Sep. 23, 2016

Design of a Sustainable Shorelines Demonstration Project at Nutten Hook

FINAL REPORT

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INTRODUCTION

The Nutten Hook site being discussed herein is located on the eastern bank of the Hudson River at Stuyvesant, NY, directly across the Hudson River from Coxsackie, NY. The site lies at the western foot of Ferry Road, which extends off of NYS Route 9J, and presently offers public utility for river-viewing, fishing and other passive recreational activities. The site is NYSDEC property and is part of the Hudson River Natural Estuarine Research Reserve.

The Nutten Hook site's shoreline has experienced significant scarping and erosion in many areas due to high-energy wave action. Many large trees at the north- and south-west corners of the shoreline are leaning due to significant erosive damage. The existing bulkhead appears to provide some protection of the shoreline from wave action below Mean High Water (MHW). However, the bulkhead is noticeably deteriorated and does not reach adequate heights (at or above MHW) to successfully offer complete shoreline protection. Therefore, the parking area located at the foot of Ferry Road and the access road are at risk of being lost to continued erosion. In order to maintain public access to the site for fishing and river-viewing, shoreline stabilization methods will need to be implemented at the site.

The NYS Department of Environmental Conversation's Hudson River National Estuarine Research Reserve (HRNERR) has requested BlueShore Engineering LLC (BlueShore) and Creative Habitat Corporation (Creative Habitat) design ecologically-enhanced, engineered shoreline treatment(s) for the west and south shoreline of the Nutten Hook site that:

1. Resist erosion;
2. Enhance the recreational use of the site by the public; and
3. Improve or maintain the habitat value of the site for fish and wildlife species of the Hudson River Estuary.

The designs will address shoreline stabilization, habitat, preservation of natural and cultural resources and human use issues. The designs will also be consistent with existing Federal and State regulatory requirements and address present day conditions as well as account for projected increases in frequency of extreme storms and sea level rise. The design process will include involvement of additional stakeholders including the NYS Department of Environmental Conversation's Hudson River Estuary Program and HRNERR staff as well as State and Federal regulatory staff and the Town of Stuyvesant, NY.

In addition to this report that includes a description of existing conditions, the proposed shoreline treatment(s), justification for the proposed design, estimated construction and maintenance costs, construction timelines and implementation recommendations, the project team will also deliver stamped, permit and construction ready plans for ecologically-enhanced, engineered shoreline treatment(s) for the west and south shoreline of the Nutten Hook site.

SITE DESCRIPTION

Nutten Hook in the town of Stuyvesant, Columbia County, NY is located on the eastern shoreline of the north Hudson River, at the western foot of Ferry Road (see Figure 1). The site once supported ferry operations between Stuyvesant, NY and Coxsackie, NY. An informal parking lot is located on site to encourage public use for river-viewing, fishing and other passive recreational activities. From historic topographic maps, the Nutten Hook site seems to have been created, by adding fill over timber cribbing in water, between the years 1921 and 1929.

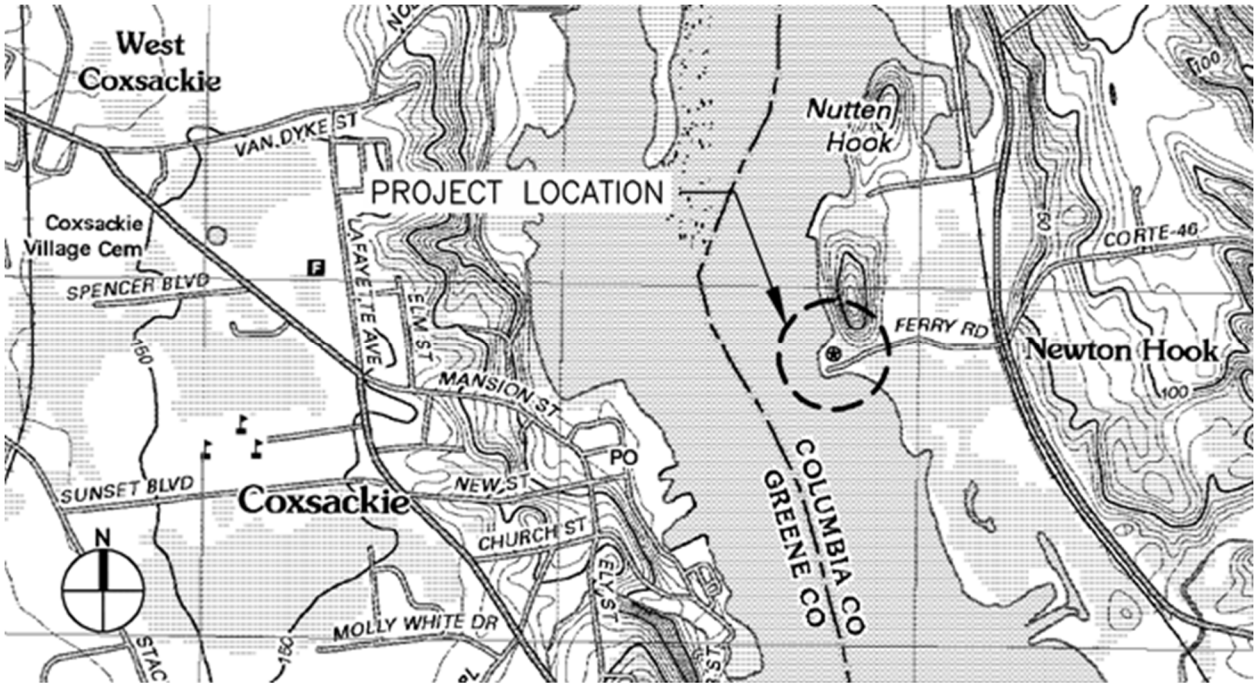


Figure 1. Nutten Hook vicinity plan (from US Geological Survey Hudson North map, dated 2013)

Noteworthy Features

A timber bulkhead runs NW-SE along the site's western shoreline. Directly east of this bulkhead lies an area of rushes at the south, a poplar tree cluster at the north and an area of grasses and shrubs in between the rushes and tree cluster. The timber bulkhead turns an almost 90° angle at the northwestern corner of the site to run SW-NE along part of the northern shoreline, which primarily boasts a sandy shore.

At the site's southern shoreline, a stacked rock seawall runs SW-NE along the eastern portion of the southern shoreline. Two precast concrete blocks are also located along the southern shoreline, to the west of the seawall and to the east of the rushes. Near these concrete blocks is another large tree cluster. A patch of wild ginger lies at the eastern-most extent of the seawall. For an existing schematic plan of the site, see Attachment A.

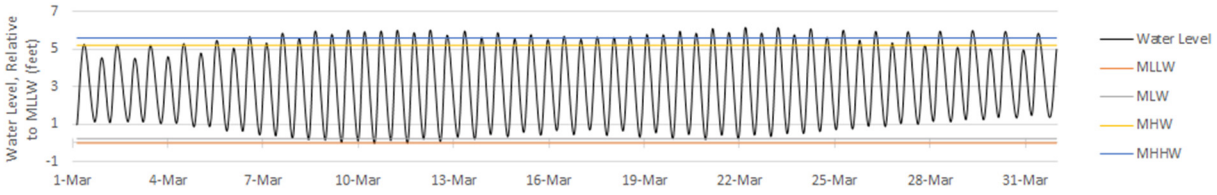
Predicted Tides and Currents

The closest National Oceanic and Atmospheric Administration (NOAA) National Ocean Services (NOS) stations to the Nutten Hook site are Station #8518995 in Albany, NY (approximately 20 miles north of Stuyvesant, NY) and Station #8518951 in Hyde Park, NY (approximately 45 miles south of Stuyvesant, NY). Linearly interpolating tide/water level data from these two stations results in the development of an approximate datum chart for the Nutten Hook site, as shown in Table 1 below.

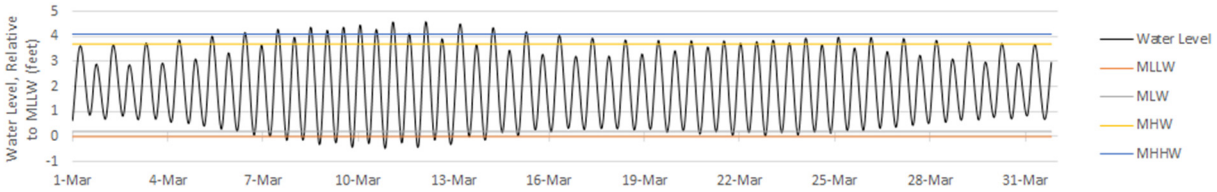
Datum Conversion Table (feet)		
	MLW	NAVD88
Mean Higher High Water (MHHW)	4.89	3.30
Mean High Water (MHW)	4.49	2.90
NAVD88	1.59	0.00
Mean Low Water (MLW)	0.00	-1.59
Mean Lower Low Water (MLLW)	-0.21	-1.80

Table 1. Datum conversion table

NOAA NOS publishes tide and tidal current prediction tables every year. Graphs of these predictions show that the Hudson River is characterized by semidiurnal tides up to Troy, NY. Based on the tide prediction data for Albany, NY, it seems that high/low tides are generally at their highest in the spring and at their lowest in the late summer. In the NOS's published *Tide Tables: 2015 East Coast of North and South America Including Greenland*, it was noted that observed tides along the Hudson River, particularly in the northern section that includes Albany, NY, have differed from the published tidal predictions in that high tides have been occurring approximately 1 hour earlier than predicted.



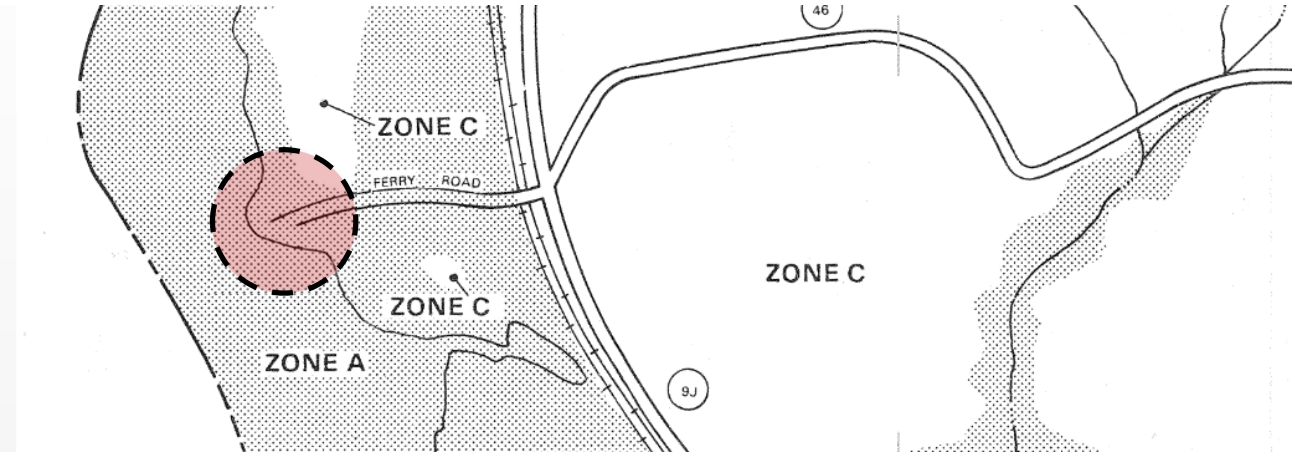
Graph 1. Predicted tide levels for March 2016 at NOAA Station #8518995 in Albany, NY



Graph 2. Predicted tide levels for March 2016 at NOAA Station #8518951 in Hyde Park, NY

Flood Elevations

The site is located in an A-Zone Special Flood Hazard Area (SFHA) according to the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) #361323-0002-B for the area, dated September 14, 1979 (see Figure 2). Flood elevations and flood hazard factors are not determined for this zone on the map.



= Project location

Figure 2. Section of FEMA FIRM #361323-0002-B

Predicted Sea Level Rise

Two sea level rise scenarios are depicted in Table 2 below. One scenario determines sea level rise if the current rate of roughly 10.9 inches per century (as determined from the NOAA Battery Station #8518750 gauge at the southern tip of Manhattan, NY) is maintained, while the other scenario determines sea level rise given a rapid ice melt scenario as predicted by the NYC Panel on Climate Change in 2009.

Time Range	2020s	2050s	2080s
Sea level rise, if current rate is maintained	1.1 inches	4.4 inches	7.6 inches
Sea level rise, with rapid ice melt	up to 9 inches	up to 26 inches	up to 50 inches

Table 2. Sea level rise projections for the Hudson River, NY (Rella & Miller, 2014)

The proposed regulatory impact statement 6 NYCRR Part 490 will establish projections of sea level rise with the purpose of ensuring that state permit, regulation and expenditures consider the effects of climate risks per Environmental Conservation Law (ECL) §3-0319. As this proposed regulation will not impose standard or compliance obligations, projections are to be solely used for consideration only. Part 490's established projections for the geographic region encompassing the Nutten Hook site is depicted below in Table 3. These projections are based on those included in the ClimAID report of 2014.

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	1 inch	3 inches	5 inches	7 inches	9 inches
2050s	5 inches	9 inches	14 inches	19 inches	27 inches
2080s	10 inches	14 inches	25 inches	36 inches	54 inches
2100	11 inches	18 inches	32 inches	46 inches	71 inches

Table 3. Projected sea level rise for mid-Hudson region, from Kingston to Troy, NY (Horton et al., 2014)

Scenic Hudson, Inc. has prepared a Geographical Information System (GIS) model called the Sea Level Rise Mapper that maps predicted future inundation and flooding to create visualizations of scenarios of sea level rise. The Mapper combines data from the NYS Department of Environmental Conservation (NYSDEC), the US Environmental Protection Agency (EPA), the US Census Bureau, FEMA and research by Roger Flood of SUNY Stony Brook. Figures 3, 4 and 5 below map predicted conditions given sea level rise of 6, 24 and 48 inches for reference on how the Nutten Hook site would be affected in such scenarios. Figure 6 contains a legend for Figures 3 through 5.

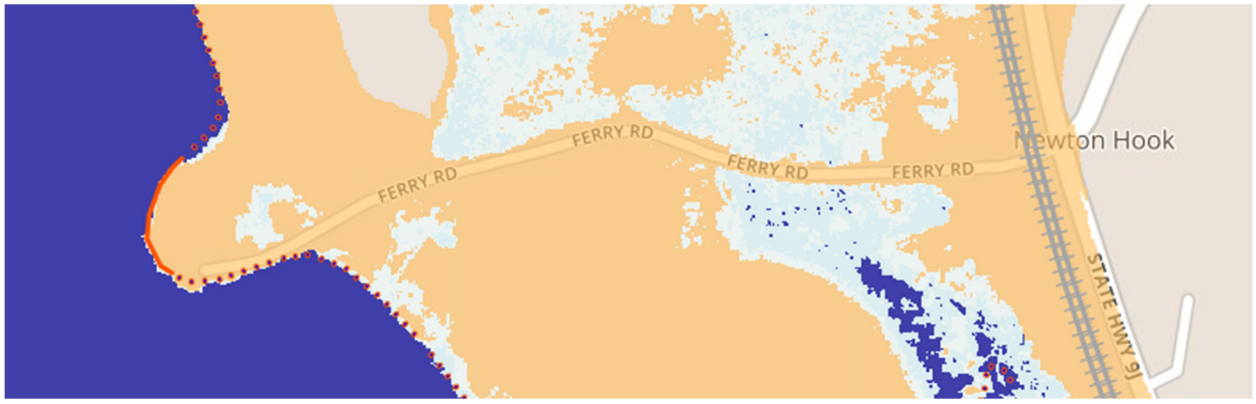


Figure 3. Predicted scenario at/around the Nutten Hook site given a sea level rise of 6 inches

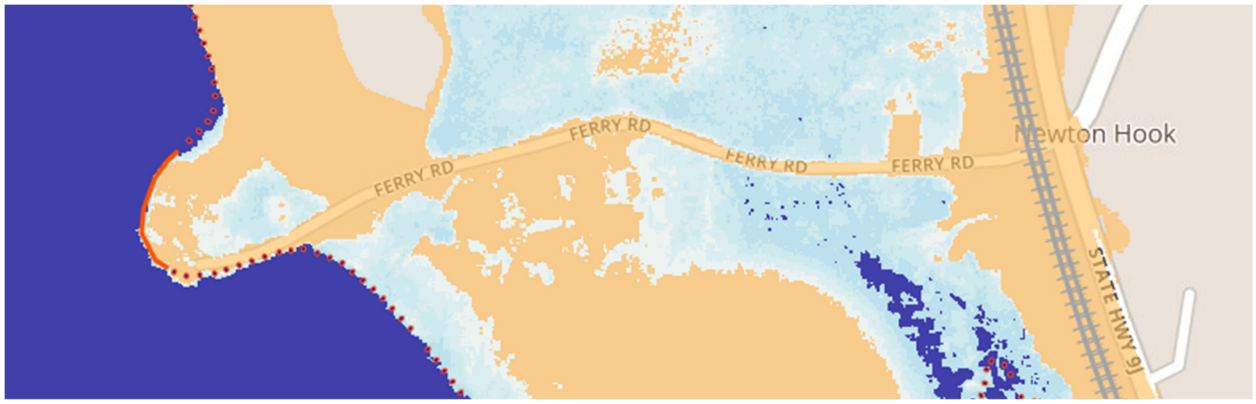


Figure 4. Predicted scenario at/around the Nutten Hook site given a sea level rise of 24 inches

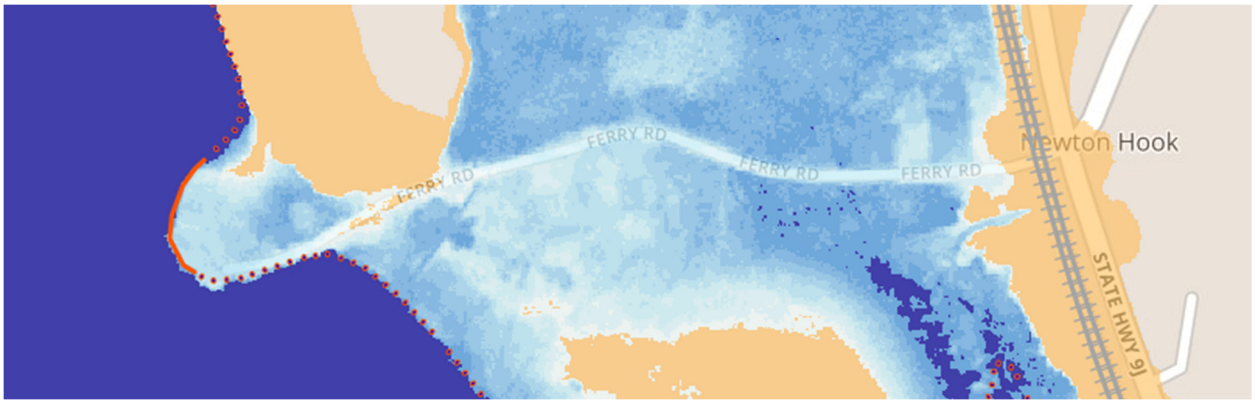


Figure 5. Predicted scenario at/around the Nutten Hook site given a sea level rise of 48 inches

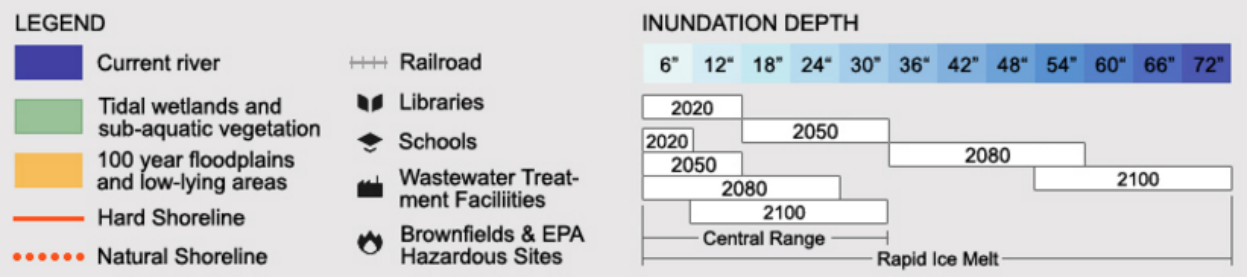


Figure 6. Legend for Figures 3-5

Given a sea level rise of 48 inches, the Nutten Hook site would be underwater, as conditions stand. Ferry Road would also be flooded the entire road length from NYS Route 9J to the site. As a result, there would be no access to the site via Ferry Road even if the Nutten Hook site itself were protected entirely from 48 inches of sea level rise.

Waves and Wakes

A high resolution numerical model grid for the Hudson River from Yonkers, NY to Troy, NY was developed by the Steven's Institute of Technology. The grid is based on data and observations along the Hudson River made throughout the year 2010 and processed in 2012. The dataset is available online at the NYS GIS Clearinghouse database. Based on this model, the simulated average surface wind-wave height at the Nutten Hook site is 2.4 inches at the northern shoreline, with a standard deviation of 2.3 inches and an average maximum wave height of 13.0 inches. At the western shoreline, the simulated average surface wind-wave height is 2.6 inches, with a standard deviation of 2.3 inches and an average maximum wave height of 14.0 inches. At the southern shoreline, the simulated average wind-wave height is 2 inches, with an average standard deviation of 1.8 inches and a maximum wave height of 13.4 inches.

Wakes created from vessels traveling along the Hudson River can contribute to shoreline erosion. In a study entitled *Hudson River Wake Study*, dated June 2015, recreational vessels (yachts, sailboats and other pleasure crafts) accounted for 50% of vessels observed along the Hudson River between Misraci Road and the Coxsackie Boat Launch in Coxsackie, NY during the June 27, 2012 and July 1, 2013

observational periods. Fishing vessels (small, less than 20-foot long boats with outboard motors) accounted for 45% of vessels observed. Vessels were primarily traveling at speeds of 11 to 20 mph and were most frequently observed to be 11 to 20 feet in length. At the Coxsackie Boat Launch, wakes recorded ranged from 0.0 inches (imperceptible) to 12.5 inches, with a 5-inch average wake. The average recorded wake along the Hudson River from Tarrytown, NY to Troy, NY was 4.2 inches.

Winds

Using Google Earth for distance measurements, along the Nutten Hook shoreline, winds blowing from the west have a worst-case 0.5-mile fetch, winds blowing from the south have a worst-case 1.1-mile fetch, winds blowing from the north have a worst-case 0.2-mile fetch, and winds blowing from the west-northwest have a worst-case 0.6-mile fetch (see Figure 7).

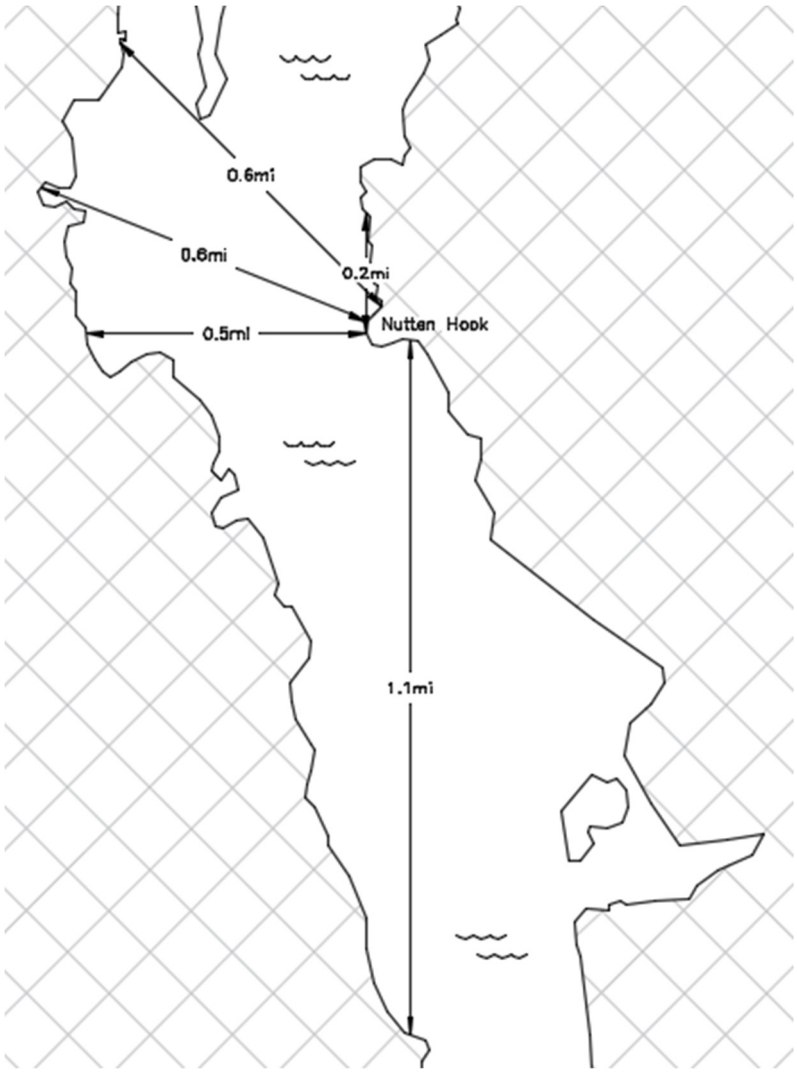


Figure 7. Hudson River wetland boundary

At a distance 100 feet out from the shoreline, winds blowing from the west have a worst-case 0.5-mile fetch, winds blowing from the south have a worst-case 1.1-mile fetch, winds blowing from the north

have a worst-case 1.5-mile fetch, and winds blowing from the west-northwest have a worst-case 0.6-mile fetch (see Figure 8).

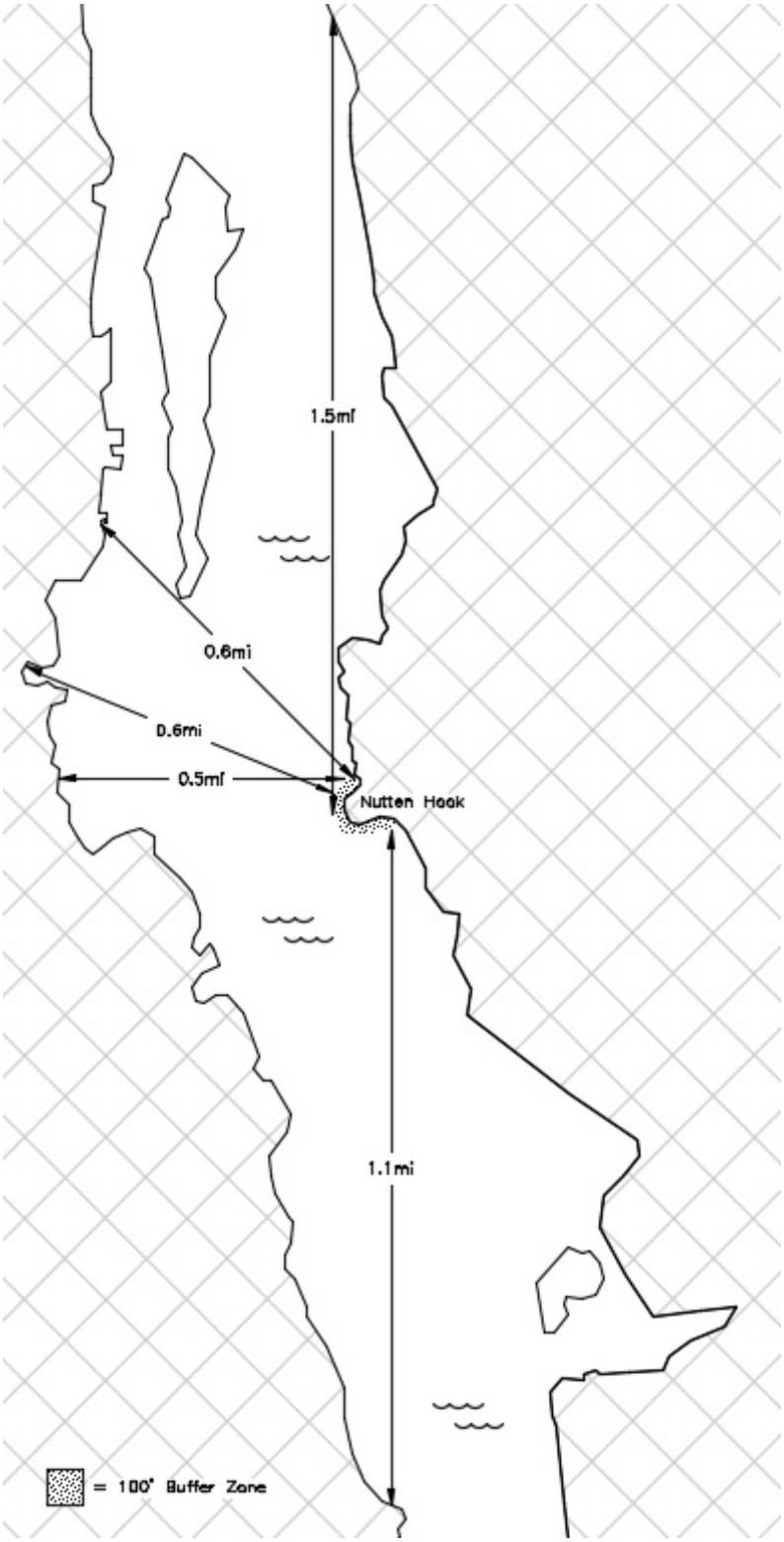


Figure 8. Hudson River wetland boundary, showing 100-foot buffer zone from site shoreline

According to the most recent *Soil Survey of Columbia County, New York* of 1989, Columbia County's prevailing wind is from the south with the highest average wind speed of 11.0 mph observed in the spring. This information is corroborated with wind data collected from the Albany International Airport, the nearest National Weather Service (NWS) monitoring site to Nutten Hook, whose data from 2006 through 2015 shows that the average yearly wind speed was 7.0 mph and that the second most prevalent winds come from the west-northwest (see Figure 9).

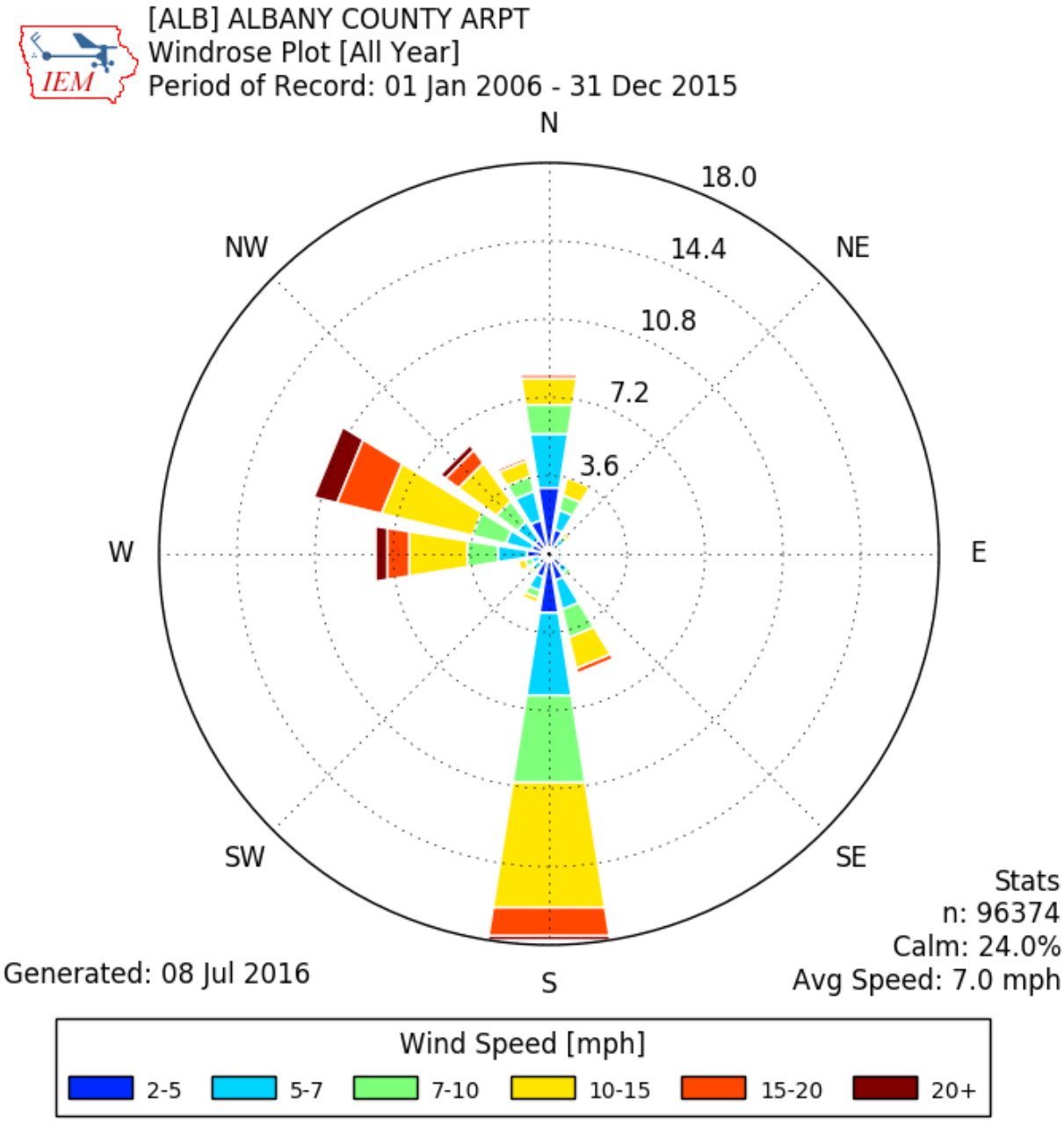
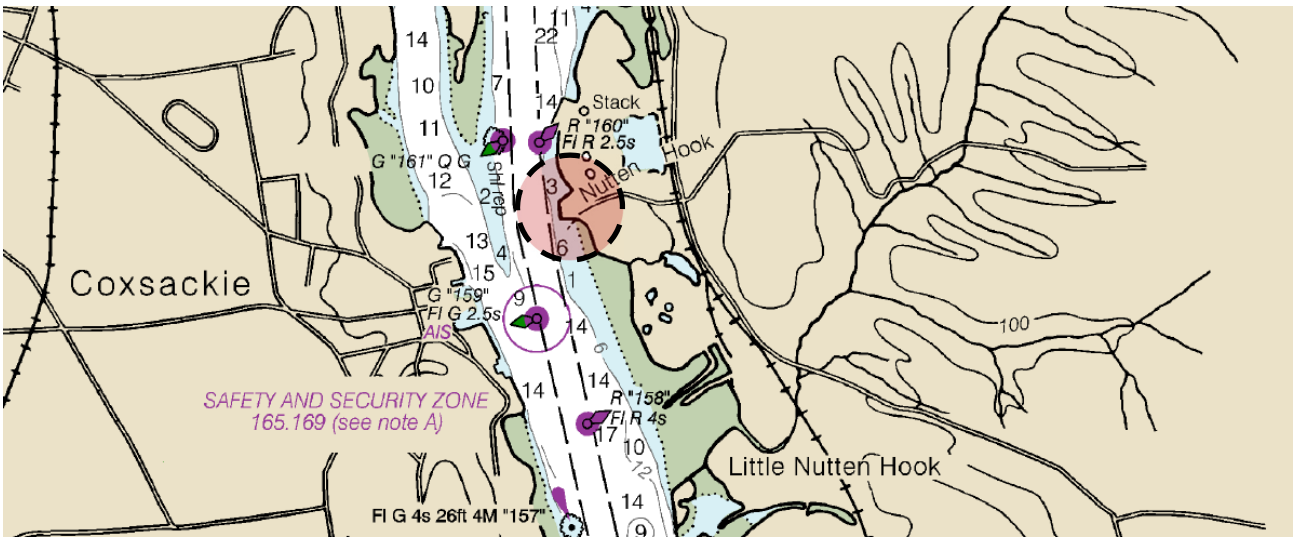


Figure 9. Wind rose for Albany, NY from 2006 to 2015 (IEM, n.d.)

Adjacent Mudline Depth

The most recently publicly accessible navigational chart #12348 for the area from the US Department of Commerce's NOAA, which was last updated on July 13, 2016, shows that the majority of the site's surrounding waterway (at an approximate distance of 40 feet from the Nutten Hook site shoreline) has an average mudline depth of 32 feet below MLLW (see Figures 10 and 11). This channel depth data was obtained from surveys conducted by the US Army Corps of Engineers (USACE) in September 2015 and reported in the USACE's Hudson River report of channel conditions of November 2015.



= Project location

Figure 10. Section of navigational chart #12348 from the NOAA, covering Coxsackie to Troy, NY

HUDSON RIVER CHANNEL DEPTHS

TABULATED FROM SURVEYS BY THE CORPS OF ENGINEERS - REPORT OF FEB 2015 AND SURVEYS TO DEC 2014

CONTROLLING DEPTHS FROM SEAWARD IN FEET AT MEAN LOWER LOW WATER (MLLW)					PROJECT DIMENSIONS		
NAME OF CHANNEL	LEFT OUTSIDE QUARTER	MIDDLE HALF OF CHANNEL	RIGHT OUTSIDE QUARTER	DATE OF SURVEY	WIDTH (FEET)	LENGTH (NAUT. MILES)	DEPTH MLLW (FEET)
HUDSON RIVER LIGHT "140" (CHART 12347) TO FOURMILE POINT	27.0	29.5	29.3	9-14	400	1.5	32
FOURMILE POINT TO 730 YARDS NORTH OF MILL CREEK LIGHT "MC"	29.5	29.4	28.1	9-14	400	7.0	32
ANCHORAGE AT STUYVESANT	31.2	31.5	28.2	11-01;9-14	400	0.4	32
730 YARDS NORTH OF MILL CREEK LIGHT "MC" TO ALBANY TURNING BASIN	28.7	32.0	26.7	6,12-14	400-500	12.1	32
TURNING BASIN AT ALBANY	34.4	28.9	22.9	5-08	600	0.3	32
TURNING BASIN AT ALBANY TO DUNN MEMORIAL BRIDGE (AT LOWEST LOW WATER)	16.0	14.4	13.6	6-14	400	0.9	27-32
DUNN MEMORIAL BRIDGE TO PATROON ISLAND BRIDGE	6.5	13.7	14.3	6-14	616-400	1.7	14
PATROON ISLAND BRIDGE TO NORTH END OF ADAMS ISLAND	10.4	12.2	7.4	6-14	400-200	5.3	14
THENCE TO TROY LOCK	6.9	12.4	9.1	5-14	600-45	0.4	14
CHANNEL EAST OF ADAMS ISLAND	13.9	14.7	14.6	6-14	145	0.4	14

NOTE - CONSULT THE CORPS OF ENGINEERS FOR CHANGES SUBSEQUENT TO THE ABOVE INFORMATION

Figure 11. Channel depth excerpt from the NOAA navigation chart #12348

Ice Conditions

According to ice climatology data prepared for the NYSDEC Hudson River Sustainable Shorelines Project, as found in the NYS GIS Clearinghouse database, the Hudson River from Catskill, NY to Albany, NY, ice occurrence has been recorded an average of 61.8% of ice season days (from mid-December to late March) between the years of 2005 and 2012. The median estimated ice thickness, when present, is 4.7 inches. The median estimated ice cover area of all reported ice days is 62.1% of the River region between Catskill and Albany. The most prevalent ice type observed is drift ice.

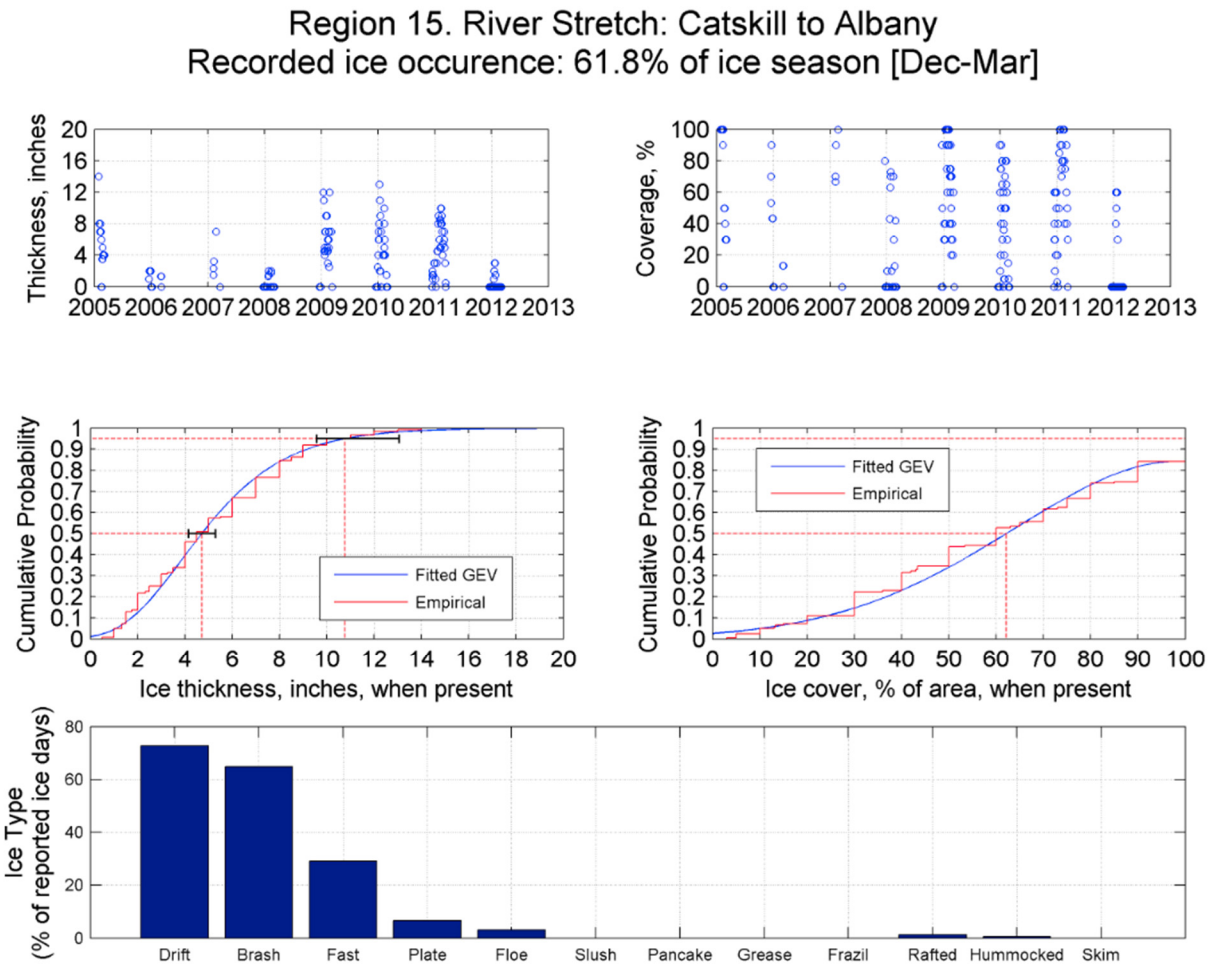


Figure 12. Compilation of observed ice data probabilistic statistics (Miller, n.d.)

The ice climatology data (depicted above) is based on US Coast Guard (USCG) daily ice reports along the tidal Hudson River during ice season. This data was then transcribed, statistically processed by fitting the Generalized Extreme Value Cumulative Distribution Functions (GEV CDFs) to the empirical mean daily data, and georeferenced at the Stevens Institute of Technology.

SAVs and Other Habitat Conditions

According to the NYSDEC Environmental Mapper, significant natural communities are located primarily in Nutten Hook's surrounding wetland area, but have also been observed on-land at the site and in the nearby ½-mile vicinity as well (see Figure 13). Rare plants and animals also exist throughout the entire Nutten Hook area, both on-land and in-water (see Figure 14).

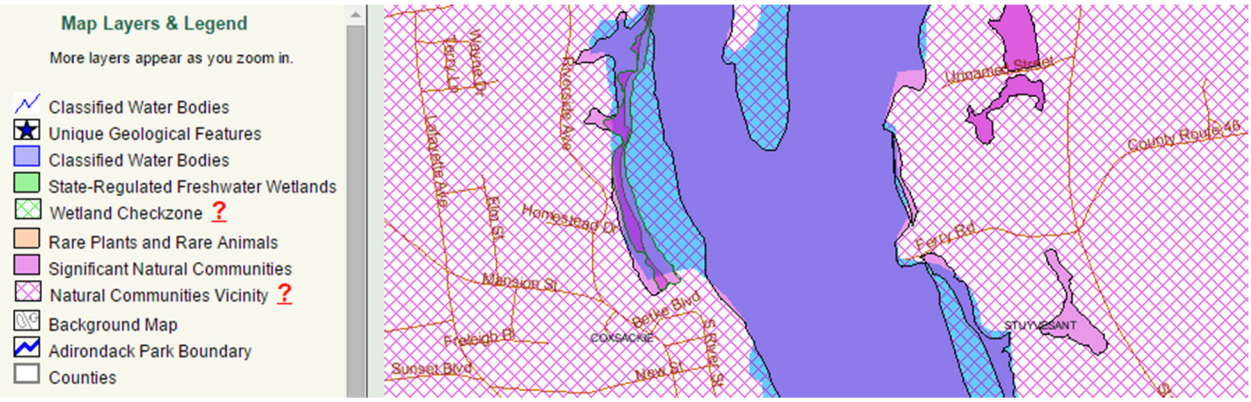


Figure 13. Significant natural communities map

Figure 14. Rare plants and animals map

Submerged aquatic vegetation (SAVs) have been documented to the south of the Nutten Hook site being discussed herein (see Figure 15). The closest SAV habitat documented in the past 20 years is approximately 140 feet from Nutten Hook's southern shoreline. This documented SAV data, last revised in August 2013, was obtained from the NYS GIS Clearinghouse database. The data was produced in collaboration of the Institute of Ecosystems Studies (IES), the NYSDEC, Cornell University and the NOAA Coastal Services Center and is a combination of 1997, 2002 and 2007 datasets, representing a culmination of all areas where SAV habitat has been documented.

Figure 15. Documented SAVs

Adjacent Wetland Area

The Nutten Hook site is located adjacent to a globally-rare freshwater, tidal wetland area as well as a state-regulated freshwater wetland area under the Freshwater Wetlands Act of 1975 (see Figure 16). The New York State regulates this freshwater area as well as a 100-foot buffer zone extending from the wetland boundary, measured horizontally.

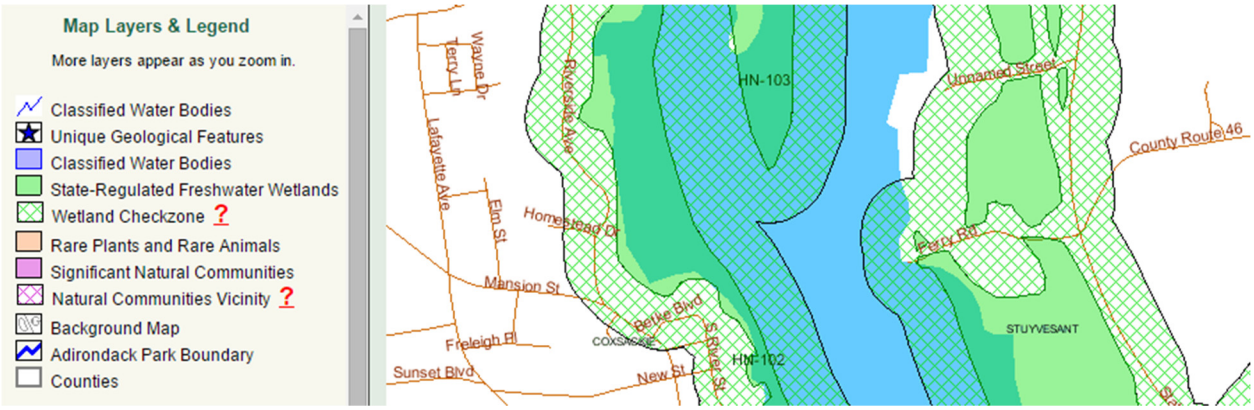


Figure 16. State-regulated freshwater wetlands map

Adjacent Waterway

The adjacent Hudson River is a US navigable waterway, which means that the USACE regularly surveys the riverbed and dredges if necessary to maintain the navigational channel. The water channel between the Nutten Hook site and Coxsackie, NY is approximately 1,550 feet at its narrowest. The River bottom primarily consists of sand or mud. The Hudson River is also a NYSDEC classified water

body (see Figure 17). The water body has an 'A' classification, which the NYSDEC assigns to waters used as a source of drinking water.

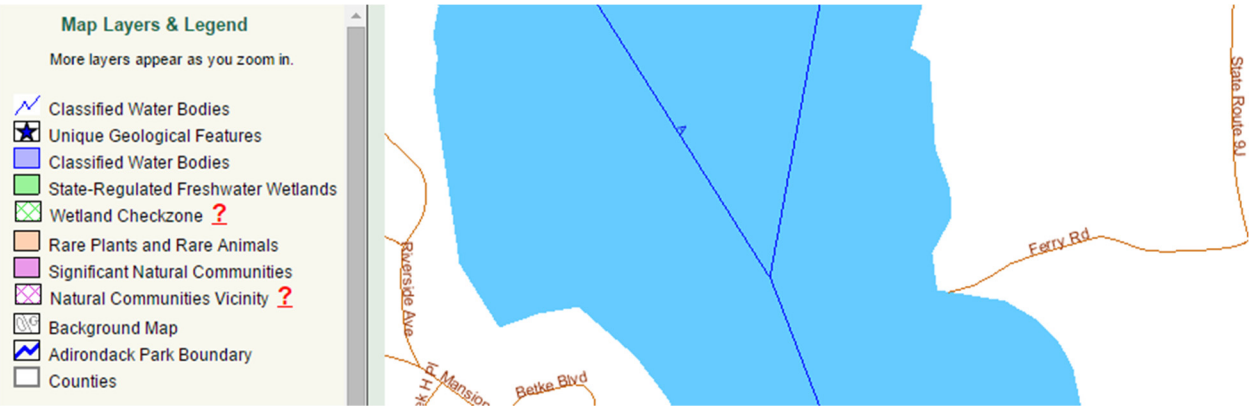


Figure 17. Classified water bodies map

SITE OBSERVATIONS

Richard W. Gilbert, PE of BlueShore Engineering LLC, Sven Hoeger, Ecologist of Creative Habitat Corporation and Catherine Hanna, EIT of BlueShore Engineering LLC have visited the site multiple times since January 2016 to observe and assess existing site conditions.

It was observed that the site's shoreline has experienced scarping and erosion in many areas due to high-energy wave action. A line of escarpment observed along the shoreline roughly follows the MHW contour. Many of the large trees at the northwest and southwest corners of the shoreline have exposed roots and are on the brink of falling over due to significant erosive damage. The existing bulkhead appears to offer some assistance with regards to protecting the shoreline from wave action below MHW. The bulkhead presently maintains a reasonable slope from the mudline to the adjacent channel and protects the slope along the bank from steepening and failing. However, as the bulkhead appears deteriorated and does not reach adequate heights (at or above MHW) to successfully offer complete shoreline protection, the parking area located at the foot of Ferry Road and the access road itself are at risk of being lost to continued erosion.

There is a stacked rock seawall along the south-facing shoreline that appears to be in relatively good condition toward the eastern end. However, it appears to be at risk for washing out toward the western end. The large amount of trees growing adjacent to the seawall aid in advancing the seawall's degeneration, as the roots slowly fragmentize the seawall and undermine its structural integrity.

Toward the western end of the southern shoreline, erosion has developed primarily from the past use of the area as an ad hoc trailer boat launch. Precast concrete blocks were placed at the top of the slope to prevent its use as a boat launch and thereby prevent further erosion at the shoreline. The blocks have been slowly sliding downward toward the Hudson River due to wave action, as tombolo formations were observed around the blocks. The area to the east of the concrete blocks and to the west of the seawall end is experiencing significant erosion also.

The railroad crossing at Ferry Road (near the Ferry Road and NYS Route 9J intersection) is inadequate for use by trailered boats. Therefore, shoreline stabilization strategies discussed herein assume that trailers will not cross the railroad tracks to get into the site and that boat ramp access will not be permitted.

Sven Hoeger, Ecologist of Creative Habitat Corporation, compiled an inventory and photographic documentation of plant species on site as part of the plant species investigation on March 29, 2016. During this investigation, wild ginger was observed for about 20 linear feet along the eastern end of the seawall. As the plant species inventory was conducted shortly after the winter season, not all plant species were observed due to dormancy. As such, another investigation was conducted on May 20, 2016 to confirm that a representative list of plant species growing on site was compiled during the initial investigation. For an inventory of plants located at/near the site's shoreline, see Attachment B.

SHORELINE STABILIZATION STRATEGIES

Due to the high-energy wave action from the adjacent River channel, vegetation cannot be solely relied upon to provide the same type of shoreline protection as that of hard shoreline protection measures, such as a fully-functional bulkhead or seawall. Therefore, shoreline stabilization strategies proposed for the site mainly use a combination of vegetation with stone armoring, a "softer" hard shoreline protection measure which will provide increased protection for comparatively little cost.

On April 26, 2016, BlueShore and Creative Habitat met with regulatory agencies, the Town of Stuyvesant and HRNERR staff to review and discuss various conceptual alternatives proposed for the Nutten Hook site. Final base designs for ecologically-enhanced, engineered shoreline treatment were tailored to include the strategies listed below. These combined strategies will help preserve the site's existing habitat value as well as maintain the seawall (though it has little historic value) and secure access to the site using minimal measures.

1. Stabilizing two undermined tree clusters at the site's northwestern and southwestern corners;
2. Removing trees at the seawall;
3. Reinforcing the seaward shoulder of the road with rock, along the full length of the seawall;
4. Adding grasses along the full length of the seawall, between the road and the seawall;
5. Reinforcing the escarpment using stones and plants; and
6. Stabilizing the shoreline between the concrete blocks and the western end of the seawall using a combination of stabilization efforts planned for use elsewhere on site.

Stabilizing the tree clusters (see Photo 1) will preserve habitat value generated by these trees. Removing trees at the seawall will prevent further damage of the seawall by tree roots, enhance the stability of the seawall and presumably increase its life expectancy. Reinforcing the shoulder of the road with rock and grasses as vegetative treatment (see Photo 2) will aid in preserving access to the site by helping to protect the road from wave action at elevations above MHW given sea level rise. Stone with plant reinforcement above MHW along the escarpment line will aid in armoring the shoreline to protect against further erosion without causing an increase in wave energies in the channel. Plants' roots will have the ability to remain anchored and retain soil fines.

Photo 1. Visualization of tree root protection at northern poplars

Photo 2. Visualization of road base armor (using stones and grasses)

Additional "add-alternative" designs, in the event that the budget allows for additional shoreline stabilizations measures to be taken, include:

1. A fixed, timber fishing pier along the western bulkhead;
2. Soldier piles to help reinforce the existing timber bulkhead, with some soldier piles doubling as timber anchor piles for the fishing pier; and/or
3. Slope armoring via rock sills.

The fishing pier will aid in maintaining scenic views given sea level rise. The fishing pier will also increase the recreational value of the site by designating an official path for fisherman and by providing a safe and stable footing to the water's edge for fishing and river-viewing purposes. The pier will be located mostly overland to minimize in-water impact, such as the potential for the pier to shade wetland vegetation. An overland fishing pier will also minimize the risk of damage due to ice conditions in winter seasons. The top of the pier deck will lie at the same elevation as the average existing parking lot elevation. Though an elevated pier will not physically disturb existing sensitive shoreline plants, the pier decking is not currently designed to be very light-permeable and will shade plants located directly underneath. After ecological review, it was determined that not many plants would be shaded by the pier. Therefore, standard wood decking is preferable, since it is more cost-effective and easier to construct. Finally, the fixed pier will require little maintenance in comparison to floating docks that must be removed seasonally.

Timber soldier piles will be placed directly adjacent to the seaward face of the existing western timber bulkhead and a portion of the existing northern timber bulkhead. The soldier piles will increase the longevity of the existing bulkhead by reinforcing part of the bulkhead and helping to prevent the bulkhead from failing and collapsing into the River channel. The soldier piles should not affect wave reflectivity. Approximately half of the fishing pier's anchor piles can double as solider piles.

Slope armoring via rock sills (see Photo 3) will involve armoring the slope using submerged, well-graded rock/stone fill below MHW on top of the shoreline at areas experiencing significant erosion. This alternative should help break waves before they reach the shoreline and will reinforce existing structures to better protect the site from erosion caused by ice, current and wave action. However, this alternative can also destroy some of the shoreline's intertidal zone, though not nearly as significantly as the net-zero fill alternative discussed below. Because the sills are made from rock/stone, fisherman and other visitors can walk on the sills without adversely affecting them.

Slope armoring via net-zero fill (see Photo 4) was considered as an additional "add-alternative" design. This option would involve excavating at areas experiencing significant scarping and placing stone in excavated areas to achieve net-zero fill below MHW. This alternative would help to break waves that wash over the shoreline to better protect the property from erosive forces. However, this alternative would heavily impact and destroy most of the shoreline's intertidal zone and habitat value, particularly it's potential to support rare plant species that rely on eroding surfaces. Plant species (such as the existing rushes) at these areas that are currently helping to hold together the shoreline would be destroyed. Therefore, we determined that this option was not a suitable shoreline stabilization strategy for the site.

Photo 3. Visualization of submerged stone sill, combined with escarpment reinforcement

Photo 4. Visualization of net-zero fill, combined with escarpment reinforcement

In addition to the shoreline stabilization strategies previously discussed, the project will also involve the following:

1. Saving as many existing plants as possible;
2. Transplanting the wild ginger at the southeastern corner of the site prior to construction;
3. Removing the concrete debris (including the two precast concrete blocks that are currently acting as barriers to prevent boats from launching at that ad-hoc boat ramp area) to the east of southwestern tree cluster and to the west of the stacked rock seawall; and
4. Restoring individually dislodged seawall stones to their original location.

The design strategies chosen for the Nutten Hook site will protect up to the projected 2025 MHW elevation of +3.6' re: NAVD88, which anticipates the sea level rise with rapid ice melt scenario. This protection elevation is 9 inches higher than the current 2016 MHW elevation. Protecting to this design flood elevation seems necessary and reasonable. Protecting to higher elevations may be impractical given the potential for lack of access to the site in 48 inches of sea level rise or less, per Scenic Hudson's Sea Level Rise Mapper. For a visualization of tide elevation projections as they relate to the Nutten Hook site, see Attachment C.

IMPLEMENTATION RECOMMENDATIONS

Tree removal along the seawall should be conducted carefully such that the existing seawall is not disturbed or destabilized in the process. Tree roots shall be cut as necessary to achieve minimal seawall impact. The Contractor shall not pull out roots with construction equipment. The Client may consider installing a guardrail or timber fencing between the seawall and Ferry Road, as trees will no longer act as a barrier between the access road and the adjacent Hudson River.

Roots at the northern and southern tree clusters shall not be cut or damaged at any time during construction work. Sand should be washed into place to fill the voids between and underneath the tree roots. The tree clusters shall then be surrounded with rock fill that will act as armor to aid in stabilizing the undermined clusters. Live stakes shall be installed into washed-into-place sand, between tree roots.

Work should be done by land to keep costs down, as driving piles from barge is expensive. The Contractor shall not disturb existing woodland vegetation during construction work. Construction staging shall be located on the parking lot only. Construction equipment and materials shall not be temporarily placed in woodland areas. There shall be minimal disturbance of existing rushes, grasses and shrubs during construction work. On-land pile-drivers shall maintain a minimum 30-foot to 40-foot clearance from the existing timber bulkhead to ensure that existing vegetation is not disturbed by construction equipment. Should the pile-driver not be able to meet this clearance criteria, a maximum of two temporary access paths may be used to assist with construction access. Temporary fencing around the parking lot and the temporary construction paths are recommended to restrict access. The Contractor is expected to submit a plan for the protection of existing woodlands, rushes, grasses, shrubs and tree cluster roots (during the placement of fill) for approval prior to commencing work.

Typically, the NYSDEC allows piles to be driven between September 30 and November 30 in the north Hudson River. The work restriction protects sturgeon spawning and juvenile overwintering. The USACE also has work restrictions to minimize impacts to anadromous and diadromous fish species. Usually, the USACE requires that in-water work only occur between July 1 and December 31. Environmental controls and mitigation measures, such as a containment boom and turbidity curtain installed and kept in place during all in-water work, may be proposed to allow for a more flexible pile-driving work window from environmental regulatory agencies.

Plantings shall occur in general between March 1 and May 15, with restriction that live stake planting shall end on or before April 15. Plantings will be exposed to sun and windy shore conditions. Therefore, the Contractor shall make necessary arrangements to have sufficient amounts of water available to soak plants during planting and to supply plants with sufficient amounts of water during the establishment period (periodic watering, automatic soaker hoses, etc.). The patch of wild ginger at the southeastern corner of the site shall be transplanted.

Chart 1 below details a rough timeframe for completing the project per the construction drawings.

Action	2016			2017										
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Prepare permit package														
Permitting agency review														
Prepare Request for Proposal (RFP)														
RFP bid process														
Mobilization														
Construction (base design)														

Action	2017	2018												2019
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Construction (base design)														
In-water work blackout dates														
Construction (add-alternate)														
Demobilization														

Chart 1. Estimated work timeline for the shoreline stabilization project at Nutten Hook

PERMITTING IMPLICATIONS

The proposed stabilization measures along the Nutten Hook site shoreline will have environmental permitting implications with the US Army Corps of Engineers (USACE), the NYS Department of Environmental Conservation (NYSDEC) and the NYS Coastal Management Program consistency review through the NYS Department of State (NYSDOS).

Fill calculations for the base and "add-alternative" designs are estimated in Chart 2 below. It is important to note that these quantities are approximations only, as estimates were calculated using a representative cross section of a shoreline stabilization strategy and assuming that cross section was true for a certain amount of linear feet along the shoreline. As cross sections vary along the shoreline in reality, actual fill quantities will vary.

Strategy	Total Amount of Fill	Fill Disturbance (Below Existing Grade)	Net Amount of Fill Below MHW
Stabilize two undermined tree clusters	20 yd^3	2 yd^3	+14 yd^3
Reinforce base of road with rock shoulder	40 yd^3	40 yd^3	0 yd^3
Add grasses along seawall	22 yd^3	22 yd^3	0 yd^3
Escarpment reinforcement	100 yd^3	21 yd^3	+24 yd^3
Escarpment reinforcement, near concrete blocks	20 yd^3	3 yd^3	0 yd^3
Fishing pier [1]	N/A	6 yd^3	N/A [2]
Timber soldier piles	N/A	18 yd^3	+25 yd^3
Rock sills	80 yd^3	0 yd^3	+78 yd^3
TOTAL	282 yd^3	112 yd^3	+141 yd^3

1. Assumes that half of the fishing pier's piles double as soldier piles. Therefore, fill from the fishing pier piles landward of the existing timber bulkhead are included in fill quantities for this strategy. Fill from fishing pier piles seaward of the existing timber bulkhead were accounted for in the "timber soldier piles" strategy.
2. The bulkhead interrupts jurisdiction, so the 7 yd^3 of fill below MHW from fishing pier piles landward of the existing timber bulkhead should not be relevant to environmental permitting agencies.

Chart 2. Estimated fill quantities

US Army Corps of Engineers

The USACE is responsible for regulating activity that may impact the nation's navigable waterways and wetlands, including the act of filling and building structures in water. The USACE's jurisdiction for this project will include all work extending over a boundary defined from the Mean High Tide line up to three geographical miles seaward of the Ordinary Low Tide line.

The stabilization strategies discussed herein involve the addition of fill below MHW to stabilize the two undermined poplar tree clusters at the northwestern and southwestern corners of the site, to stabilize the shoreline between the concrete blocks and the western end of the seawall, to reinforce the existing timber bulkhead and to armor the slope rock sills. If on average, the maximum fill added is not greater than 1 yd^3 per linear foot, then a Nationwide Permit (NWP) will apply. The base and "add-alternative" designs (excluding the fishing pier) will result in a net-addition of approximately 140 yd^3 of fill below MHW for a total of 300 linear feet of protected shoreline. Therefore, applicable NWPs may include NWP #3 for maintenance, NWP #13 for bank stabilization and/or NWP #27 for aquatic habitat restoration, establishment and enhancement activities.

As the fishing pier involves the construction of a new structure on-site, this will likely require individual permitting under Section 10 of the Rivers and Harbors Act for construction over navigable waters and Section 404 of the Clean Water Act for the installation of anchor/soldier piles, which can be considered a filling activity.

The USACE makes permit decisions by considering the advantages and disadvantages of the project itself, impacts to aquatic ecosystems, property rights of land owners and public opinions. Permit applications require a discussion of methods used to avoid or minimize disturbance to the wetlands. Because the work involved in this project demonstrates sufficient purpose and need and attempts to preserve as much currently existing habitat value as possible, there is no clear impediment toward obtaining the required USACE permits.

NYS Department of Environmental Conservation

In order to implement the New York State policy to preserve and protect the state's water resources set forth in Title 5 of Article 15 of the Environmental Conservation Law, the NYSDEC created the Protection of Waters Regulatory Program in order to regulate activity that may adversely affect the state's water resources and environmental quality. Established regulations ensure water resource value preservation and enhancement, public health and welfare protection, and state economic and social development. Regulated activities include the construction of piers and other in- and over-water structures as well as the placement of fill in waters.

Because the proposed project will potentially involve the construction of a fishing pier as well as the addition of fill in navigable waters, the following will be required:

1. Protection of Waters Permit, in accordance with the Protection of Waters Regulatory Program created under Title 5 of Article 15 of the Environmental Conservation Law.
2. Water Quality Certification, in accordance with Section 401 of the Clean Water Act.
3. Freshwater Wetland Permit, in accordance with the Freshwater Wetlands Act created under Article 24 of the Environmental Conservation Law.

Water Quality Certifications from the NYSDEC are required for permitting applications that involve activities that may result in discharge into US waters. Certification is used to ensure that the proposed activity will adhere to water quality standards. Applicable state-regulated freshwaters wetlands include the two areas with bulrushes, which the designs discussed herein will attempt to protect.

As previously stated, because the work involved in this project demonstrate sufficient purpose and need and attempts to preserve as much currently existing habitat value as possible, there is no clear impediment toward obtaining the required NYSDEC permits. As the fishing pier will be constructed of pressure treated timber, will be located mostly overland, will serve as reinforcement for the existing timber bulkhead and will utilize vibratory pile driving as much as possible, there is no clear impediment toward obtaining the required NYSDEC permits for the pier. It should be noted that the NYSDEC restricts pile-driving activities to a short work window at the end of the summer months.

NYS Department of State

This shoreline stabilization/improvement project must also be reviewed for consistency with the NYSDOS's Coastal Management Program (CMP) to ensure the project meets the state's standards regarding the protection of its coastal resources. Many activities authorized under USACE NWPs do not require consistency review by the NYSDOS.

The proposed project generally promotes a majority of the listed policies under NYS CMP. The project will revitalize an underutilized waterfront, facilitate water dependent uses, expand public access and water-related recreation, redevelop the existing built environment, minimize damage to property, natural resources, and the endangering of human lives caused by erosion, prefer non-structural measures to minimize damages from erosion, and protect and enhance resources that contribute to the overall scenic quality of the coastal area.

ADDITIONAL CONSIDERATIONS

Depending on when or if the "add-alternative" designs are to be constructed, additional surveying may be needed after a few years' time to assess changes in condition.

For the fishing pier, a soil investigation should be conducted prior to construction. A soil investigation will provide accurate information on subsurface conditions. This additional information will minimize the potential for issues during construction and the associated costs for change in conditions. It is possible that the piles to be driven over-land may hit below-grade obstruction (such as existing timber cribbing, steel tie-backs or rock fill) if they are to be driven per our construction drawings. Therefore, a soil investigation is recommended to determine whether fishing pier pile placement is acceptable, to obtain more accurate soil information and to determine whether over-land piles will require different specifications (such as the addition of rock sockets) than presently listed in our construction drawings.

The fishing pier and ramp were designed for ADA compliance. The ramp uses concrete footings that extend down to the frost depth. The Town of Stuyvesant confirmed that the frost depth is 42" below grade, with typical concrete footings at a depth of 48".

Maintenance and Monitoring

The plantings (grasses and live stakes) should follow the maintenance plan depicted in Chart 3 below. Maintenance above and beyond the watering costs, which should be included with the cost of plantings, should be between $1,000 and $1,500 per year for the first three growing seasons.

Year	Maintenance Tasks
Year 1	• Watering of grass plugs three (3) times weekly during the first month after planting and once weekly during the second month after planting • Remove tree sprouts from tree roots that remained near the seawall once a year in August • Debris removal from all planted areas (grasses and live stakes) three (3) times yearly in March, July and November
Year 2	• Replacement of plant material as necessary if losses exceed 85-percent • Remove root sprouts from tree roots that remained near the seawall once a year in August • Debris removal from all planted areas (grasses and live stakes) three (3) times yearly in March, July and November
Year 3	• Mowing of grass planting strip along access road once a year in March or early April • Targeted weed removal (if any) once a year in July or August • Debris removal from all planted areas (grasses and live stakes) three (3) times yearly in March, July and November

Chart 3. Yearly monitoring plan for plantings at the Nutten Hook site

The stone armoring (including escarpment reinforcement, rock shoulder at the base of the road and sills) should not require maintenance. If any "add-alternatives" are to be constructed after the escarpment reinforcement has already been placed, then construction equipment may track over some stone armoring at the temporary access path locations. In this case, the permanent stone armoring shall be restored to its pre-construction condition after the temporary access paths are disassembled. Similarly, no regular maintenance is necessary for the fishing pier and piles, as these structures were designed with a 15-year minimum life expectancy.

For plantings and stone armoring, site monitoring is recommended once prior to construction, followed by a series of yearly post-construction monitoring visits. Managing agents shall be furnished monitoring reports on a yearly basis to best be prepared to adapt their maintenance protocols accordingly, a procedure generally known as "adaptive management." A 5-year post-construction monitoring plan is highly recommended to best document not only successes and failures, but to also allow for enough time to follow-up on any management recommendations that are implemented, for example, to help improve, repair or otherwise steer the plantings into a desired trajectory of development. For the fishing pier and timber piles, a 5-year monitoring interval should be appropriate.

Monitoring of plantings shall report vegetation cover of planting areas in terms of percent. 85-percent of grass plugs and live stakes are expected to survive after the first year, while the growth rate of live stakes is expected to be 12" to 24" per year for the first three years. In addition, monitoring reports shall address the following:

- Causes of damage to plantings, such as ice sheer, beaver and muskrat feeding, debris accumulation, etc;
- Voluntary recruitment overall;
- Voluntary tree and shrub seedlings as well as root re-sprouts along seawall;
- Assessment of the potential for improvement or competitive harm from volunteering tree and shrub seedlings to live stake planting areas;
- Potentially invasive plant establishment overall;
- Status of areas protected during construction, such as beds of rushes and two tree clusters;
- General observations regarding ecological developments in adjacent floodplain forest;
- Wildlife usage of the site as observed during monitoring site visits;
- Obvious debris accumulations and damage; and
- Recommended management initiatives to improve, repair or otherwise steer the plantings into a desired trajectory of development.

Monitoring should primarily focus on the stated goals of this shoreline stabilization project:

1. *Resistance to erosion.*
    - Does tree removal at the seawall increase the seawall's stability or erosion resistance?
    - How successful is the reinforcement of the road shoulder?
    - Do grasses stabilize the road shoulder sufficiently?
    - Can regression of the shoreline be stopped by reinforcing the escarpment with stone?
    - Can the dying members of the two tree clusters be prevented from falling into the adjacent channel?
    - Does the use of live stakes improve erosion resistance along the shoreline?
2. *Enhancement of the recreational use of the site by the public.*
3. *Improvement or maintaining of the habitat value of the site for fish and wildlife species of the Hudson River Estuary.*
    - Will the stabilization of the two tree clusters at the northwestern and southwestern corners of the site preserve/improve habitat? What species will volunteer among the live stakes? Are these species native, alien and/or invasive?
    - Do the grasses along the seawall provide noticeable habitat function? What species will volunteer among the grasses? Are these species native, alien and/or invasive?
    - Can tree and shrub recruitment successfully be suppressed along the seawall?
    - Will the natural marshes (rush beds at western and northern shore) and intertidal grasses (western shore) remain unaffected or will they change in size and/or species composition?
    - Does shoreline stabilization lead to more shrub/tree growth at the site's perimeter?

CONCLUSION

Currently existing breakwater structures only offer shoreline protection below MHW. The proposed shoreline stabilization strategies that involve the use of vegetation and rock fill will improve the value of Nutten Hook's shoreline by offering shoreline stabilization below, at and above MHW at the areas of the site that are experiencing significant damage from erosion. Additional strategies, including the anchor/soldier piles, tree removal at the seawall and base of road reinforcement via grasses and stones, will help to maintain existing serviceable structures, while the fishing pier will preserve recreational value of the site. Along the site's northeastern shoreline, no additional shoreline protection measures are needed at this time.

Finally, given predictions from the rapid ice melt sea level rise scenario, the site will be inaccessible in around 50 to 60 years or less since Ferry Road is anticipated to be inundated with water after only about 36 inches to 48 inches of sea level rise. Therefore, even the most substantial reinforcement of the entire Nutten Hook site shoreline will not protect the site from flooding from the east, unless fill is added over the entire site. If, after 4 feet of sea level rise, fill is placed over the entire site to maintain its existence, the site will become a part of an island and consideration for preserving access to the site (via bridge or ferry landing) will be required.

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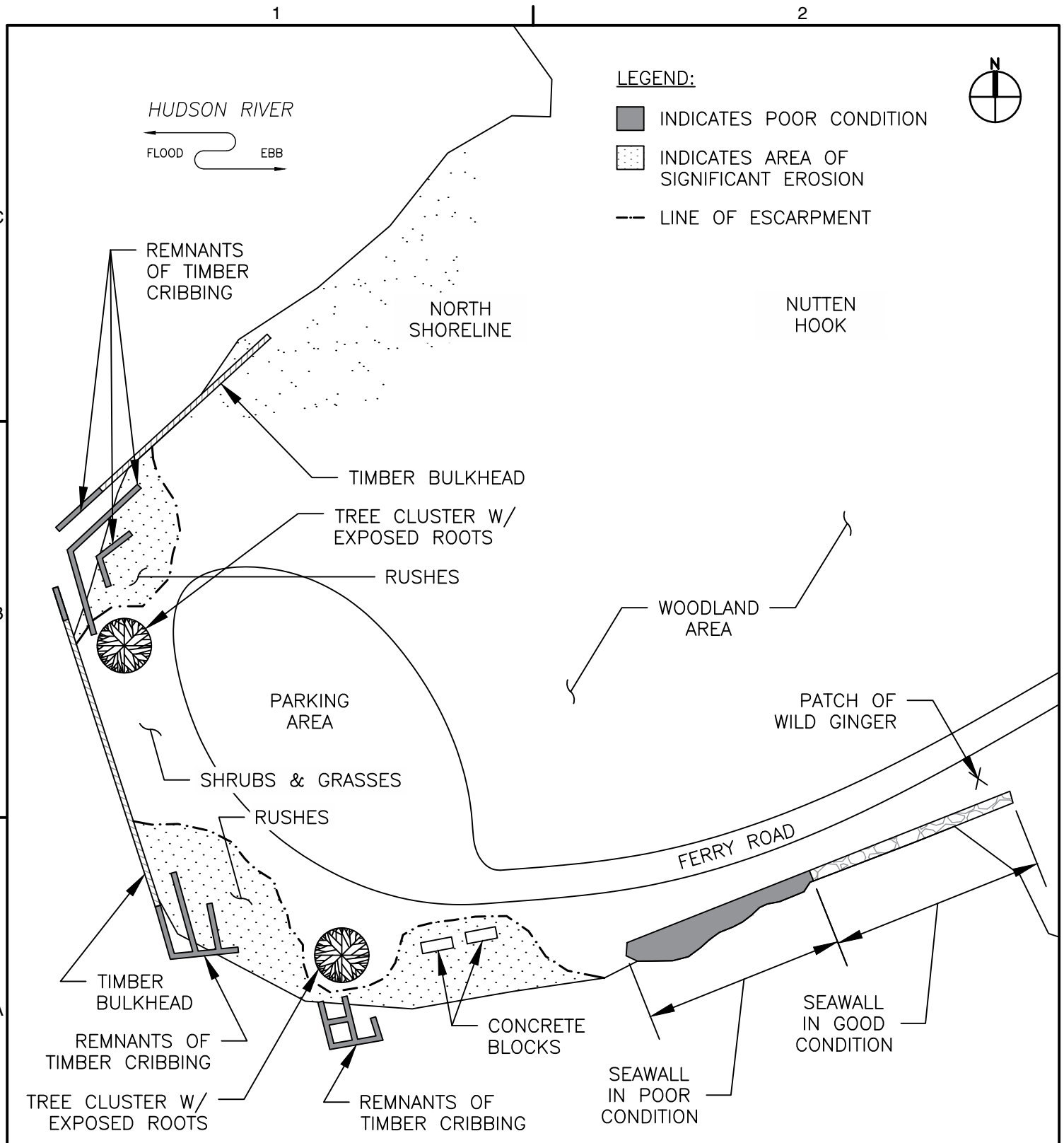
Sep. 23, 2016

Attachments



MARK	DESCRIPTION	DATE	APPR.

Project Number: 150515
Datum: NAVD88
USGS Quad: Hudson North
Waterway: Hudson River
Latitude: 42° 21' 14.89" N
Longitude: 73° 47' 19.10" W

ATTACHMENT A: EXST. SITE SCHEMATIC

NYSDEC HRNERR
259 Norrie Point Way
Staatsburg, NY 12580

Scale: 1"=50'

Sept. 23 2016

BlueShore
ENGINEERING LLC
TEANECK, NJ (201)817-2001
INFO@BLUESHORELLC.COM

R-1.0

Sht 33 of 39

2016 Plant inventory of shoreline at Ferry Point

Site survey date: 5/18/2016

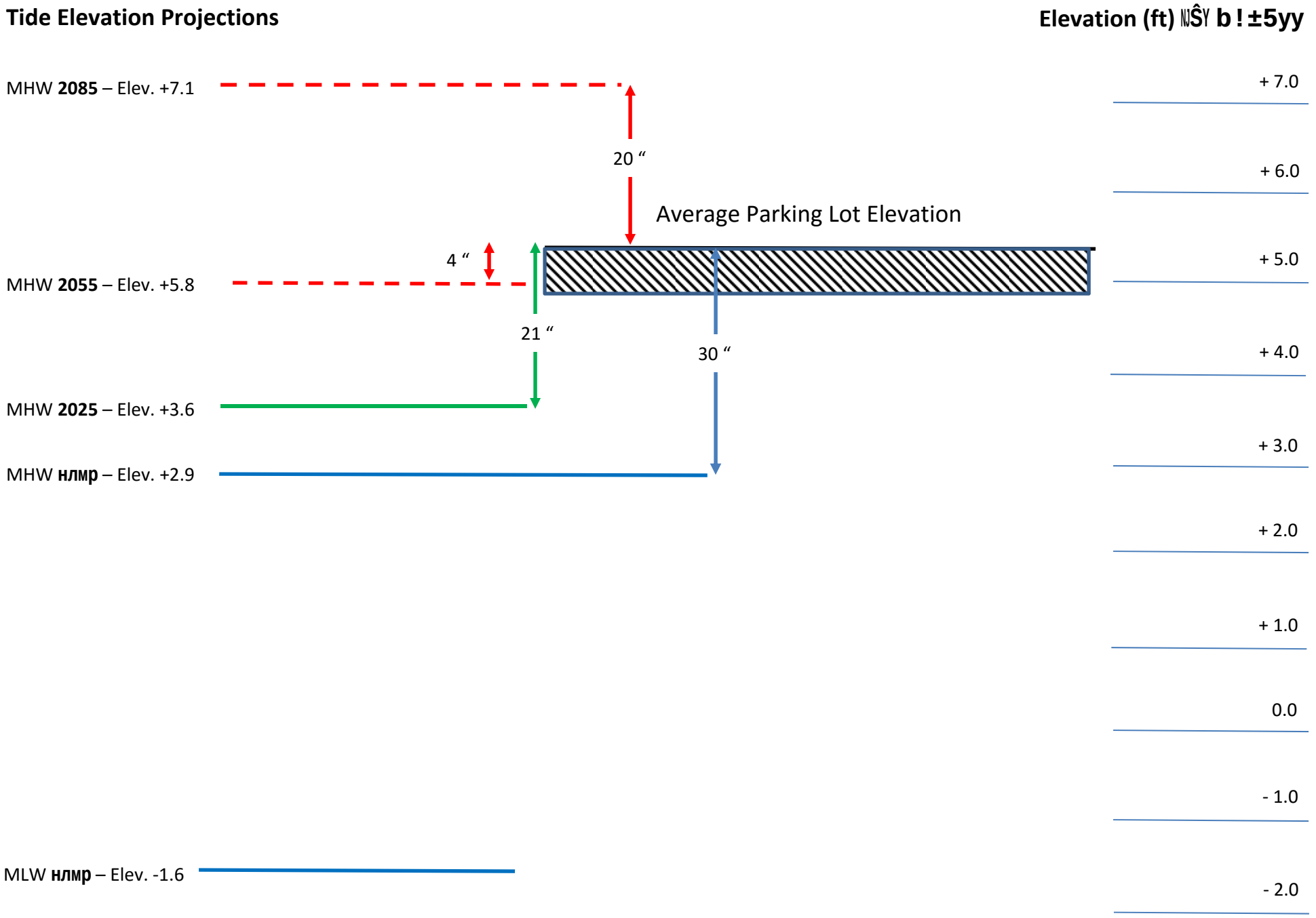
Line	Scientific Name	Common Name	intertidal west	upland edge west	tree island south	seawall roadside
1	*Acer platanoides*	Maple, Norway (seedlng)			Y	Y
2	*Acer saccharinum*	Maple, silver	Y			Y
3	*Amorpha fruticosa*	Indigobush		Y		
4	*Artemisia vulgaris*	Common wormwort	Y	Y	Y	
5	*Asarum canadensis*	Wild ginger				Y
6	*Asclepias sp.*	unidentified milkweed		Y		
7	*Bidens sp.**	Bur-marigold	Y		Y	
8	*Carex spp*	Sedges		Y	Y	
9	*Celastrus ?orbiculatus*	Bittersweet		Y	Y	Y
10	*Celtis occidentalis*	Hackberry				Y
11	*Comus amomum*	Dogwood, silky		Y	Y	Y
12	*Cornus foemina*	Dogwood, gray			Y	
13	*Cynanchum nigrum*	Black swallow-wort		Y	Y	
14	*Dactylis glomerata*	Grass, orchard		Y	Y	
15	*Daucus carota*	Queen Anne's lace	Y	Y		Y
16	*Erigeron pulchellus (tent. ID)*	Robin's plantain			Y	Y
17	*Eupatorium ?maculatum*	Joe-Pye-weed	Y		Y	Y
18	*Fraxinus ?americana*	Ash, white?		Y	Y	Y
19	*Galium mollugo*	Bedstraw		Y	Y	
20	*Glecoma hederacea*	Ground-ivy				Y
21	*Grasses*		Y	Y	Y	Y
22	*Iris sp.*	unidentified Iris	Y	Y		
23	*Juniperus virginiana*	Cedar, eastern red (seedlings)				Y
24	*Lonicera x bella*	Honeysuckle, Bell's		Y	Y	
25	*Lonicera morrowii (tent. ID)*	Morrow's bush honeysuckle				Y
26	*Lysimachia ciliata*	Loosestrife, whorled	Y			Y
27	*Lythrum salicaria*	Loosestrife, purple	Y	Y	Y	Y
28	*Melilotus officinalis*	Sweet-clover, yellow		Y	Y	
29	*Morus sp*	Mulberry		Y	Y	Y
30	*Moss*		Y		Y	Y
31	*Oenothera biennis*	Common evening primrose				Y
32	*Ostrya virginica*	Hop-hornbeam			Y	
33	*Panicum virgatum*	switchgrass	Y	Y		
34	*Parthenocissus quinquefolia*	Creeper, Virginia		Y		Y
35	*Phalaris arundinacea (tent. ID)*	Reed Canarygrass	Y			
36	*Plantago lanceolata*	English planatain				Y
37	*Plantago major*	Broadleaf plantain			Y	
38	*Plantago rugelii*	Plantain, blackseed				Y
39	*Populus deltoides*	Cottonwood , eastern		Y	Y	Y
40	*Prunus virginiana*	Cherry, choke			Y	

2016 Plant inventory of shoreline at Ferry Point, continued:

Line	Scientific Name	Common Name	intertidal west	upland edge west	tree island south	seawall roadside
41	*Rhamnus cathartica*	Buckthorn, European			Y	Y
42	*Rhus typhina*	Sumac, staghom		Y		
43	*Ribes americanum (tent. ID)*	Eastern Black Currant		Y	Y	Y
44	*Robinia pseudoacacia*	Locust, black			Y	Y
45	*Rosa multiflora*	Rose, multiflora	Y		Y	Y
46	*Rubus sp.*	unident. Brambles				Y
47	*Rumex*	Dock	Y			
48	*Schoenoplectus americanus*	Chairmakers rush	Y			
49	*Securigera varia*	Crownvetch		Y	Y	Y
50	*Solidago*	Goldenrod	Y	Y	Y	Y
51	*Staphylea trifolia*	Bladdernut			Y	
52	*Taraxacum officinale*	Dandelion		Y		Y
53	*Thalictrum sp.*	unident. Meadow rue			Y	
54	*Tilia americana*	Basswood				Y
55	*Toxicodendron radicans*	Poison-ivy		Y	Y	Y
56	*Trifolium spp.*	Clovers	Y	Y	Y	
57	*Tussilago farfara*	Coltsfoot			Y	
58	*Ulmus americana*	Elm, American		Y		Y
59	*Violet, blue*	Viola	Y		Y	Y
60	*Vitis labrusca*	Fox grape		Y	Y	
61	*Xanthium sp.*	unident. Cocklebur				Y

Note: * 1998 records from Hudsonia Limited indicate the potential presence of
Bidens bidentoides (NYS Rare, NYNHP S3, G3)
Seedlings of unidentified Bidens sp. are present at the site.

Tide Elevation Projections



Source: NYS ClimAid Report, Sea Level Rise Projections for the Hudson River, NY (rapid ice melt scenario)

BlueShore ENGINEERING L.L.C.

ATTACHMENT D: METADATA CHART

The chart below summarizes metadata for the referenced sources, as listed in the "References" section.

Source	Data Description	Intended Data Use	Date Published	Additional Metadata Available?
http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/new_york/NY021/0/Columbia.pdf	Soil survey of Columbia County, New York	Information to be used in land planning programs in Columbia County, NY	June 1989	N
http://gis.ny.gov/gisdata/metadata/nysdec.Documented_SAV_Habitat.xml	Documentation of the location of submerged aquatic vegetation (SAV) in the Hudson River Estuary, created from the aggregate extent of data from inventories collected in 1997, 2002 and 2007	To determine the status of SAV resources and to compare the extent of SAV observed in 2007 with that observed in 1997 and 2002	5/31/2011, revised August 2013	Y
https://msc.fema.gov/portal/search?AddressQuery=stuyvesant%2C%20ny#searchresultsanchor	FEMA Flood Insurance Rate Map #361323-0002-B	For flood insurance purposes	9/14/1979	N
http://gis.ny.gov/gisdata/metadata/nysdec.Hudson_Physical_Process_Model.xml	Compilation of simulated riverside water circulation statistics from a high-resolution numerical model along the Hudson River for the year 2010	Characterization of the physical environment (i.e. water levels, currents, vertical current stresses and mixing, surface wind waves) impacting the Hudson River shoreline for the Hudson River Sustainable Shorelines Project	5/20/2013	Y
http://gis.ny.gov/gisdata/metadata/nysdec.hudson_ice_meta.xml	Compilation of observed ice data statistics from the USGS daily ice reports (December to March) along the Hudson River	Characterization of the physical environment (i.e. ice conditions) impacting the Hudson River shoreline for the Hudson River Sustainable Shorelines Project	N/A	Y
Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information (report)	Climate analysis and risk update	To provide updated climate risk information to be used in resiliency efforts	September 2014	N
https://store.usgs.gov/b2c_usgs/usgs/z_lat_lon_matnr_list.do?b2cb2b=b2c&G_SEARCH_TYPE=GPDD&b2cb2b=b2c&g_search_shop_shops=15&&ZCOORD_DEC_DEG-LONGITUDE=-73.8125&ZCOORD_DEC_DEG-LATITUDE=42.3125	Topographic map of a piece of New York state	Developed to provide comprehensive graphic representations of features of the Earth's surface throughout the US	2013	Y
http://www.charts.noaa.gov/PDFs/12348.pdf	Navigational chart of the Hudson River Channel, from Coxsackie to Troy, NY	Designed to promote safe navigation	6/1/2010, revised 7/13/2016	N
From Hudsonia Ltd. (email)	Documentation of plant species in/around the Nutten Hook site	N/A	5/5/2016	N
https://mesonet.agron.iastate.edu/sites/dyn_windrose.phtml?station=ALB&network=NY_ASOS	Archive of observed wind data, to create custom wind rose plots	To collect environmental data from cooperating members with observing networks, store it in one location and make it available to the public	N/A	N
Spring Bird, Reptile, and Amphibian Surveys at Nutten Hook Reserve, Town of Stuyvesant, Columbia County, New York (report)	Survey of all birds, reptiles and amphibians at the Nutten Hook Reserve	These findings were developed for the NYSDEC Hudson River National Estuarine Research Reserve and are provided impartially to those persons and organizations involved in public decision-making	7/21/1997	N
https://www.hrnerr.org/hudson-river-wake-study/	Study to determine the wake heights produced from recreational and commercial vessels as they travel along the Hudson River	To help inform shoreline stakeholders and decision-makers of the required design thresholds for varying methods of ecologically enhanced shoreline stabilization	June 2015	N
https://www.hrnerr.org/doc/?doc=240577263	Describes the methodology and results of a comparative cost analysis of ten different shoreline stabilization approaches at three sites, under two sea level rise scenarios	Designed to compare the construction, long-term maintenance, damage and replacement costs of ecologically enhanced stabilization approaches to those of traditional approaches as sea levels rise	July 2012, revised September 2014	N
http://www.historicaerials.com/	Historic/modern aerial photographs and topographic maps of areas in the US	To provide records to the public online	N/A	N
http://www.dec.ny.gov/imsmaps/ERM/viewer.htm	NYSDEC interactive map of New York state	Can be used to identify New York state's natural resources and environmental features that are state protected, or of conservation concern	N/A	N
http://www.dec.ny.gov/regulations/103894.html	6 NYCRR Part 49, Regulatory Impact Statement Summary	Part 490 was promulgated to fulfill ECL § 3-0319, which requires the NYSDEC to adopt regulations establishing sea-level rise projections, with the purpose of ensuring that state decisions include consideration of the effects of climate risk	1/1/2016	N
http://www.scenichudson.org/slr/mapper	Scenic Hudson's interactive map of projected sea level rise in the Hudson River	Tool for visualizing sea level rise scenarios and supporting adaptation planning	N/A	N
https://tidesandcurrents.noaa.gov/tidetables/2015/ectt2015book.pdf	Tide tables for the east coast of North and South America, including Greenland	For the use of mariners	2014	N
https://tidesandcurrents.noaa.gov/stations.html#NewYork	NOAA tide station data	To monitor, assess and distribute tide, current, water level and other coastal oceanographic products that support NOAA's mission of environmental stewardship and environmental assessment and prediction	N/A	N

Date 9/23/2016

Sheet No. 1 of 1

Prepared by: BlueShore Engineering LLC

150515: Nutten Hook Project
Attachment E: Opinion of Probable Costs

Made by CVH
Checked by RWG & SH
Stage FNL

Base Design

Item	Description	Quantity	Unit	Unit Price	Total		Remarks
	BASE SCOPE				MIN	MAX	
1	Stabilize undermined tree clusters	20	CY	$ 250	$ 5,000	$ 5,000	See note 3
2	Tree removal, along seawall	15-20	EA	$300-$750	$ 4,500	$ 15,000	See note 4
	Restore dislodged seawall stones	1	LS	$ 5,000	$ 5,000	$ 5,000	Estimated 7 CY
3	Reinforce base of road with rock shoulder	40	CY	$ 210	$ 8,400	$ 8,400	See note 3
4	Add grasses, 3' width along seawall	740	SF	$2.25-$4.25	$ 1,665	$ 3,145	See note 5; 22 CY max.
5	Escarpment reinforcement, using stones/plants	100	CY	$ 250	$ 25,000	$ 25,000	See note 3
6	Escarpment reinforcement, near concrete blocks	20	CY	$ 250	$ 5,000	$ 5,000	See note 3
	SUBTOTAL				$ 54,565	$ 66,545	
	Mobilization/Demobilization				$ 30,000	$ 30,000	
	10% Contingency				$ 5,457	$ 6,655	See note 1
	15% Contractor overhead and profit				$ 8,185	$ 9,982	
	15% Soft costs				$ 8,185	$ 9,982	See note 2
	TOTAL				$ 106,391	$ 123,163	

Add-Alternative Design

Item	Description	Quantity	Unit	Unit Price	Total		Remarks
	OPTIONAL ADD-ALTERNATIVES				MIN	MAX	
1	Fishing pier, 60'X10', along west bulkhead	600	SF	$125-$200	$ 75,000	$ 120,000	
	Soil investigation	1	LS	varies	$ 10,000	$ 15,000	
2	Timber soldier piles, 12"ØX27.5' average	31	EA	$ 4,000	$ 124,000	$ 124,000	
3	Slope armoring, rock sills	80	CY	$ 200	$ 16,000	$ 16,000	See note 3
	SUBTOTAL				$ 225,000	$ 275,000	
	Mobilization/Demobilization				$ 30,000	$ 30,000	
	10% Contingency				$ 22,500	$ 27,500	See note 1
	15% Contractor overhead and profit				$ 33,750	$ 41,250	
	20% Soft costs				$ 45,000	$ 55,000	See note 2
	TOTAL				$ 356,250	$ 428,750	

Combined Base and Add-Alternative Designs

Item	Description	Quantity	Unit	Unit Price	Total		Remarks
	BASE SCOPE				MIN	MAX	
1	Stabilize undermined tree clusters	20	CY	$ 250	$ 5,000	$ 5,000	See note 3
2	Tree removal, along seawall	15-20	EA	$300-$750	$ 4,500	$ 15,000	See note 4
	Restore dislodged seawall stones	1	LS	$ 5,000	$ 5,000	$ 5,000	Estimated 7 CY
3	Reinforce base of road with rock shoulder	40	CY	$ 210	$ 8,400	$ 8,400	See note 3
4	Add grasses, 3' width along seawall	740	SF	$2.25-$4.25	$ 1,665	$ 3,145	See note 5; 22 CY max.
5	Escarpment reinforcement, using stones/plants	100	CY	$ 250	$ 25,000	$ 25,000	See note 3
6	Escarpment reinforcement, near concrete blocks	20	CY	$ 250	$ 5,000	$ 5,000	See note 3
	OPTIONAL ADD-ALTERNATIVES				MIN	MAX	
7	Fishing pier, 60'X10', along west bulkhead	600	SF	$125-$200	$ 75,000	$ 120,000	
	Soil investigation	1	LS	varies	$ 10,000	$ 15,000	
8	Timber soldier piles, 12"ØX27.5' average	31	EA	$ 4,000	$ 124,000	$ 124,000	
9	Slope armoring, rock sills	80	CY	$ 200	$ 16,000	$ 16,000	See note 3
	SUBTOTAL				$ 279,565	$ 341,545	
	Mobilization/Demobilization				$ 30,000	$ 30,000	
	10% Contingency				$ 27,957	$ 34,155	See note 1
	15% Contractor overhead and profit				$ 41,935	$ 51,232	
	15% Soft costs				$ 41,935	$ 51,232	See note 2
	TOTAL				$ 421,391	$ 508,163	

Additional Notes:
1. The contingency was included to account for uncertainties and unforseen events/circumstances in cost estiamtes.
2. Soft costs include fees not directly related to labor and building materials, including permitting, construction administation, additional engineering fees for design updates and other expesnes related to pre-/post-construction activities. Soft costs do not include costs associated with monitoring and maintenance.
3. Estimated quantities were approximated to the nearest ten cubic yards.
4. Cost for tree removal widely varies depending upon whether stump grinding/removal and hauling of trunk wood is included. Cost is also dependant on difficulty of removal at seawall.
5. Cost for the addition of grasses depends on whether existing conditions provides suitable topsoil for planting.

0 20 40 60

1 INCH = 15 FEET

File Path:	Y:\PARKS\NUTTEN HOOK 110533\DELIVERED\
File Name:	110533 ALL_REV1.DWG
Plot Date:	08-01-2016
Plot Time:	1:17 pm

LEGEND

- BOM FOOT OF MOUNTAIN
- BUL BULKHEAD
- BUL TOP TOP OF BULKHEAD
- CLN CENTERLINE
- CON CONCRETE
- CONC CONCRETE
- D DEPTH SOUNDING
- DISC GOVT SURVEY DISC
- EOR EDGE OF ROAD
- GL GROUND LEVEL
- GRED GRASS EDGE
- HUB SURVEY STAKE
- IRON IRON PIPE
- KIO KIOSK
- OPUS POINT FOR 2016 SURVEY
- PAT PATH
- PIL PILING
- PK "PK" SURVEY NAIL
- PKG PARKING AREA
- RKY ROCKY OR GRAVEL GROUND
- ROC LARGE ROCK
- ROOT ROOT
- SAN SAND
- SLAB LARGE CONCRETE SLAB
- TIM TIMBER
- TIM/GL TIMBER AT GROUND LEVEL
- TOP TOP
- TP TRAVERSE SURVEY POINT
- TRE TREE
- WAL WALL
- WOD WOOD AREA OR GROUND COVERED WITH LEAF MATTER
- X SPOT ELEVATION

SURVEY NOTES:

1. HORIZONTAL CONTROL IS REFERENCED TO NAD83 OPUS OBSERVATIONS CONDUCTED AS PART OF THIS SURVEY AND DISPLAYED IN THE NEW YORK EAST COORDINATE PROJECTION SYSTEM.
2. ELEVATIONS ARE BASED ON NAVD88 OPUS GPS OBSERVATIONS CONDUCTED AS PART OF THIS SURVEY.

Nutten Hook

at the end of Ferry Road
Town of Stuyvesant
Columbia County, NY

SHORELINE STABILIZATION ASSESSMENT

HYDROGRAPHIC / TOPOGRAPHIC SURVEY

SCALE: 1" = 15'

SURVEY AUGUST 1, 2016

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