall be governed by the loading provisions of ASCE 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE/SEI 2010).

Design and construction of structures located in flood hazard areas shall consider all flood-related loads and conditions, including the following: hydrostatic loads, hydrodynamic loads, wave action; debris impact; rapid rise and rapid drawdown of floodwaters; prolonged inundation; alluvial fan flooding; wave-induced and flood-related erosion and local scour; deposition of sediments; ice flows and ice jams; and mudslides in accordance with requirements of this standard if specified, or if not specified in this standard then in accordance with requirements approved by the authority having jurisdiction. Design considerations shall be documented and shall take into account the applicable flood-related loads and conditions, and load combinations that will act on the foundation and the structure.

1.6.2 Combination of Loads Flood loads shall be combined with other loads as specified in ASCE 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE/SEI 2010), either by using the allowable stress design method load combinations or by using the strength design method load combinations.

NH Coastal Viewer SLR and Salt Marsh Maps

SEE DESIGN PLANS LINK ON WEBPAGE

Map by NH GRANIT

Legend

MHHW Baseline

Map Scale

1: 2,947

Map Generated: 4/1/2022

Notes

The data base contains Mean Higher High Water (MHHW) baselines for Great Bay, Piscataqua River, embayment zones, and the open ocean for the New Hampshire seacoast region. The data are based on LiDAR data collected in 2011 and were derived using MHHW levels by zone, as reported by AECOM in their report entitled "SEA LEVEL RISE MAPPING NEW HAMPSHIRE OPEN COAST, PISCATAQUA RIVER, AND GREAT BAY", December, 2013

Map by NH GRANIT

Legend

MHHW + 1-ft SLR
- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 10

Map Scale

1: 2,947

Map Generated: 4/1/2022

Notes

The data base contains predicted sea level rise extent layers along the open coast of New Hampshire, the Piscataqua River, and Great Bay for nine scenarios, as follows:

Mean higher high water + 1' sea level rise

Map by NH GRANIT

Legend

MHHW + 2-ft SLR
- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 10
- 10 +

Map Scale

1: 2,947

Map Generated: 4/1/2022

Notes

The data base contains predicted sea level rise extent layers along the open coast of New Hampshire, the Piscataqua River, and Great Bay for nine scenarios, as follows:

Mean higher high water + 2' sea level rise

Map by NH GRANIT

Legend

Initial Conditions (2014)

- Tidal wetland
- Transitional salt marsh
- Salt marsh
- Mud flat
- Inland open water
- Tidal water

Map Scale

1: 2,947

Map Generated: 4/1/2022

Notes

2014 Marsh

Map by NH GRANIT

Legend

Predicted Marsh Migration 2

- Tidal wetland
- Transitional salt marsh
- Salt marsh
- Mud flat
- Inland open water
- Tidal water

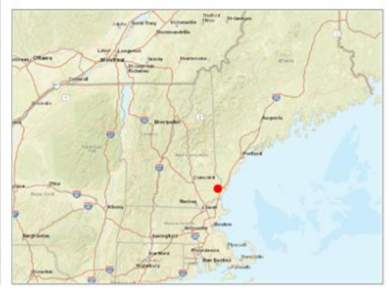
Map Scale

1: 2,947

Map Generated: 4/1/2022

Notes

Predicted 2050 Salt Marsh with 3.9' SLR by 2100
(which is consistent with 1.6' SLR at 2050 for medium tolerance for flood risk per NH Coastal Risk Summary Part II)



Coastal Upland

Conceptual Design Figures

SEE DESIGN PLANS LINK ON WEBPAGE

Challenges

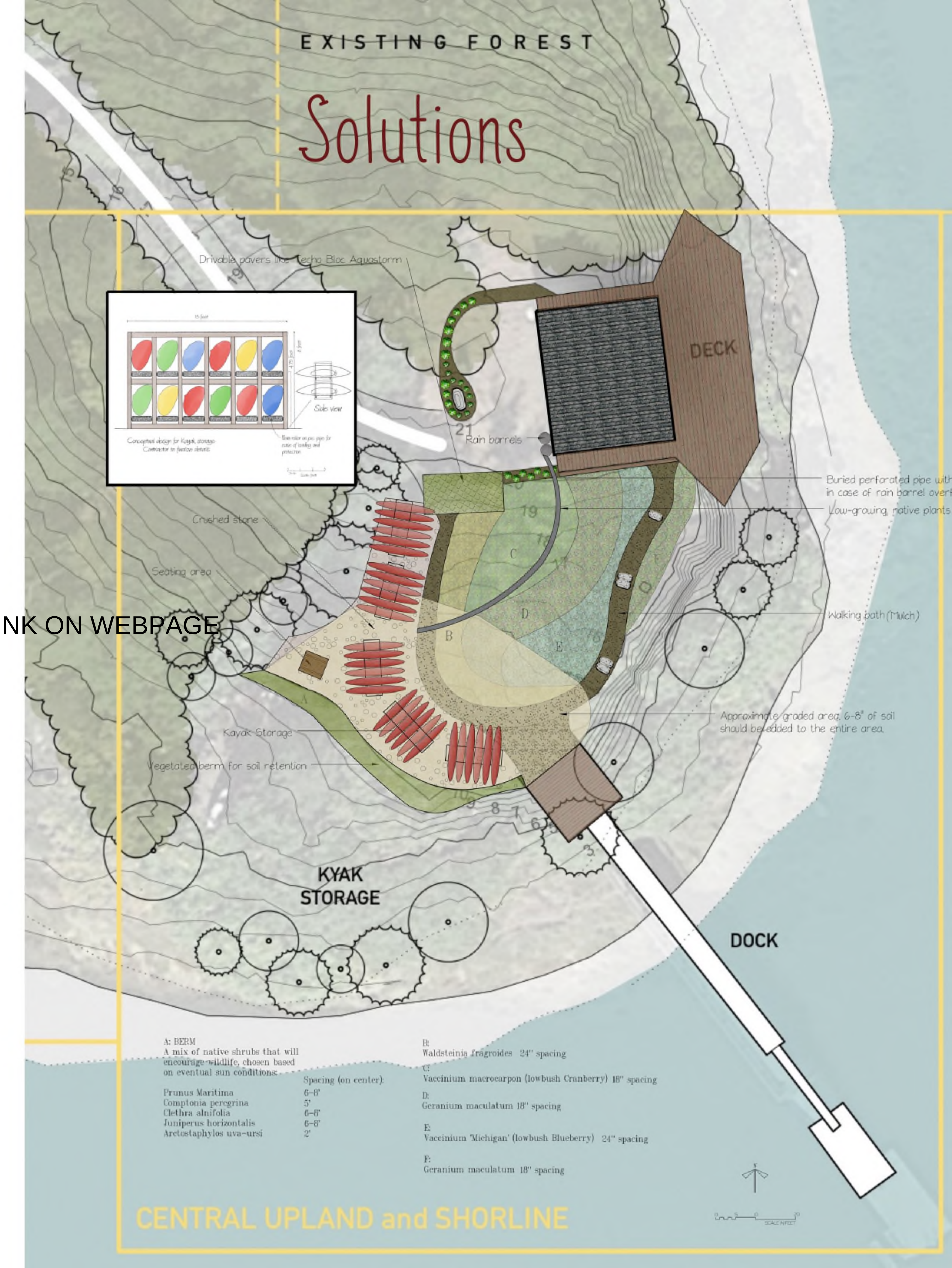
-Runoff

-Kayak access/ease of use/storage

Coastal Upland
Conceptual Design

THE GREAT BAY
LIVING SHORELINE PROJECT

SEE DESIGN PLANS LINK ON WEBPAGE



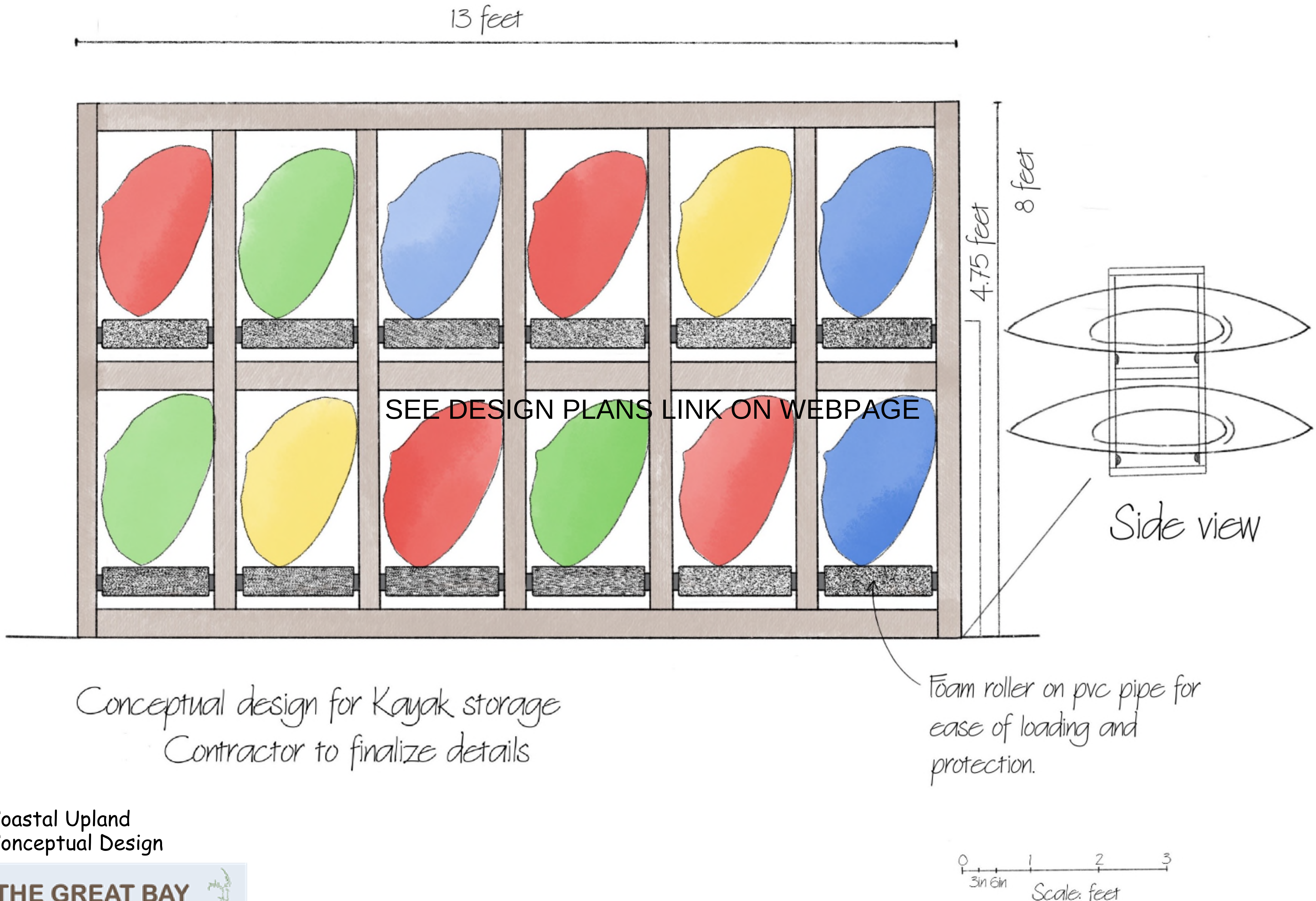
Before

SEE DESIGN PLANS LINK ON WEBPAGE

After

Coastal Upland
Conceptual Design

THE GREAT BAY
LIVING SHORELINE PROJECT



Conceptual design for Kayak storage
Contractor to finalize details

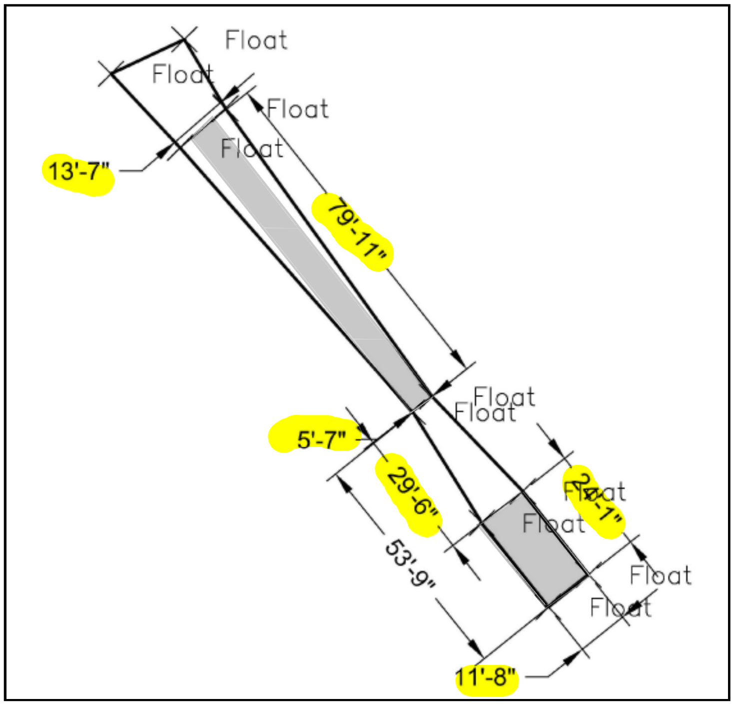
Coastal Upland
Conceptual Design

THE GREAT BAY
LIVING SHORELINE PROJECT

Water Access
Conceptual Design

SEE DESIGN PLANS LINK ON WEBPAGE

Estimated Dimensions from handheld GPS unit on 22 October 2021

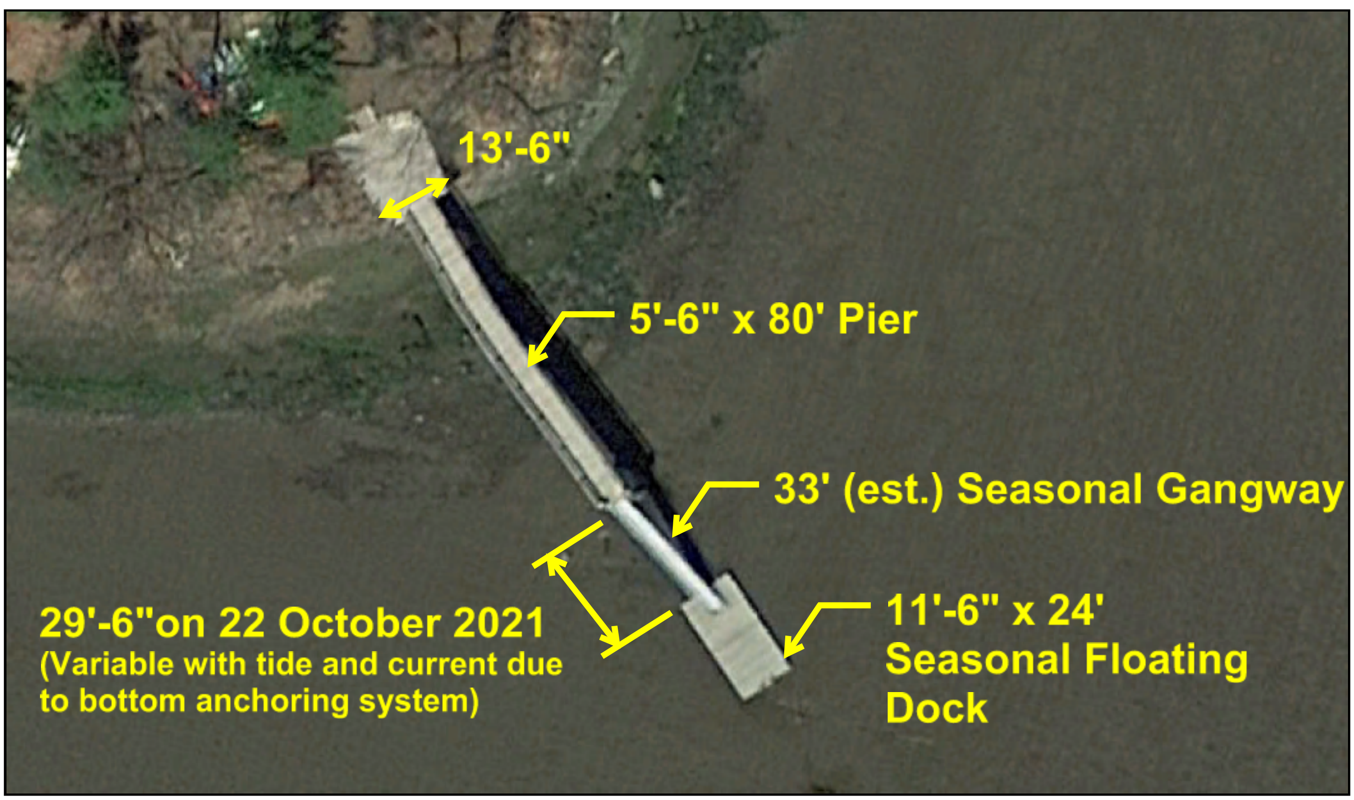


Snippet of field data collection

13'-6" wide landing at begin Pier
5'-6" wide x 80'-0" long Fixed Pier
29'-6" from end of Pier to Floating Dock
11'-6" wide x 24'-0" long floating dock

Note: linework connects GPS points and does not represent the pier configuration. The points at the beginning of the pier are at the corners of the approach landing.

SEE DESIGN PLANS LINK ON WEBPAGE



(Aerial Image: Google Earth Pro, 4/27/2016)

<u>Estimated Gangway Width</u>

Using approx width using the pier width (previous page) and scaling from photograph (22 October 2021)

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SHEET NO 1 OF
Calculated By CMC Date MARCH '22
Checked By Date
Scale FLOAT RELOCATE

FLOAT RELOCATION OPTION

USING COLLECTED DATA FROM 22 OCT '21 (PRESSURE TRANSDUCER)

LOW TIDE @ 08:55 AM EL -2.64' NAVD88
HIGH TIDE @ 14:55 PM EL +3.73 NAVD88
LOW TIDE @ 21:05 PM EL -3.37 NAVD88

CONVERT TO MLLW

NAVD 88
2.92' PER SITE DATA
MLLW

∴ EL -2.64' NAVD88 = +0.28' MLLW
EL +3.73 NAVD88 = +6.65' MLLW
EL -3.37 NAVD88 = -0.45' MLLW

TIDAL CHANGE RATE

LOW TO HIGH : $\frac{6.65' - 0.28'}{1455 \text{ TO } 0855} = \frac{6.37'}{6 \text{ HRS}} = \frac{6.37'}{360 \text{ min.}}$

$= +0.01769 \text{ ft/min}$

HIGH TO LOW = $\frac{-0.45' - 6.65'}{2105 \text{ TO } 1455} = \frac{-7.1'}{5 \text{ HRS } 10 \text{ min}} = \frac{-7.1'}{310 \text{ min}}$

$= -0.0229 \text{ ft/min}$

LEADLINE READINGS.

1ST READING @ 14:50 : +0.28' + 0.01769 ft/min (355 min) = +6.56' MLLW WATER LEVEL

2nd READING @ 1500 : +6.65' - 0.0229 ft/min (5 min) = +6.54' MLLW WATER LEVEL

1st READING = TOP OF PIER DECK TO ML = 13'4" (@ OUTER CAISSON) ≈3' FROM END PIER.
TOP OF PIER DECK TO WL = 6'8"

∴ TOP OF DECK EL ≅ +6.56' WATERLINE + 6'8" = +13.23 MLLW

ML = +13.23' − 13'4" = −0.10' MLLW

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~~Scale~~	FLOAT RELOCATION

FLOAT RELOCATION OPTION CONT'D

LEADLINE READINGS CONT'D

2nd READING = TOP OF FLOAT TO WL = 14.5" (AT END OF FLOAT)
TOP OF FLOAT TO ML = 8'6"

∴ TOP OF FLOAT EL @ TIME = +6.54' + 14.5" = +7.75' MLLW
ML @ END OF FLOAT = +7.75' − 8'6" = −0.75' MLLW

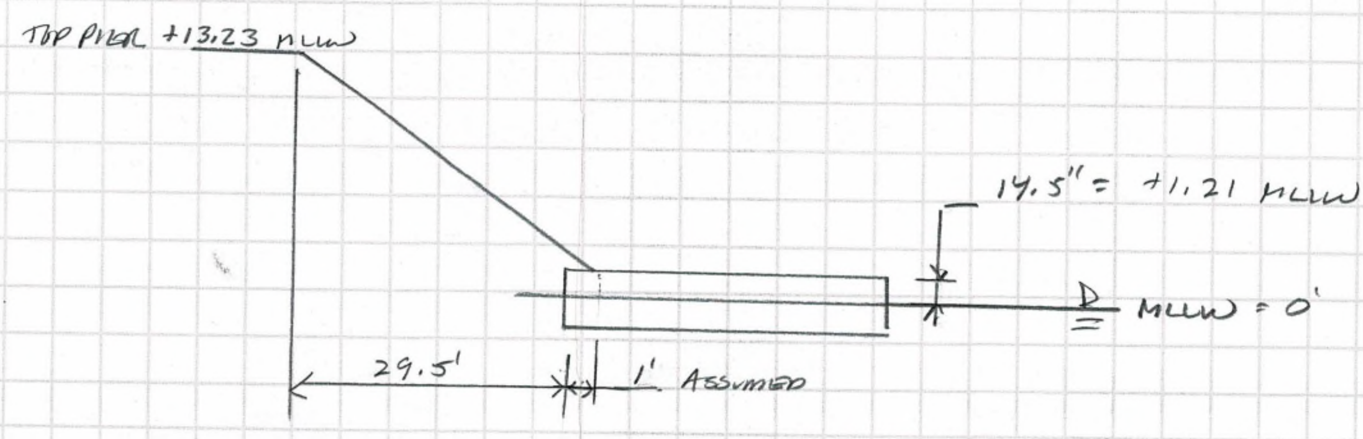
FROM GPS OF APPROX. END OF PIER & FLOAT CORNERS

END OF PIER TO FLOAT = 29'6"
FLOAT

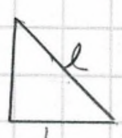
SEE DESIGN PLANS LINK ON WEBPAGE

ESTIMATE EXIST. GANGWAY SLOPE @ MLLW

ASSUME G.WAY SITS ≈ 1' ON THE FLOAT @ MLLW.



13.23' − 1.21' = 12.02'



$l = \sqrt{(12.02')^2 + (30.5')^2} = 32.7'$ → LIKELY A 33' G.WAY

30.5' / 12.02' = 2.5 ∴ 1V:2.5H @ MLLW

See next sheet for photograph of gangway slope near the time of low tide.

<u>Estimated Gangway Slope Approx Around Time of Low Tide</u>

Photograph is from 13 September 2021 at 2:15 PM.
Low tide occurs approximately 20 minutes after low tide at NOAA Dover Point based on comparison of predicted tides per NOAA Dover Point and Tide King website for Moody Point predicted tides. (https://www.tideking.com/United-States/New-Hampshire/Rockingham-County/Moodys-Point/)

Therefore, on 13 September '21, low tide at Moody Point was approximately at 11:53 AM + 20 minutes = 12:13 PM. Photo below is approximately at 2 hours after low tide.

Scaled measurements in the photograph may not be "actual" distances. The photo perspective is skewed relative to the alignment of the pier and dock. However, the scaled measurements are relative to one another and provide an approximate gangway slope.

(28'-10.75") / (12'-6.5") = 2.30

The gangway slope based on the scaled measurements is within order of magnitude expected slope based on the estimated calculations.

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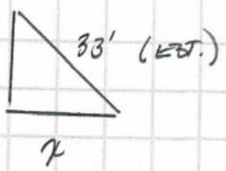
~~Scale~~ FLOAT RELOCATE

FLOAT RELOCATION OPTION CONT'D

ESTIMATE EXIST. GANGWAY SLOPE @ ELT

PER REVIEW OF ANNUAL TIDE PREDICTION FOR NOAA STA DOVER PT & NOAA STA SQUAMSCOTT RIVER RR BRIDGE, EXTREME LOW TIDE (ELT) IS BETWEEN -1.3' MLLW & -1.0' MLLW RESPECTIVELY. USE -1.3' MLLW.

```
  13.23'
+  1.3'
-  1.21'
---------
  13.32'
```



$x = \sqrt{(33')^2 - (13.32')^2} = 30.2'$

$\therefore\ 30.2' / 13.32' = 2.27$

$\therefore$ GANGWAY SLOPE ≈ 1V : 2.27 H

SEE DESIGN PLANS LINK ON WEBPAGE

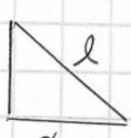
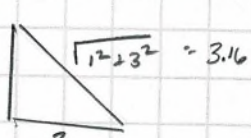
IF GANGWAY = 32' LONG. $x = \sqrt{(32')^2 - (13.32')^2} = 29.1'$

THIS IS < DISTANCE FROM THE PIER TO THE FLOAT. $\therefore$ GANGWAY WOULD FALL OF THE FLOAT. $\therefore$ GANGWAY IS LIKELY 33' LONG.

SLOPE OF 1:2.27 IS STEEPER THAN A 1:3 INDUSTRY STANDARD FOR DESIRABLE MAXIMUM GANGWAY SLOPE.

CONSIDER RELOCATING FLOAT FARTHER OFFSHORE & REPLACE GANGWAY W/ A LONGER GANGWAY.

FOR 1:3 SLOPE:

13.32'  = 1 

$\therefore\ \frac{l}{13.32'} = \frac{3.16'}{1} \Rightarrow l = 42.1'$

42' G.WAY

IF USE 45' G.WAY: $\sqrt{45^2 - 13.32^2} = 43' = x$

$\therefore\ 43' / 13.32' = 3.2$ 1:3.2 SLOPE ← USE

SINCE OLDER DEMOGRAPHIC

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~~Scale~~ FLOAT RELOCATE

FLOAT RELOCATION OPTION CONT'D

W/ A 45' GANGWAY, RELOCATE THE FLOAT
43' − 2' LENGTH OF FLOAT TO GANGWAY. = 41' OFF THE PIER

THIS REPRESENTS 41' − 29.5' = 11.5' FLOAT RELOCATION.

See next sheet for sketch of proposed relocation at extreme low tide.

CHECK THAT RELOCATED FLOAT ≠ OVER EELGRASS.
GRANIT LAYERS FOR EELGRASS MAPPING 1986, 1996 & 2019 SHOWS EELGRASS > DISTANCE OFFSHORE THAN RELOCATED FLOAT LOCATION. SEE ATTACHED GRANIT MAPS.

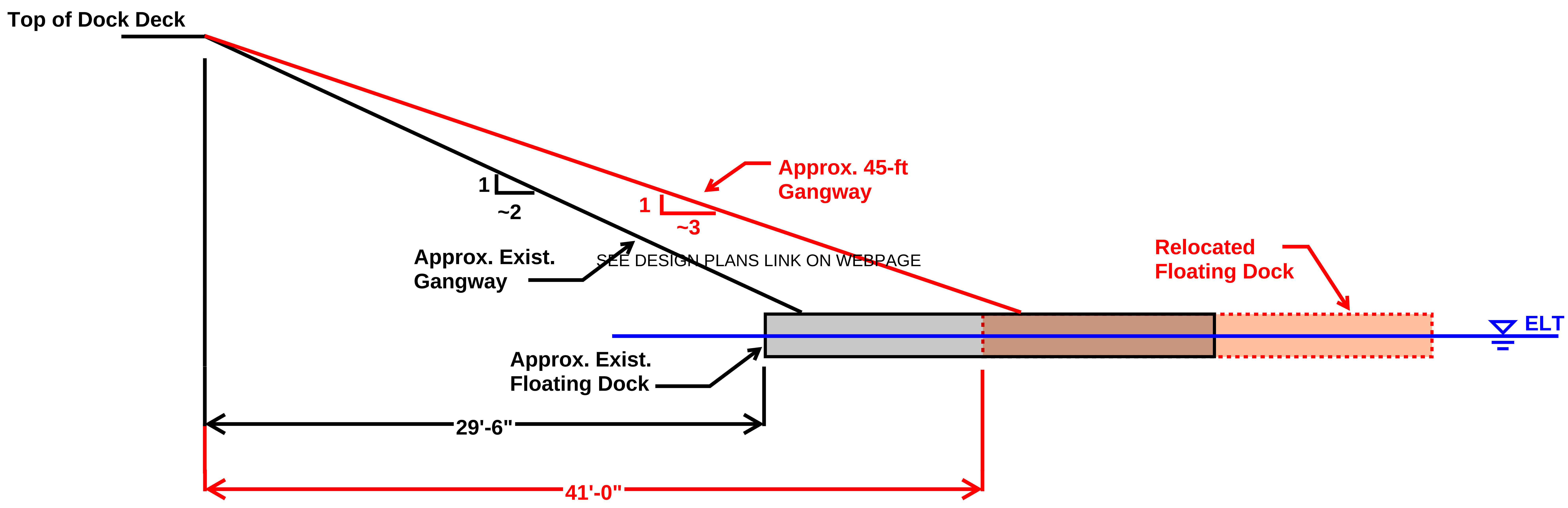
CHECK N[illegible] RELOCATION:

SEE DESIGN PLANS LINK ON WEBPAGE

SCALING IN NOAA CHART, CHANNEL ~ 160 YDS MIN. FROM SHORE = 480' SEE ATTACHED NOAA CHART EXCERPT.

PIER ≈ 80' LONG + 41' TO FLOAT + 24' FLOAT = 145' < 480' ✓ OK.

Great Bay Living Shoreline Project
Moody Point Site
Approximate Pier and Dock Layout



Map by NH GRANIT

Legend

- 2019

Map Scale

1: 3,612

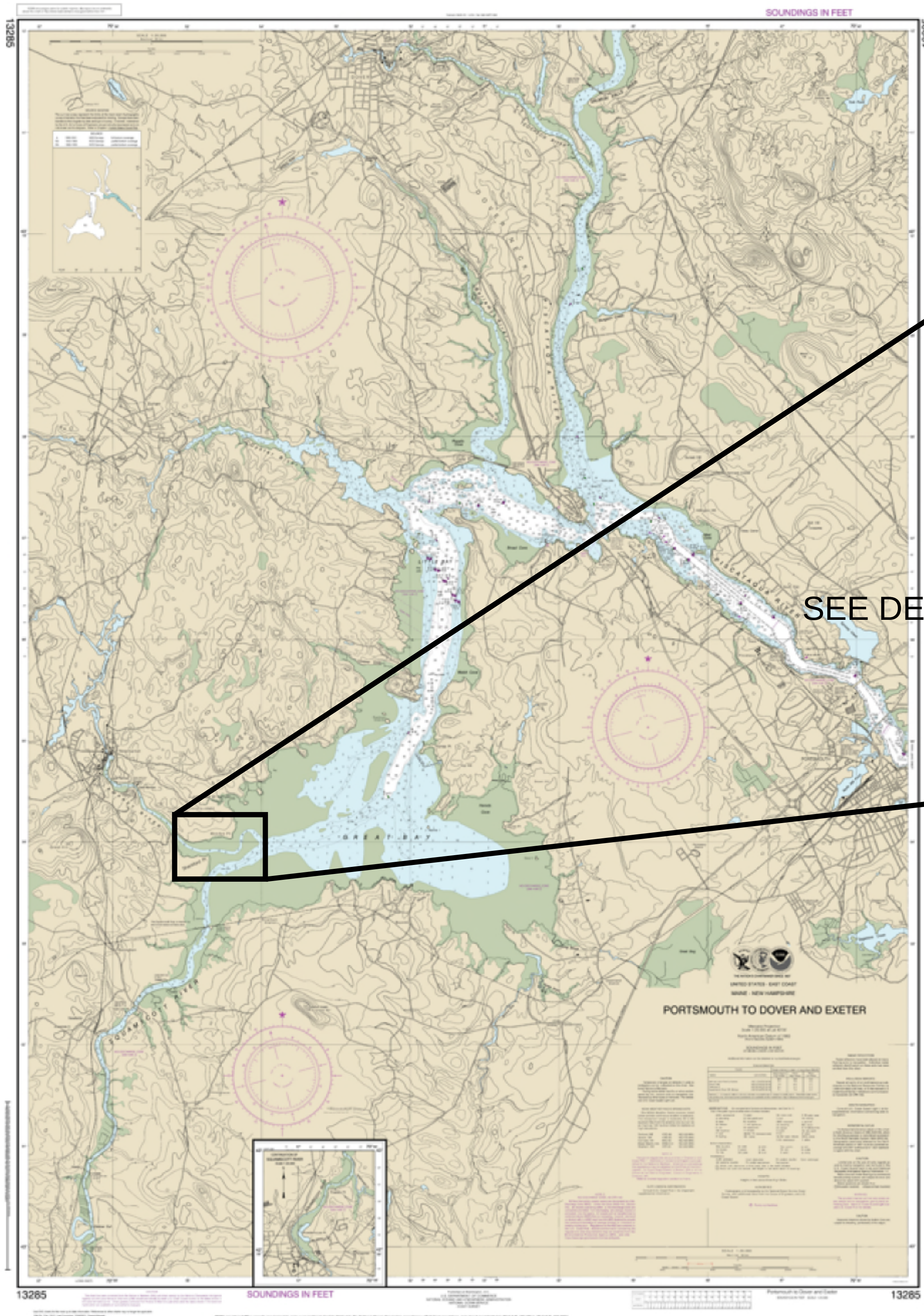
Map Generated: 2/8/2022

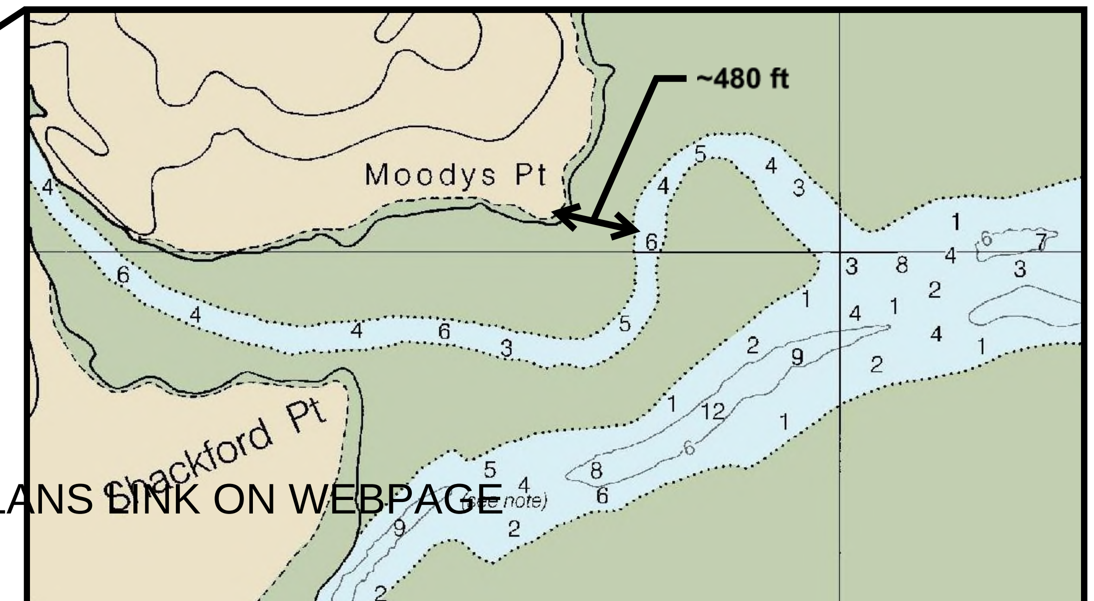
Notes

2019 Eel Grass

NOAA Navigation Chart 13285

Great Bay Living Shoreline Project
Moody Point Site
Conceptual Float Relocation





SEE DESIGN PLANS LINK ON WEBPAGE

The navigation channel is approximately 480 feet from the shore at the dock location.

Map by NH GRANIT

Legend

- 1996
- 1986

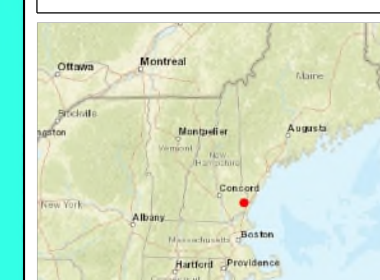
Map Scale

1: 3,612

Map Generated: 2/8/2022

Notes

1996 and 1986 Eel Grass



CONCEPTUAL DESIGN PLANS

SEE DESIGN PLANS LINK ON WEBPAGE