Climate Adaptive Design (CaD) Studio

Shoreline Revitalization and Community Connectivity Project

Town and Village of Ossining, Westchester County, New York

Final Preliminary Design Report – Version 3

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1 Project Background

In the fall of 2019, students from Cornell University's Climate Adaptive Design (CaD) Studio began a four-month design process to investigate alternatives for waterfront reinforcement, adaptation and relocation in the Town & Village of Ossining, New York. Working with the Town & Village, the students developed ten independent designs that envisioned a process for future possibilities in Ossining as climate conditions change and flooding and other climate risks pose increasing threats to this community located along the Hudson River.

Ossining's riverfront location, including the Sing Sing Kill, is understood to be both a great asset and a significant challenge, as documented in the County's Hazard Mitigation Plan. Both municipalities have experienced significant damages from periodic waterfront flooding due to storms, high tides, and Sea Level Rise (SLR) (Westchester County 2015). In 2011, Hurricane Irene caused a section of roadway to collapse along Albany Post Road as a result of stormwater erosion exacerbated by steepened slopes. One year later in the fall of 2012, Hurricane Sandy caused extensive public infrastructure and private property damage in both municipalities.

Through the community's experience with these storms and the collective planning for flood risk reduction and greater resilience, Ossining has a solid foundation of knowledge regarding SLR and floodplain adaptation approaches (NYSDEC 2017a). Both the Town and Village of Ossining wish to move forward to reduce risk and improve resilience with professional consultant support. In October 2021, Henningson, Durham and Richardson Architecture and Engineering, P.C. (HDR) was awarded a Hudson River Estuary Program (HREP) grant (administered through NEIWPCC) to conduct stakeholder engagement, site assessment activities, and the preliminary design for a proposed living shoreline with cultural and educational amenities on the south side of the existing pier (Figure 1). These would build upon the concepts and design ideas developed by the CaD Studio students.

Figure 1. Proposed Project Area in Ossining (Facing Southeast).

2 Review of Existing CaD Studio Concepts

Each of the original CaD Studio designs offered innovative ideas for improving Ossining's coastal resiliency. However, based on subsequent review and communications between Village leadership and New York State Department of Environmental Conservation (NYSDEC) staff, each of these designs would be challenging to implement given today's regulatory climate and expected funding limitations. For this project, HDR provided a qualitative review of each of the CaD Studio designs and selected key elements that would be feasible for implementation from permitting, high-level cost-effectiveness, and community perspectives (Table 1). Stakeholder engagement (see Section 4) was then used to guide the design selections and refine the final concepts through an engaged process by taking common elements from the CaD Studio concepts and developing them into a cohesive and implementable preliminary design for a coastal resiliency project that aligns with the Village of Ossining's Comprehensive Plan and Local Waterfront Revitalization Plan (LWRP) (Village of Ossining 2012) as well as the Town of Ossining's Comprehensive Plan (Town of Ossining 2021).

Table 1. Overview of Phase I Climate Adaptive Design Concepts.

	A Latent Buffer for Ossining	Eco-Line	Step Back, Step Up, Move Forward	True Urban	Unlocking The Ossining Waterfront	Remix of GI	River Guards	Tracing Place, Shifting Shores	Sing Sing Fugue	Shifting Lines, Rising Tides
CaD Phase I Concepts										
Elevated Train	X	X	X[1]	X		X	X[1]			
Relocation of Train			X		X					
Living shoreline/ Ecological buffer	X			X	X	X	X	X	X	X
Levees/Berms	X	X		X		X		X		
Floodgate		X								
Neighborhood relocation				X				X	X	
Amphibious / floodproof neighborhoods or facilities	X	X						X		
"Floating Walkways"			X		X	X				
Traffic / Pedestrian improvements	X	X	X	X	X	X	X	X	X	X
Stormwater: Green Infrastructure		X	X	X		X			X	
Educational component		X					X	X	X	
Resilient marina		X					X			
Relocation of critical facilities	X	X	X	X	X		X	X	X	X
Habitat / natural area improvements	X	X	X	X	X	X	X	X	X	X
Regulatory update regarding construction in floodzone		X					X			

[1] Indicates temporary relocation

- **A Latent Buffer for Ossining** proposes a green buffer between the waterfront and the community. As sea levels rise this buffer zone becomes a combination of floodable public spaces, with critical infrastructure raised above. Concepts worthy of future consideration include the floodproofing of several buildings, the raising of the Metro-North Railroad to create new connections between the waterfront and Village, and the use of native plants to create new wetlands.
- **Ecoline** proposes elevating the existing rail line on a levee to reduce rail inundation and flooding risk while providing some protection for the inland area. Concepts worthy of future consideration include the creation of a levee underneath a raised Metro-North Railroad, a floodgate on Sing Sing Kill to protect against storm surge, the use of “sunken” parks in series to alleviate storm runoff, a terraced park south of the sing Ossining Boat and Canoe Club, the installation of a new elevated promenade in Engel Park, and floating docks.

- **Step Back, Step Up, Move Forward** proposes a strategic relocation and cut-fill grading strategy to create waterfront open space while encouraging development upslope and facilitating marsh migration in certain locations. Concepts worthy of future consideration include relocating the wastewater treatment plant, transitioning the marina to a new location on the western edge of the Sing Sing Correctional Facility Property, new wetlands along the Sing Sing Kill, a new ferry terminal, and the temporary elevation of the rail line in place to be followed by a move uphill to a location near Route 9.
- **True Urban** proposes the creation of an accessible, flood adapted park, where the rail line has been raised and the area underneath become open public space that will gradually transition to underwater habitat. Concepts worthy of future consideration include the raising of the rail line to allow for new pedestrian plazas and spaces underneath the train.
- **Unlocking the Ossining Waterfront** proposes moving the rail line underground, elevating land to create an extensive park along the waterfront, a redeveloped marina and using a complete streets strategy to enhance connectivity between downtown Ossining and the waterfront. Concepts worthy of future consideration include the relocation of the rail line underground, new bulkhead installations along the waterfront, the creation of new wetlands along the southern edge of Engel Park, “floating” walkways through these wetlands allowing for access as the landscape changes, and the creation of “mounds” off the west section of the Sing Sing Correctional Facility for new recreational and ecological opportunities.
- **Remix of Green Infrastructure** proposes using nature-based features common to green infrastructure to be incorporated into the Ossining Waterfront. Concepts worthy of further consideration include the creation of berms and nature-based shoreline to protect the existing rail line, a new green space on the western section of the Sing Sing Correctional Facility, and the creation of a new network of green corridors that would connect the Village of Ossining to the waterfront.
- **River Guards** proposes transitioning development upslope of the waterfront and using a new plaza where Water Street crosses the Sing Sing Kill to encourage community engagement. Concepts worthy of future consideration include the gradual withdrawal from the water’s edge, the creation of a new public plaza along the Sing Sing Kill, the redevelopment of the marina and wetlands along the shoreline, as well as the relocation of the Marina’s oil tanks outside of potential flood areas.
- **Tracing Place, Shifting Shores** proposes using land contouring, materials, and planting strategies to create memorable, attractive waterfront places that enhance ecosystems, and the use of a portion of the current Sing Sing Correctional Facility for a “green jobs” opportunity for inmates. Concepts worthy of future consideration include the raising and flood proofing of several building and areas along the waterfront, the relocation of buildings and neighborhoods that are not reliant or related to the waterfront, installation of berms to prevent erosion and the creation of a living shoreline. Note that this design only considers a 2050s climate projection.

- **Sing Sing Fugue** proposes the gradual retreat from the current shoreline to allow for an interstitial zone to be created up to Water Street which then becomes the new "second coast". Concepts worthy of future consideration include the addition of waterfront attractions at the western portion of the current Sing Sing Correctional Facility, the creation of islands along the waterfront with new stores, hotels, and public spaces, and new wetlands created along practically the entire waterfront with new docks for public and private access
- **Shifting Lines, Rising Tides** proposes encouraging flood prone areas as locations of nature-based activities while relocating vulnerable infrastructure and increasing public access to the waterfront. Concepts worthy of further consideration include the relocation of vulnerable infrastructure, a new swimming beach near the Ossining Boat & Canoe Club, new resilient plantings, and greater access to the waterfront.

3 Site Assessment

In advance of the preliminary design development, HDR conducted a detailed site investigation of the proposed project area on April 25, 2022. The full HDR Site Assessment Report is available as **Appendix A** of this report.

Prior to the site assessment a qualitative review of each of the ten original CaD Studio concepts (Section 2) and input from the stakeholder engagement process (Section 4) were used to identify the potential study area located primarily in Louis Engel & Henry Gourdine Park in the Town & Village of Ossining.

The following activities were conducted during the site assessment in accordance with the approved Quality Assurance Project Plan (QAPP), Version 2 dated January 14, 2022:

1: General assessment of existing shoreline features and condition.

2: Ecological assessment of existing ecological communities and functions at the site, with emphasis on dominant plant species; invasive species present; rare plants or animals; wildlife species observed; dominant substrate types, bank and shoreline stability, and observed site constraints/opportunities.

3: Topographic mapping to measure and record three-dimensional locations of both natural and man-made elements within the project area and reference shoreline, and graphically represent the site's existing conditions in a plan-view map.

4: Collection of aerial imagery, videography, and photogrammetry using a DJI Phantom 4 RTK UAS platform.

During the site visit, a number of subtidal (below Mean Low Water) and intertidal (between Mean Low Water and Mean High Water) shoreline features and potential engineered solutions for the existing shoreline were discussed with the project partners. These features were further evaluated during the development of the preliminary design and the site-specific information collected during the site assessment was used to inform the design.

Overall, a variety of native and non-native plant species were documented in the supra-tidal (above Mean High Water) and terrestrial environments above and adjacent to the site; however, aquatic/intertidal vegetation was noticeably absent in the vicinity of the project area, possibly due to hydrodynamic (wind/wave) conditions and substrate type. Non-native species present above the shore zone included Japanese knotweed, mugwort, and tree-of-heaven. The dominant substrate type in the study area was cobble/gravel, with a gradation to coarse sand/gravel to the northwest, approaching the nearby marina (Figure 2). Estuarine organisms noted in the tidal shallows and intertidal zone included ivory acorn barnacles attached to rocks. Atlantic rangia clam shells were abundant along the shore and in shallow water areas. Small ribbed mussel shells were observed along the shoreline, predominantly among the wrack line, but no live mussels were present in the intertidal zone. Fragments of American oyster shells were present throughout the intertidal zone. Both aquatic and terrestrial/arboreal bird species were present. No state or federally listed rare plant or animal species were observed during the site assessment.

Figure 2. Existing Substrate Conditions within the Proposed Project Area.

4 Stakeholder Engagement

Throughout the project, HDR in conjunction with its project partners (NEIWPCC and NYSDEC) and the Village and Town of Ossining developed and implemented a stakeholder engagement strategy designed to identify appropriate community, municipal and state regulatory staff to engage during the design development. Inclusive and equitable engagement was vital for a successful, community-supported project. Therefore, the engagement strategy included a variety of touchpoints which met the community where they gather and provided accessible materials

such as fact sheets or mobile-friendly surveys. Stakeholder engagement partnered with community-based organizations such as Neighbors Link which serves immigrants, Green Ossining which promotes a sustainable future, and IFCA Housing Network which contributes to affordable housing opportunities. A database of key stakeholders and contact information was maintained by the project partners on a shared website during the project that included summaries of discussions held and information shared with or provided by each key stakeholder.

Early in the project, the team tabled at the Green Ossining Earth Day Celebration on April 23, 2022 at Louis Engel Park to start the public engagement process and raise awareness of the project with the Town and Village of Ossining. The team heard from residents about what features and uses of the park are important. Attendees were invited to join the project email list and complete a mobile-friendly survey. The survey was promoted through email and social media following the event and received 33 responses. Figure 3 is a sample of the responses received. The responses to this survey were compiled and attached to the report in **Appendix B1**.

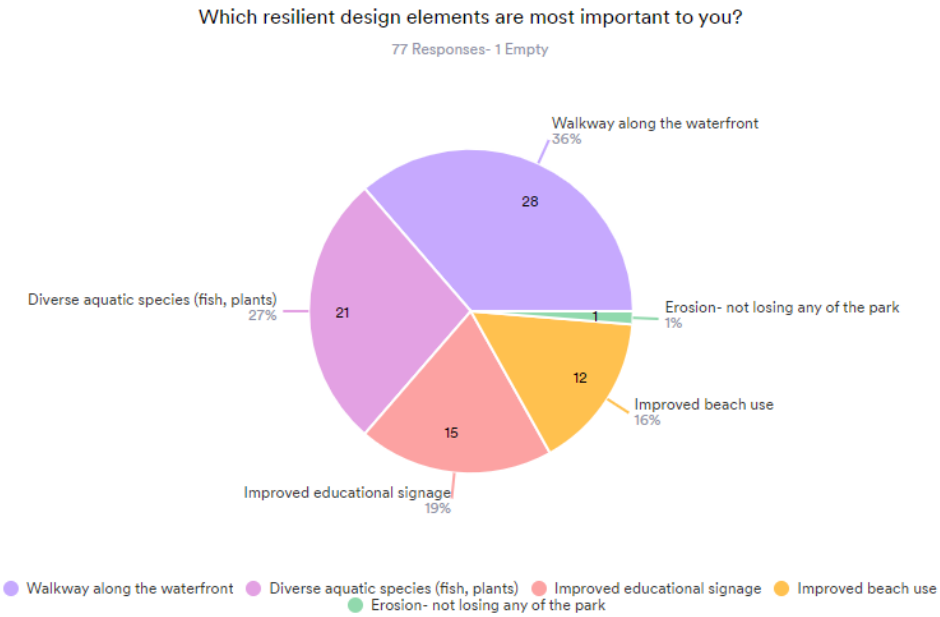

Figure 3. Sample of Responses Received During Earth Day Tabling Event

Following this tabling event, a stakeholder workshop was held at the Ossining Community Center on June 10, 2022, with key stakeholders to review the CaD concepts, discuss their potential, and seek input on the conditions in the project area. The PowerPoint presentation from this meeting is also provided in **Appendix B2** of this report.

Based on the stakeholder feedback, the project team revised and refined the design concepts to be shared with the Ossining community. A Virtual Open House was created to educate the public on shoreline resiliency, share the resilient design concepts, describe how they could be implemented on Ossining's shoreline, and asked for input on the designs through an online survey. This format was accessible by mobile and translated to Spanish. The Town and Village of Ossining and other community-based organizations promoted the virtual open house through email, social media and by handing out flyers at Louis Engel Park on the weekends. The survey was live from August 1, 2022, to September 6, 2022, and received 121 survey responses in English and Spanish. Figure 4 shows the translated virtual open house and can be accessed at this link. The responses to this survey were compiled and attached to this report in **Appendix B3.**

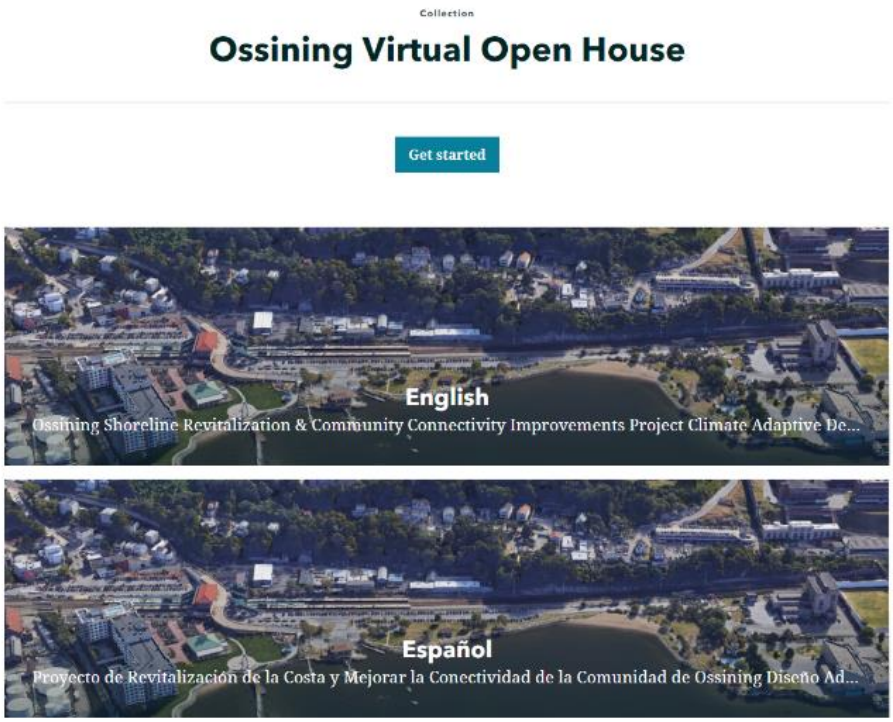

Figure 4. Virtual Open House Homepage

Based on the feedback from the virtual open house, the project team continued to refine the conceptual design. This design was shared at a community meeting on November 3, 2022, at the Ossining Community Center. After sharing the updated designs, the participants had the opportunity to share feedback. There was a Spanish translator present, and the fact sheet was also translated into Spanish. The PowerPoint presentation from this meeting is provided in **Appendix B4** of this report. This workshop provided an opportunity for more than 25 key stakeholders to review the draft preliminary designs and to provide the HDR design team with input early in the design process.

5 Preliminary Design

5.1 Design Approach

The original preliminary concepts that were developed based on applicable design criteria, in addition to stakeholder input and virtual open house survey responses, are provided in **Appendix B4**. These concepts were presented during Stakeholder Meeting #2, and later revised to reflect input received during that meeting, as well as from the Permitting Strategy meeting held with NYSDEC. The final preliminary design drawings are included in **Appendix C**.

The preliminary design for the proposed project followed the overall guidance outlined in NYSDEC Tidal Wetlands Guidance document (2017b) for the issuance of permits for living shoreline techniques in the Marine and Coastal District Waters of New York including the Hudson River North of the Mario M. Cuomo Bridge. The design was also informed by the experience garnered from other ecological engineering projects and from larger coastal civil work projects that HDR has implemented. It was developed with input from stakeholders and in consultation with the Town and Village of Ossining as well as other coastal experts.

Living shorelines use vegetation and other natural elements, such as oysters or mussel beds, often in combination with harder structures to stabilize and protect shorelines in an estuarine system. They offer the added benefit of improving water quality by filtering nutrients and pollutants, creating habitat for fish, birds and other living resources, and can promote recreation and adaptive uses. At least eight of the CaD Studio designs suggested some form of natural shoreline protection as part of their overall plan (Table 1). Additionally, elements of traffic and pedestrian improvements and habitat creation were found in every CaD Studio concept.

The upfront stakeholder input and data review for the project included an identification of native marsh and upland plant species that would be expected to thrive along the Ossining coastline between the Sing Sing Kill and the Westchester County Wastewater Treatment Plant. A focus on native and sustainable plantings will improve connectivity between the terrestrial and estuarine environments and promote biodiversity along the shallow-sloped shoreline. However, initial stakeholder input suggested that the present wave/current energy regime in the vicinity of the project may not be suitable for the development of intertidal vegetation without including wave attenuating features in the river; the results of the site assessment corroborate these concerns as little to no intertidal wetland vegetation currently exists along the project area shoreline in its present state. Thus, an emphasis on enhancing wave attenuation using a combination of hard (yet “nature-like”) engineering features while promoting habitat benefits for native estuarine fauna (including fish and shellfish) provides the basis for the design.

Four fundamental and overarching design goals emerged for the project:

1. Improve coastal resiliency while protecting and stabilizing the shoreline;
2. Create habitat and improve habitat functionality for native flora and fauna;
3. Increase access and connections to the waterfront while improving recreational opportunities; and
4. Align with the Town and Village’s ongoing plans for overall community improvements

Table 2 summarizes the criteria from the Request for Proposal as well as the policies noted in the Village of Ossining’s LWRP that were considered for this project and the overall projected outcome from the preliminary design.

Table 2. Summary of Preliminary Design Criteria.

Criteria From Request for Proposal	**Preliminary Design Summary**
Ability to obtain local agency support and permits	Likely; subject to further review by state and federal agencies
Consider up to date maps and data on current / future conditions	Yes - proposed plan based on drone survey data collected in 2022
Reduce shoreline / stormwater flooding	Yes - design considers
Cost-Effective over long term (O&M, replacement, etc.)	Yes - proposed materials are readily available for purchase and likely available near to the site
Conserve or add ecological value (restore existing features and pathways to migrate over time)	Yes - perch points, microhabitat features, reef balls, etc. are proposed
Improve / create water-dependent or -enhanced uses, or relocate water-independent uses out of risk areas	Yes - multiple boat launch and river access points are proposed
Improve/mitigate Diversity, Equity, and Inclusion (DEI)	Yes - design considers
Educational / Interpretive Elements / Public access	Yes – public art installation along the Sing Sing Kill and interpretive signage along proposed waterfront esplanade
Address contaminated soils, brownfields, etc.	N/A
Policies from Village of Ossining's LWRP	**Preliminary Design Summary**
Concentrate development in or adjacent to traditional waterfront communities, and take appropriate advantage of waterfront locations	N/A
Protect stable residential areas	N/A
Maintain / enhance existing and anticipated uses	Yes - promotes the use of the river for recreational purposes and increases connectivity of parks for residents
Improve or maintain economic base of the community	Yes – no change in use of parks
Preserve historic nature of waterfront area, culture, and archaeological resources	N/A
Enhance visual quality of waterfront area	Yes – adds visually pleasing habitat features to shoreline area
Minimize loss of human life and structures from flooding and erosion	Yes - erosion mitigation measures are part of the design
Preserve / restore natural protective features	Yes - rock sills will help preserve the low marsh areas and still allow water access
Prevent erosion of filled land west of the railroad tracks with erosion protection structures which have a reasonable probability of controlling erosion for at least 30 years	Yes – promotes the overall resilience of the two parks in this area
Manage navigation infrastructure to limit adverse impacts on coastal processes	Yes – maintains boat and canoe club access and boat ramp access
Ensure expenditures of public funds for flooding / erosion control projects result in public benefit	Yes
Ensure public access to Louis Engel is not reduced	Yes
Protect and restore ecological quality, fish and wildlife habitats, and tidal / freshwater wetlands	Yes - proposes use of fish habitat reefballs Submerged (fully or partially) rock sills and low

	marsh also provide fish habitat; low/high marsh represents restored wetlands; marsh and intertidal rock features benefit wildlife; beaches provide turtle basking/nesting habitat.
Protect air quality	Yes- wetland creation/restoration contributes to blue carbon (carbon dioxide) storage
Minimize environmental degradation in the waterfront area from solid and hazardous wastes	N/A
Promote appropriate public access and recreation throughout waterfront area	Yes – multiple river access points are proposed
Protect existing water-dependent uses	Yes – multiple river access points are proposed
Promote sustainable use of living marine resources	Yes
Promote appropriate use of energy resources	N/A

5.2 Shoreline Features

5.2.1 Sub-tidal Areas

Given the existing shallow water bathymetry, current recreational uses of the project area and the desire to maintain views from nearby buildings and the park, a variety of submerged aquatic habitat enhancement features were included in the preliminary design including concrete "reef balls" and shoreline protection in the form of concrete tidal pools for toe protection of created marsh. These features are shown in plan view on Sheet C-101 in **Appendix C**. The toe protection could also be a rock sill, however manmade features such as sheetpile are shown as they have a smaller footprint and therefore lower impacts to the existing underwater substrate.

The potential to support native shellfish was also an important initial design consideration. However, given the uncertainty of oyster recruitment, survival and growth (B. DeGasperis, NYSDEC, pers comm.) in shallow waters and potential permitting challenges, the placement of live oysters were not included as a component of the design. Rather, the created habitat features would rely on recruitment by native, local suspension-feeding organisms (e.g., ribbed mussels, barnacles, etc.) to support the development of an epifaunal community on placed hard structures within shallow areas. The proposed pile wraps on the existing and proposed pier extension (a separate effort from the Phase II program) are ideal structures for recruitment and attachment of these types of organisms (**Appendix C**, Sheet C-501, Detail 3). A series of offshore reef ball aggregations (using a combination of height and width profiles) would be placed along a bathymetric gradient from shallow to deeper waters to attract native epifauna (oysters, mussels, and other suspension-feeders and associated invertebrates) and motile macrofauna (fish, crabs, and shrimp). These reef ball fields are expected to provide structurally complex habitat for native estuarine fauna without substantially modifying sediment deposition in the shallow subtidal and intertidal zones.

Recreational access through the project area for kayaks and similar non-motorized recreational vessels will be maintained during the placement of habitat enhancement structures. To avoid potential collision of non-motorized vessels with submerged habitat features, appropriate signs

would be placed at the boat launch and beach areas, and buoys or other navigation aids would be situated in the river to demarcate the location of structures along the primary access route offshore of the vessel launch area.

Figure 5. Examples of Concrete Reef Balls Pre-Installation (Upper Left) and Rock Sill with Microhabitat Features and Low Marsh (Upper Right) – NYSDEC (2017), and Econcrete ecological toe protection.

5.2.2 Intertidal Areas

Opportunities for vegetated marsh plantings focus on creating marsh areas, with a protected toe, where wave attenuation and subsequent scouring or erosion is less of a concern. The concept of using intertidal native vegetation plantings to promote resiliency and habitat enhancement was considered in all of the original CaD concepts.

To maintain structural integrity and protect vegetated and other living shoreline features from wave-induced erosion, especially during storm events, toe protection is proposed. A readily available source of rock material, including some large boulders, exists at this location presently, and could potentially be re-distributed to form, in part, the proposed rock sills or man-made

concrete structures that allow for attachment of organisms such as Econcrete blocks (**Appendix C**, Sheet C-301, Section B-B', and Sheet C-501, Detail 6). Finer materials (gravels/sand) would be graded behind the sills/terraces, and, where appropriate, planted with native intertidal marsh vegetation (e.g., saltmarsh cordgrass at lower elevations; a mix of native high species such as salt meadow hay, salt grass, black needlerush, etc. at higher elevations). Although the constructed rock sills are intended to receive the majority of the wave energy anticipated during storm events, the vegetated marsh areas behind the rock sills are also intended to buffer wave energy.

The ability of a wetland to attenuate storm surges depends on several factors, including the degree of surface roughness attributed to vegetation, the height of storm surge waves relative to the height of the emergent vegetation canopy, and the distance over which storm surges may travel across the wetland (Knutson et al. 1982). Emergent plant stems (e.g., *S. alterniflora*) function as a flexible baffle to dampen wave energy and detain water. Stems may also trap organic debris which may further induce drag and decrease water velocity. Mean flow speed and turbulence intensity of storm surges are inversely related to stem density and distance inland from the marsh edge; the intensity of these variables may decrease by as much as one order of magnitude as flow passes through vegetated marsh canopies (Leonard and Luther 1995).

In general, the waterfront is very limited in areas where the land could be excavated above Mean High Water (MHW) to create intertidal habitat. Several permanent structures including storefronts, parks, the Ossining Boat and Canoe Club, and playgrounds prevent the opportunity of marsh creation in these areas. Additionally, there is the potential for interacting with contaminated soils given the extensive historic use of the waterfront in this area which may increase excavation and disposal costs.

5.2.3 Vertical Seawall

Structural protection, such as vegetated revetments with boulder or cobbled stone toe protection was evaluated in order to stabilize the slope, attenuate wave energy, and protect against erosive forces such as boat wakes, ice scour and storm surge. Given that the existing shoreline is dominated by large riprap for protection of the shoreline, hardened protective measures are recommended to remain.

Linear shoreline protection features were included in the design in the form of a sheetpile wall. The proposed extents of the sheetpile wall are shown on Sheet C-101 and Section A-A' on Sheet C-501 in **Appendix C**. Sheetpile is suggested to maintain the existing top of slope alignment and elevation, while maintaining open water for intertidal marsh and limiting fill extents by removing the riprap along sections of the shoreline and placing marsh soils at a lower elevation. The sheetpile could be designed to allow for vertical extension in the future, as sea levels rise, and additional protection is required to limit flooding during normal tide cycles.

Alternatively, if sheetpile is not desired, the riprap shoreline could be revised to a steeper 1:2 or 1:1.5 slope to create the square footage required to offset proposed in-water fill and shading impacts from proposed elements. However, a steeper riprap slope would not dissipate wave

energy as well as a longer shallower slope. Additionally, raising of the riprap elevation to manage tidal flooding would be more challenging as additional space would be required either in-water or within the park to support the required angle of repose. For these reasons a vertical wall is suggested.

5.2.4 Boardwalks & Tidal Steps

Due to the narrow linear nature of the open space, the community felt strongly that boardwalks would provide critical access that is currently limited to primarily onshore areas. Refer to **Appendix C**, Sheets C-101 and C-301 for the proposed locations of the boardwalks and tidal steps. While three boardwalks are illustrated in the preliminary design, NYSDEC felt that justification of all the boardwalks would be challenging from a regulatory and permitting perspective. The need for the boardwalks would have to be clear and linked to a service that is currently lacking such as access to fishing in deeper water or Americans with Disabilities Act (ADA) access to a feature such as a kayak launch.

Concrete tidal steps are depicted in the southern end of the site, as well as to the north of the existing pier and beach area on the Village. The steps would provide additional access to the waterfront. Currently, fishing access is to traverse the large riprap stones adjacent to the southern plaza. These steps would allow safer access for recreational fishing by means of egress during tide cycles. Similarly, the beach to the north of the existing pier is accessed via stone step downs within the riprap shoreline. The oversized concrete steps would provide an alternative means of egress, as well as additional seating adjacent to the waterfront.

5.2.5 Upland Areas

Deciduous and flowering native tree plantings are proposed, as the community sought to replace the tree canopy and shade lost overtime due to previous improvements and the age of the trees. Additionally, a plaza will be located to the south of the Metro-North Railroad parking lot, adjacent to the beach area which helps to unify the north and south areas and makes a narrow section of the park more inviting and welcoming. Raised planters would provide seating and areas for pollinator plantings.

Continuing north from the plaza, a proposed sidewalk runs parallel to the parking lot, separating the parking from the park area and connecting to a crosswalk. The curbline would extend down the overpass service ramp to separate vehicles on the ramp and cars utilizing the boat launch area, from pedestrians, as shown in Figure 6. This reduces the crossing distance, normalizes the

Figure 6. Park Walkway Improvements

intersection, and creates a clear connection between the park properties which is currently separated by hard features including fences and the Secor Road overpass ramp. It also improves the safety and visibility of pedestrians using this walkway to traffic. Vehicles with trailers can make the turning movements necessary, therefore access to the launch is not hindered.

ADA access from the overpass was considered, however a switchback ramp would require substantial area and cost to construct. Figure 7 (from preliminary concepts shown in **Appendix B4**) illustrates the area that would be required, taking up approximately a third of the lawn area to the north of the playground. Due to the size of the structure required, the ramp was removed from the final design presented in **Appendix C**.

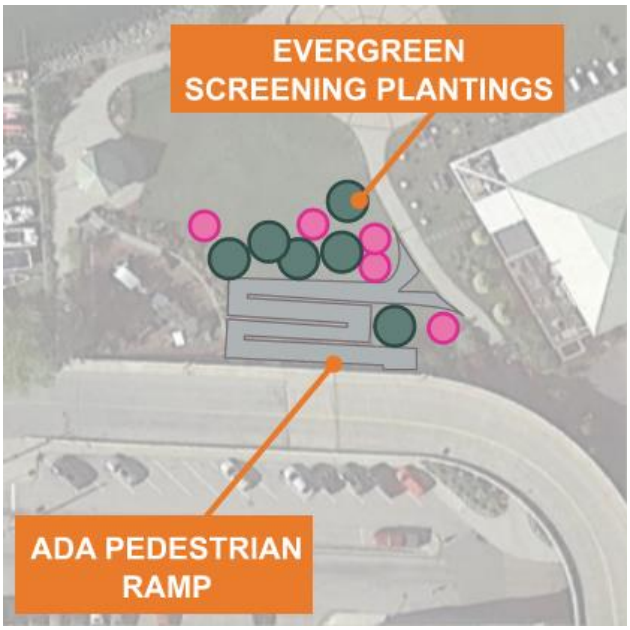

Figure 7. Sketch of ADA Pedestrian Ramp

5.3 Recreational and Educational Opportunities

Access to the boat launch, beaches, kayak launches, and fishing areas would remain as part of the proposed design. Seating and boardwalks would provide locations for additional passive recreation and fishing, along with public art features to enhance the user experience and provide placemaking features. Distinctive ‘Front Porch’ swinging benches will also be incorporated to provide unique seating opportunities (**Appendix C**, Sheet C-501, Detail 4).

Educational signage describing the purpose and benefit of living shorelines, native and pollinator plantings, aquatic species of the Hudson River, and/or historic features will be placed along the project area.

5.4 Coastal Engineering Evaluation

The primary engineering design objectives for the proposed design are cost-effectiveness, ability to obtain state and local agency support and permits, deflection of floating debris, and wave energy attenuation along the beach area. A summary of the major engineering features proposed for this project are within this section.

5.4.1 Sea Level Rise Considerations

The existing MHW for the project site is 1.8 feet NAVD88 and the NYSDEC medium projection SLR scenario for 2050 in the Lower Hudson is 1.3 feet. Refer to Table 3 for a summary of the projected SLR for various time intervals within the New York City / Lower Hudson Region.

Table 3. Sea Level Rise Projections

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

(NYSDEC, https://www.dec.ny.gov/regulations/103877.html)

For planning purposes, this project considered the 2050s medium SLR projection to avoid being overly conservative or optimistic. During future design phases various SLR conditions can be assessed in greater detail to identify what level these project features should be adapted to.

5.4.2 Jetty

The original proposed concept shown in **Appendix B4** included adding a rock jetty to deflect floating debris from and attenuate wave energy along the beach area. A portion of the jetty would also provide a platform for native emergent marsh vegetation. Ongoing maintenance will be necessary to remove potential debris collected on the jetty. The conceptual-level cross section design of the jetty (Figure 8) considers anticipated material and construction costs and wave attenuation performance. The jetty crest elevation exceeds the MHW elevation to attenuate waves during typical water level conditions. Alternatively, a wider and lower jetty crest was considered that could attenuate waves, but this approach was not selected due to the increased fill volume and plan view acreage required.

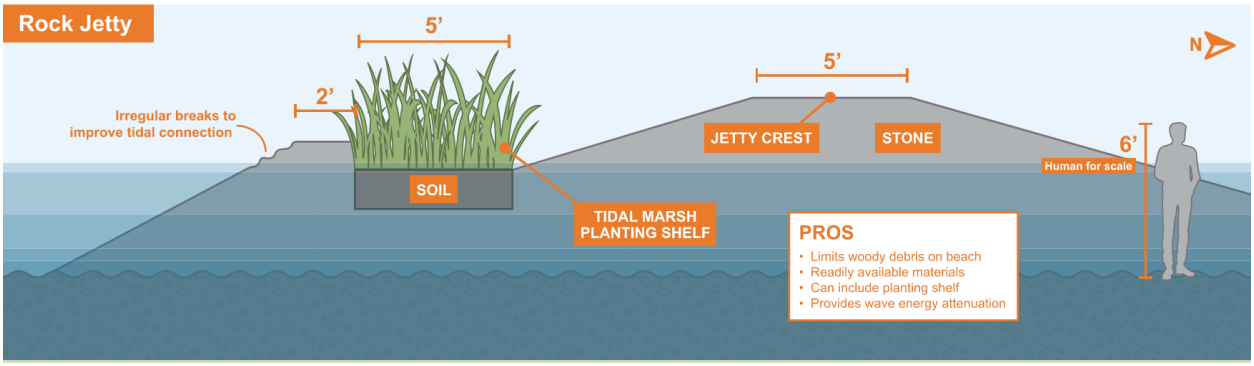

Figure 8. Cross Section of Jetty

The proposed jetty was 200 feet long and is comprised of 100 feet considered to be nearshore portion and 100 feet considered to be offshore portion. The entire length of the jetty is designed to deflect floating debris and attenuate wave energy directed towards the beach from the northern direction. The nearshore cross-section will be similar to the offshore cross-section but will also include a platform designed to accommodate a native emergent marsh habitat.

The offshore cross-section would have had a crest elevation of 5.5 feet NAVD88, side slopes of 2.5H:1V and is underlain by geotextile fabric. The selected jetty crest elevation would attenuate wave energy directed towards the beach area from the north and to deflect floating debris. This elevation was designed relative to the anticipated wave run-up elevation which incorporates the design wave height and MHW. The design wave height of 3 feet was determined using the approach in “Living Shoreline Design Guidelines for Shore Protection in Virginia’s Estuarine Environments; Version 2.0”, for a 3.8-mile fetch distance and a 48-mile-per-hour wind speed. The approximate largest fetch (originating from the NW) that could direct waves and floating debris towards the beach was selected for this calculation. The wind speed was selected from the ASCE-7-22 manual. The wave run-up was calculated as 3.7 feet using the NYSDEC guidance, “Protection against Wave-based Erosion”. Adding this on to the design water elevation yielded a run-up elevation of 5.5 feet NAVD88 which is the crest elevation of the proposed jetty.

Similar to the offshore cross-section, the nearshore cross-section includes a 5.5 feet NAVD88 crest elevation, a northern side slope of 2.5H:1V, and is underlain by geotextile fabric. Unlike the offshore cross-section, a native emergent marsh vegetation shelf is proposed on the southern side of the jetty. The southern side slope is 2.5H:1V from the crest to the high marsh habitat area. The high marsh habitat area is a 5-foot-wide platform that contains 18 inches depth of sand underlain by filter fabric. The top of soil elevation is 2.1 feet NAVD88, which is Mean High Higher Water (MHHW). This elevation was selected for the proposed high marsh habitat to facilitate ecological functions that are reliant on tidal inundation. Along the southern edge of the high marsh habitat is stone that crests at elevation 3.2 feet NAVD88, is two feet wide, and slopes to the south at 2H:1V. The stone along the southern edge of the high marsh habitat is elevated to protect the marsh area from washout, and to allow for additional soil to be filled into the high marsh habitat as sea levels rise.

SLR was considered during the design of this proposed jetty. The peak crest elevation of the jetty is designed to deflect floating debris and attenuate wave energy directed towards the beach. This is likely achieved for current conditions given the design wave height and run-up calculations previously discussed. To accommodate changing conditions due to SLR, an additional layer of stone may be needed at a future time. The additional height to the jetty needed to accommodate for SLR was not included in this design because it would limit the community's view of the river from the beach area and increase the cost of construction. The native emergent marsh vegetation area is contained by stones that match the elevation of projected SLR. Therefore, the high marsh habitat area would only need additional sand backfilled to match SLR.

Additional analysis is recommended for future design phases to quantify the wave attenuation with calculation of wave transmission under multiple storm events and crest elevations. For the purpose of this conceptual design, a wave transmission calculation was performed using the Van der Meer (1990) equation. The purpose of this limited wave transmission calculation was to guide conceptual design. The calculation assumed a peak wave period of 3.25 seconds and significant wave height of 3 feet. These assumptions were derived from "Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments; Version 2.0." The wave transmission calculation also used a water surface elevation of 3.2 feet, which is the combination of MHW and the medium projection SLR scenario for 2050. The result of the wave transmission calculation was 10%, which indicates a wave transmission of approximately 0.3 feet. It should be noted that due to the uncertainty of SLR and climate change, more severe conditions could occur than what is currently included in the design.

Additional hydraulic and wave modeling is recommended for further design. Hydraulic modeling is recommended to evaluate the erosive forces of river currents and ice jams on the jetty. Furthermore, hydraulic modeling will inform the design objective of deflecting floating debris. Two-dimensional wave modeling is recommended to better understand processes including wave reflection, refraction, and seiching considerations.

There are several design aspects that should be considered in further design. The project may have impacts to adjacent areas that need to be reviewed including water levels, waves, currents, scour, debris, and more. The ability of the structure to withstand impacts from hydrodynamic or debris forces must be reviewed. Further design should consider the cross-section and stone stability relative to extreme flood and wave events. Geotechnical concerns will also need to be explored.

After presenting this concept to the community, the deflection jetty was ultimately removed from the proposed design, primarily due to permitting and safety concerns of people walking on top of the jetty rocks, as well as the natural attenuation of sand that occurs at the beach area and questioning whether the jetty would prevent this action.

5.5 Phased Design Considerations

The proposed design presented herein is considered the first phase of what may be a multi-phase project. Per guidance from the NYSDEC HREP, the overall design should serve as a standalone

and sustainable first step to a larger project. Construction of the project may include a pilot installation of in-water habitat features and phased approach to plantings to ensure the greatest success. While not within this present scope of work, additional considerations for future phases may include the following features:

1. Construction of one marsh area and boardwalk / overlook, followed by others
2. Increasing sheet pile wall height if required as sea level rises
3. Addition of Econcrete blocks or other riprap material to help protect the toe of the marsh area overtime

5.6 Quality Assurance Practices

In accordance with the QAPP, all data, including data generated from the drone survey, has been Quality Control reviewed for accuracy and completeness before integration with the design. All drawings and calculations have also been internally checked and the Project Manager performs a final review of the document prior to submission.

6 Permitting Approach

The overall permitting for this project will fall under the purview of NYSDEC's Region 3 regulatory office. During a future design phase of the project, a joint Army Corps of Engineers and NYSDEC permit application will be required with some of the following elements included but not limited to:

- Article 25 – Tidal Wetlands Permit
- Article 15 – Excavation & Fill in Navigable Waters with Water Quality Certification
- Coastal Zone Consistency – 15 CFR Part 930 and 19 NYCRR Part 600
- NYS Office of General Services (NYSOGS) – Public Land Law, Article 6
- Essential Fish Habitat (EFH) consultation with National Marine Fisheries Service
- USFWS and State threatened and endangered species coordination
- Upland regulatory requirements related to tidal wetland adjacent areas (up to 300-feet inland from the wetland boundary)

In addition, the project will likely be subject to the State Environmental Quality Review (SEQR) process and the completion of SEQR documents (e.g., Environmental Assessment Form or Environmental Impact Statement) may be required as part of the permit application process. Additionally, local permits will be required during construction.

A key element to the successful permitting of this type of in-water project is the early engagement of regulatory staff at both the state and federal level. Additional coordination with NYSOGS will be required to determine underwater land ownership and jurisdictional requirements. In addition,

permit applications will need to clarify that the project has authorization from involved property owners.

As currently proposed, the project would result in the creation and enhancement of 0.68 acres of intertidal and subtidal habitat including the creation of 0.54 acres of low marsh (Table 3). In order to create these habitat enhancement features, the project (as currently proposed) would require approximately 2,963 cubic yards (CY) of fill (Table 4).

The overall permitting approach was discussed during a pre-application permitting meeting with NYSDEC in February 2023 (see **Appendix D** for meeting minutes). This meeting was intended to document the type of project information required by regulatory staff for future permit approvals and, with this documentation, assist future final design to be initiated under a separate contract. This meeting provided an opportunity for regulatory staff to provide initial design feedback and perspective to be used in future design development. Actual permit applications will be submitted during the next phase of the project (30-100% Design & Permitting Phase). There are many uncertainties associated with the ability to permit the project in full, as shown in the proposed conceptual design. Additional justification may be required to support the need for certain features such as the boardwalks to demonstrate that they are reasonable and necessary.

Table 4. Estimated Habitat Area by Zone with Estimated Fill Volumes.

Habitat Zone	Habitat Area (Acre)	Habitat Area (ft^2)	Estimated Fill Depth (ft)	Estimated Fill Volume (CY)
Low Marsh	0.54	23,427	3	2603.0
Tidal Pools	0.067	2,927	3	325.2
Pile Wraps	0.035	1,508	6	-
Reef Balls	0.043	1,881	0.5	34.8
Totals	**0.68**	**29,743**		**2,963**

7 Implementation Strategy & Costing

Implementation of this conceptual design will require a multi-phased approach over several years. The next phase of this project would likely include a final design and permitting phase that would advance the current conceptual design to 90-100% design. The final design should include a detailed planting and monitoring plan. From there the project would likely enter a bid construction phase that would finalize the construction design and carry through the construction and monitoring phases of the project which may last several years. Key project findings from this report and the future design phases of this project can be incorporated into the Proposed Public and Private Projects section IV-B of the Village of Ossining's LWRP (2012). Section V of the LWRP provides an overview of how the living shoreline project might be implemented by the Village. The section includes a summary of local legislative techniques and tools and other public

and private actions necessary to implement a project through the LWRP. A management structure, including the procedures for coordinating LWRP consistency review of federal and state actions, and financial resources are also available.

Funding for future phases of the living shoreline project (both partial and full) will likely be available through future New York State grant opportunities or at the federal level through various coastal resiliency programs and initiatives. New York's Department of State, for example, provides technical assistance and grants to prepare or implement strategies that would support the Village of Ossining's LWRP. The funds are offered on a reimbursement basis to villages, towns, cities, and counties located along New York's coasts or designated inland waterways and typically require a certain percent match from the community. NYS recently passed the Environmental Bond Act, which authorizes up to $4.2 billion to fund capital projects that mitigate climate change, provide flood risk reduction, conserve land and recreation areas, and improve water quality.

Several other current and applicable grant opportunities for planning and implementation of climate adaptation and resilience projects in New York State are listed below, along with the associated agency:

- Climate Smart Communities (NYSDEC)
- Water Quality Improvement Project (NYSDEC)
- Local Waterfront Revitalization Program (New York Department of State [DOS])
- Brownfield Opportunity Area Program (DOS)
- NYS Community Development Block Grant Program (Housing and Urban Development [HUD])
- Recreational Trails Program (Office of Parks, Recreation and Historic Preservation [OPRHP])

Federal funding opportunities might include coastal resiliency funding through FEMA's Building Resilient Infrastructure and Communities (BRIC) program, or the National Coastal Resilience Fund administered by the National Fish and Wildlife Foundation, or the National Estuary Program's Coastal Watersheds Grant Program, as examples.

Another funding strategy would be for Ossining to update the county Hazard Mitigation Plan to thoroughly define SLR, flooding, and erosion in the potential in the Risk Assessment section. Additionally, this CaD Phase II project should be acknowledged in this plan to recognize the benefits it may have in reducing these risks.

Although the overall goal of the shoreline revitalization design is to create a more resilient and appealing public space, as with any public park area, some annual maintenance is expected to be required including debris removal from marsh areas as well as maintenance of the upland park amenities.

Appendix E provides a Class V Reasonable Order of Magnitude - Opinion of Probable Final Design and Construction Costs. Based on the current preliminary design, additional site assessments and investigations would cost approximately $505,000 and engineering design to 100% and permitting would be approximately $870,000. The total estimated project cost including engineering support during construction, materials, and contractor costs in 2023 dollars would be approximately $10.5 million without contingencies. The most expensive component of the conceptual project would be the design and construction of the boardwalk overlooks (three locations proposed) which would cost an estimated $4.9 Million in materials alone including the pile supports. This component was a highly valued feature by the community, but it could be designed and constructed separately as funding became available and/or scaled back to include less locations or less square footage. Additionally, the project construction could be phased as funding becomes available between the in-water construction estimated at approximately $5.6 Million and upland improvements estimated at approximately $900,000. However, designing and constructing the project in multiple phases may result in increased soft costs for the total project due to multiple rounds of site investigations, permits, and surveys. Additionally, phasing the project into multiple construction contracts may increase contractor management, mobilization and demobilization costs as well.

7.1 Monitoring Plan

Monitoring of the living shoreline plantings is typically required by the regulatory agencies and would serve to demonstrate that the shoreline features are establishing and meeting performance standards based on pre-determined success criteria, as specified in permits. Typically, vegetation is monitored annually, for up to 5 years post-construction, and an adaptive management approach is used during the monitoring program to identify any required supplemental plantings or site maintenance that may be necessary to ensure long-term success of the project.

A monitoring plan to track measurable engineering and ecological success criteria for the project would be developed following the Hudson River Sustainable Shorelines Rapid Assessment Protocol Manual (Findlay *et al.* 2018) and the recently released NYSDOS natural and nature-based shoreline monitoring protocols (NYSDOS 2020). Annual monitoring would be completed at randomly selected locations within the project site and a regional reference site for a period of 5 years post-construction. Monitoring may consist of collection of elevation, substrate, vegetation, habitat, wave, water level, and species information along transects, plots, or discrete locations (see Figure 9 as an example datasheet from the Hudson River Sustainable Shorelines Manual).

Photographic monitoring stations and repeated drone surveys may also be used to monitor changes throughout the period. Potential engineering and ecological success criteria would include:

- No significant changes in critical landform crest elevations or slopes from the as-built condition,
- No observed mass erosion of constructed features,
- No observed transport of large rocks used to construct the low rock sills and rock jetty,

- Planted areas should achieve similar percentage areal cover relative to a reference plant community,
- Planted areas below MHW should be dominated by native tidal wetland species,
- Substrates within planted areas should be of similar gradation to a reference plant community.

EVERY SITE VISIT - **ASSESSMENT POINT DATA COLLECTION**

WORKSHEET 10: Ecological Attributes

Data are collected within 6 ft diameter circle around Assessment Points (AP).

Site Name:

Date:

Make multiple copies

Percent Cover Table						
Percent Ground Cover		Absent-10%	11%-25%	26%-50%	51%-75%	>75%
Value to Assign		0	1	2	3	4
Segment #						
Profile #						
Assessment Point #						
Present / Absent (Use Column 1)	Wrack (dead plants, stems, in a band > than 3 in wide)					
	Large Woody Debris > 1 in Diameter and > 3 ft Length					
	Aquatic Plants					
	Mowing/Management					
% Cover of Vegetation (Value 0 - 4)	Canopy (> 15 ft tall)					
	Understory (3 – 15 ft)					
	Ground Cover (<3 ft)					
Species Richness						
Species Composition (top 3)						
Invasive Species						

Figure 9. Example Ecological Attributes Worksheet for Shoreline Monitoring from Findlay et al. (2018).

8 References

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Appendix A

HDR Site Assessment Report

(July 7, 2022)

Memo

Date:	Thursday, May 26, 2022
Project:	Climate Adaptive Design (CAD) Studio – Shoreline Revitalization and Community Connectivity Project in Ossining, NY
Prepared By:	HDR Engineering
Subject:	Site Assessment Report
Site Visit Participants:	HDR: Kim Lukas, Dave Yozzo, Kevin Verweire, Casey Stokes, James Eberhardt

PURPOSE AND INTENT

HDR conducted a site investigation of the proposed Town and Village of Ossining's Ossining Shoreline Revitalization & Community Connectivity Improvements Project ("Project") area on April 25, 2022. Prior to the site assessment a qualitative review of each of the ten original Climate Adaptive Design (CAD) Studio concepts and input from the stakeholder engagement process were used to identify the potential project area located at Louis Engel Park and Henry Gourdine Park in Ossining, New York (Figure 1). The site assessment was intended to gather aerial drone, topographic, and ecological data to be used for the development of the conceptual design of shoreline improvement and public access features that will meet the goals and objectives of the Project.

An ecological functional assessment was conducted to document the level to which the proposed Project area was performing NYSDEC-cited (Part 661.2; Tidal Wetlands – Land Use Regulations) functions and values for tidal wetlands and adjacent areas. By assessing the current ability of the Project area to perform these functions and values, goals may be set to improve or enhance functions through the Project design.

Site Assessment Activities

The following activities were conducted during the site assessment in accordance with the approved Quality Assurance Project Plan (QAPP), Version 2 dated January 14, 2022:

1: General assessment of existing shoreline features and condition.
2: Ecological assessment of existing ecological communities and functions at the site, with emphasis on dominant plant species; invasive species present; rare plants or animals; wildlife species observed; dominant substrate types, bank and shoreline stability, and observed site constraints/opportunities.

3: Topographic mapping: measure and record three-dimensional locations of both natural and man-made elements within the Project area and reference shoreline, and graphically represent the site's existing conditions in a plan-view map.
4: Collection of aerial imagery, videography, and photogrammetry using a DJI Phantom 4 RTK Unmanned Aerial System (UAS) platform.

General Site Description

Under NYSDEC Article 25, the regulated tidal wetlands adjacent area can extend up to 300 feet landward of the wetland edge. Bulkheads, riprap, and roadways running parallel to the wetland edge (and lawfully existing prior to 1977) can limit the extent of NYSDEC's tidal wetlands jurisdiction. Virtually the entire upland in the Project area has been developed, consisting of condominiums, a restaurant, concession stands, a boat and canoe club, paved parking areas, walking paths, lawns, and gardens. Vegetation in the upland area adjacent to the shoreline is dominated by non-native species such as mugwort, Japanese knotweed, chickweed, and cocklebur.

The intertidal area is unvegetated. The substrate consists of sand, fine gravel, cobbles, cinders, and glass. The intertidal community area is best described by the "Marine Intertidal Gravel/Sand Beach" in Edinger (2014). The majority of the Project area's shoreline is reinforced with stone rip-rap. Tidally stranded logs and woody debris are also present, especially along the sandy beach. A photographic log of key features observed during the site assessment is included as Attachment A of this report. The reinforced intertidal areas along the shoreline are best described by Edinger as the "Estuarine Riprap/Artificial Shore."

Based on NOAA topobathymetry data available from 2018, intertidal areas from Mean Higher High Water (MHHW) to Mean Lower Low Water (MLLW) down to an elevation of -2 feet (NAVD88) generally extend from approximately 35 to 40 feet riverward along the shoreline with greater extents along the beach at the southern end, the launch ramp at the canoe club, and the sand bar at the mouth of the Sing Sing Kill. Elevations recorded along shoreline transects and in upland areas during the field survey will be used during the development of the conceptual design to confirm the general bathymetric and topographic conditions.

Ecological Assessment

HDR ecologists walked the proposed Project area, documenting existing habitats and general site conditions, along with surrounding land use. A variety of native and non-native plant species were documented in the supra-tidal and terrestrial environments above and adjacent to the site; however aquatic/intertidal vegetation was noticeably absent in the vicinity of the Project area, possibly due to hydrodynamic (wind/wave) conditions and substrate type. Refer to Table 1 for a complete list of observed vegetation.

Dominant (non-native) herbaceous plant species present above the shore zone included Japanese knotweed, mugwort, yellow flag iris and cocklebur. Japanese knotweed was especially prevalent among the rock revetments along the shoreline throughout the park, interspersed with patches of poison ivy. Small patches of common reed were present in the upper intertidal zone, near the mouth of Sing-Sing Kill. Trees and shrubs present along the shoreline included native (ash, hickory), non-native (Bradford pear) and ornamental species (black willow, red mulberry, river birch). The dominant substrate type in the study area was cobble/gravel, interspersed with coarse sand. The designated beach area was predominantly coarse sand, as was a small sandy beach area in the vicinity of a relict pile field, once the site of a "shad shack." (Gareth Hougham, through personal communication).

Estuarine organisms noted in the tidal shallows and intertidal zone included ivory acorn barnacles attached to rocks. Atlantic rangia clam shells were abundant along the shore and in shallow water areas. Small ribbed mussel shells were observed along the shoreline, predominantly among the wrack line, but no live mussels were present in the intertidal zone. Fragments of American oyster shells were present throughout the intertidal zone. Refer to Table 2 for a complete list of observed invertebrates.

Both aquatic and terrestrial/arboreal bird species were present; consisting of, American crow, mallard, Canada goose, double-crested cormorant, rough-winged swallow, house sparrow, European starling, herring gull, rock dove, gray catbird, American robin, and black-capped chickadee. No state or federally-listed rare plant or animal species were observed during the site assessment. Refer to Table 3 for a complete list of observed birds and waterfowl.

Table 1: Vegetation Observed on April 25, 2022

Common Name	Scientific Name	Native / Non-native/ Ornamental
Ash	*Fraxinus spp.*	Native
Black Willow	*Salix nigra*	Ornamental
Bradford Pear	*Pyrus calleryana*	Non-native
Common Chickweed	*Stellaria media*	
Common Cocklebur	*Xanthium strumarium*	
Common Dandelion	*Taraxacum officinale*	
Common Groundsel	*Senecio vulgaris*	Native
Common Hawkweed	*Hieracium lachenalii*	Non-native
Common Reed	*Phragmites australis*	
Dock Plant	*Rumex obtusifolius*	
European Field Pansy	*Viola arvensis*	
False Indigo	*Baptisia australis*	Native
Hairy Bittercress	*Cardamine hirsuta*	Non-native
Hedge Bindweed	*Calystegia sepium*	
Henbit Deadnettle	*Lamium amplexicaule*	
Hickory	*Carya spp.*	Native

Hydrangea	*Hydrangea spp.*	Ornamental
Japanese Knotweed	*Fallopia japonica*	Non-native
Mugwort	*Artemisia vulgaris*	
Poison Ivy	*Toxidendron radicans*	Native
Red Mulberry	*Morus rubra*	Ornamental
River Birch	*Betula nigra*	
Rugosa Rose	*Rosa rugosa*	
Seaside Goldenrod	*Solidago sempervirens*	Native
Siberian Iris	*Iris sibirica*	Ornamental
Unidentified Sedge	*Carex spp.*	Native
White Clover	*Trifolium repens*	Non-native
Wild Onion	*Allium canadense*	
Yellow Flag Iris	*Iris pseudacorus*	

Table 2: Invertebrates Observed on April 25, 2022

Common Name	Scientific Name
American Oyster	*Crassostrea virginica*
Atlantic Rangia	*Rangia cuneata*
Ivory Acorn Barnacle	*Amphibalanus eburneus*
Ribbed Mussel	*Geukensia demissa*

Table 3: Birds/Waterfowl Observed on April 25, 2022

Common Name	Scientific Name
American Crow	*Corvus brachyrhynchos*
American Robin	*Turdus migratorius*
Black Capped Chickadee	*Poecile atricapillus*
Canada Goose	*Branta canadensis*
Double Crested Cormorant	*Nannopterum auritum*
European Starling	*Sturnus vulgaris*
Gray Catbird	*Dumetella carolinensis*
Herring Gull	*Larus argentatus*
House Sparrow	*Passer domesticus*
Mallard	*Anas platyrhynchos*
Rock Dove	*Columba livia*
Rough-Winged Swallow	*Stelgidopteryx serripennis*

Functional Assessment

A summary of the NYSDEC-cited tidal wetland functions and values and observations with regard to the Project area's current value for each function is presented below:

Wildlife Habitat – Bird use of the intertidal area and upland were noted; 12 bird species were observed during the site assessment. Mallard, Canada geese, and gulls were observed in the intertidal area or nearby offshore waters. Shells of Atlantic rangia clams, ribbed mussels, and American oyster were also observed. Although not observed during daylight hours, while the park was being used by the public, a variety of urban-adapted small mammals are likely to occur in the park, including raccoon, skunk, opossum, and red fox – these species are often most active at night and their presence/absence in the Project area could be assessed using motion-sensing game cameras placed at fixed locations. Diurnal small mammals, including gray squirrel and chipmunk are also likely inhabitants of the park (although none were observed during the site visit), along with field mice and other small rodent species, especially among the rock revetments which provide shelter and nesting habitat.

Recreation – Numerous walkers, joggers, dog walkers, and people pushing strollers were observed on the walkways and paths in the upland areas. There is an existing launch ramp and club house for the Ossining Boat and Canoe Club for kayak and canoe launching. Fishing access is provided at several locations, including a small pier at the southern end of the Park, and the multi-use pier that also serves as the landing point for the NY Waterway ferry which brings commuters directly to the Ossining Metro-North Station from its origin point at Haverstraw, on the western shore of the river. During the site assessment, anglers were observed using the smaller pier and also fishing from the large rip-rap structure at the southern terminus of the park, adjacent to the Sing-Sing prison property line. A kayaker was also observed launching from the beach area.

Flood, Storm and Hurricane Control – The rip-rap revetments situated along much of the park protects against shore erosion by attenuating wave energy, and the interstitial spaces among the rocks provides structurally complex habitat within the intertidal and shallow subtidal shoreline areas for invertebrates, small fish, and other wildlife. Above the tide line, the rock revetments provide potential habitat for small mammals, including various rodents such as chipmunks and field mice; however, no mammals were observed during the site visit. Seaward of the rock revetments, sufficient energy is apparently present to preclude intertidal plant growth; however, it was reported (Gareth Hougham, through personal communication) that submerged aquatic vegetation does occur during mid-summer in a shallow cove adjacent to the NY Waterway ferry terminal, just south of the mouth of Sing-Sing Kill.

Marine Food Production – is limited by the lack of intertidal vegetation present in the shore zone. Presumed (but not observed) use of the shallows by forage fish does contribute to the food base for larger fish and fish-eating birds. As mentioned previously, submerged vegetation has been observed in the shallow cove near the multi-use fishing/ferry pier which provides food for diving ducks as well as substrate for grazing of microbial films (and direct consumption of plant tissue) by estuarine invertebrates such as amphipods and isopods.

Education and Research – Knowledge gained during the current project will contribute to living shoreline and ecosystem restoration efforts elsewhere along the tidal Hudson River. Design elements proposed as part of the shoreline and community connection project may include interpretive kiosks and other educational features. The Town/Village of Ossining hosts environmental events, including an annual Earth Day celebration that includes presentations and displays by environmental stewardship and research organizations in the region. Proposed plans to re-vision the existing multi-use ferry pier at the southern end of the site includes docking facilities for "tall ships" which provide maritime educational opportunities for the general public throughout the Hudson River Estuary. In the near future, Ossining may host such vessels, should adequate dockage and supporting facilities be provided through pier reconstruction.

Open Space – The park areas and walkways provide access to the Hudson River waterfront. Benches in the park were being used during the site visit. The existing beach could be enhanced and maintained; however present-day water quality conditions (high levels of pathogens) preclude swimming at present. Should the sources of pathogens (e.g., outflow from Sing-Sing Kill and/or the Sing-Sing Correctional Facility's wastewater treatment plant) be ameliorated in the future, swimming could be component of active recreational use of these parks.

Aesthetic Appreciation – The Project area provides views of the Hudson River and the Governor Mario Cuomo Bridge. The walking paths include areas of ornamental plantings, and a large sculpture exhibit at the entrance to the restaurant in Gourdine Park, as well as a former Prison watch tower in the southern section of Engel Park. The existing beach in Engel Park is in need of improvement/maintenance but could be aesthetically improved as part of the conceptual design.

Ecosystem Cleansing – is limited due to the lack of intertidal or subtidal vegetation (however, see previous discussion of the presence of subaquatic vegetation in the study area vicinity). There is also limited functional transition area between the upland and the intertidal area; much of the tidal range encompasses hard surfaces in the Project area, primarily the rip-rap revetments.

Sediment/Toxicant Retention – retention of organic material in the intertidal and shallow subtidal areas within and offshore of the park is limited due to tidal flushing, the general lack of intertidal and subtidal vegetation along the shoreline, and predominantly coarse sediments. The sandy beach area does accumulate some coarse (woody) organic debris and detritus which forms a distinct "wrack line" demarcating the average high tide level.

Topographic Survey

A topographic survey was completed for the area including four intertidal transects extending from water's edge up the shoreline to above MHHW. Elevation data was collected using an Emlid Reach RS2 high accuracy Real-Time Kinematic (RTK) Global Navigation Satellite System (GNSS). Ground surface shots (latitude, longitude, and

elevation) were recorded at various natural and man-made points of interest within the parks and along the shoreline. Finally, elevations corresponding to structures and shoreline features (e.g., manholes, outfalls, wrack line, Mean Low Water, etc.) were recorded. See also Attachment B for a map including the elevation contours developed from the data collected during the drone survey.

Following the site visit, the tidal datums were retrieved for the reference site using the NOAA Vdatum online tool on (May 17, 2022). The values are shown in Table 4 below.

Table 4: Estimated Tidal Datum Elevations computed using NOAA Vdatum Online Tool. Retrieved 5/17/22.

Location	
Lat	41.156029
Lon	-73.870195

Tidal Datum	Elevation (NAVD88, US-feet)
MLLW	-1.835
MLW	-1.668
LMSL	0.138
MTL	0.058
MHW	1.856
MHHW	2.146

The estimated tidal datum elevations were plotted along with elevation, substrate, and vegetation data collected at four transects at the reference site (Figures 3 through 6).

Aerial (Drone) Survey

The drone survey was completed on April 25, 2022. Aerial still imagery, videos, and a photogrammetry survey were completed for the Project area during multiple drone flights.

The drone used was a Phantom 4 RTK, capable of cm level positioning using the same correction sources as the terrestrial survey. Since the drone is capable of positioning itself to a high degree of accuracy, the resulting 2D and 3D products generated are high accuracy.

Following the drone survey, a 2D orthorectified aerial mosaic was created and is shown in **Figure 2**. The orthoimagery is to scale, georeferenced to within about 2cm accuracy, and each pixel is approximately 2.5cm across. This allows terrain and other features to be measured very precisely across the site, in up-to-date imagery.

A preliminary digital surface model and point cloud of approximately 20 million points of 3D data was also created from the drone data for the Project site. Comparing features captured by terrestrial survey and drone, the two datasets agreed with each other to within

about 2cm horizontal and 2.5cm vertical. These models will be reviewed further along with the on-the-ground topographic survey data during development of the conceptual design.

Engineering Summary

During the site visit, a number of subtidal and intertidal shoreline features and potential engineered solutions for the existing bulkhead were discussed with the Project partners. These features will be evaluated during the development of the conceptual design and the site-specific information collected during the site assessment will be used to inform the design. The following are some preliminary notes of those discussions and are not intended to be all inclusive of the potential features that will be considered for the design.

Subtidal Areas

Given the existing shallow water bathymetry, current recreational uses of the Project area and potential visual concerns from nearby property owners and park users, a variety of submerged aquatic habitat enhancement features could be included in the conceptual design, including the use of concrete “reef balls” and “oyster castles” which could be placed parallel to an eroding shoreline area or installed in an aggregated, nature-like non-linear manner, to mimic “rock reefs” which were once prevalent in sections of the lower Hudson River Estuary, but were removed by blasting and dredging during the late 19th and early 20th Centuries to benefit navigation. Given the uncertainty of biological success in the Project area vicinity (low-salinity) and potential permitting challenges, live oysters would likely not be transplanted but habitat for recruitment by native, local oysters (via natural reefs present downstream of the Project area, in the vicinity of the GMC Bridge) could be created.

Note that the average salinity conditions at Ossining may be sub-optimal for oyster growth and recruitment at levels considered sustainable to maintain a local population (or reef development). However, Hudson River oysters have historically (and recently) been known to occupy a relatively broad salinity range. Habitat enhancement for other, native suspension-feeding invertebrates such as barnacles and ribbed mussels should be considered, and the design of the habitat structures should be optimized for use by a variety of resident, as well as transient/migratory species. Placing artificial reef structures within casting distance from the shoreline/fishing piers would benefit recreational anglers by aggregating target species. This was one of the specific design goals for the Harlem Piers reef ball project, designed and constructed by HDR in the mid-2000s, off upper Manhattan. This project represented the very first permitting application of reef balls in the Hudson River Estuary, pioneering the use of this habitat development alternative in a number of successive projects in the region. Recreational access through the Project area for kayaks and similar non-motorized recreational vessels should be maintained in the placement of habitat enhancement structures.

An additional, potentially innovative and multi-functional option to combine habitat enhancement and public access elements on the site is available via proposed expansion

and improvements to the current multi-use fishing and commuter ferry pier. Should proposed efforts to develop a pier extension to accommodate historic tall ships and Hudson River cruise boats (funded in 2015 through a grant from NYSDEC) get underway, several eco-friendly design elements and enhancements could be incorporated during the construction process. These include reticulated “pile wraps” intended to provide increased surface roughness and structural heterogeneity to standard wooden, concrete, or steel piles. The wraps encourage colonization and growth of a diverse assemblage or epifaunal invertebrates, which contributes to local biodiversity, and provides water filtration benefits as well as food for estuarine fishes. Reef balls, as described earlier can also be incorporated into pier design, via placement at the base of each pile, such that the reef ball encompasses the pile, and is held in place. These design elements have been proposed for several pier reconstruction projects in the lower Hudson River Estuary, and most recently the pile wraps have been retro-fitted to existing pier structures within the Hudson River Park Trust’s (HRPT) estuarine sanctuary, located offshore of the Tribeca area of lower Manhattan, in the Hudson River. Reef balls and submerged rock gabions are also a component of the HRPT habitat enhancement effort, and have been demonstrated to support a sustainable, diverse assemblage of fishes and invertebrates among the engineered/enhanced structures.

Intertidal Shoreline

Opportunities for vegetated marsh plantings would likely focus on existing sandy substrate areas along the shoreline, but would not include the present beach area, which would be preserved/enhanced for aesthetics and active recreation (under anticipated future conditions of improved water quality). Plant species selection, substrate type and planting elevation ranges may be optimized based on bio-benchmarking data gathered from local reference shorelines in the vicinity of the Project area, including potential shoreline/marsh sites on the Hudson River’s western shore.

Upland Areas

Educational signage describing the purpose and benefit of habitat development and shoreline enhancement efforts could be placed along the existing pedestrian paths in Louis Engel Park. The existing boat/kayak launch would remain within its present footprint and should be incorporated into the conceptual design.

Restoration Constraints

Several potential design constraints were identified in the Project area. The current use of the adjacent upland including a park, active roadway, parking lot, boat club, restaurant(s) and walking paths may preclude any re-contouring to increase the width of the tidally affected area. Preservation of the existing boat club and canoe/kayak launch in its current location may also limit the extent of plantings and shoreline stabilization measures. The potential effects of storm-driven tides on living shoreline features will need to be considered; storm tides at high water can cause flooding; storm tides at low water can erode or displace features in the tidal shallows. The present rock revetments afford substantial protection to the shoreline as currently configured, this structural (and habitat)

element will likely need to be retained; although there may be potential opportunities to improve the function of these structures to benefit native plant communities and wildlife.

The existing sandy beach within the park can be preserved and enhanced/stabilized; however, erosion of fine, unconsolidated substrate associated with future severe storm events may require a commitment to periodic maintenance, recontouring and placement of new sand to ensure the continued use of this shoreline feature. Furthermore, water quality in the vicinity of the park/beach would need to be addressed/improved prior to gaining NYS Department of Health approval and designation as a public swimming beach.

Based on the results of this site assessment and ongoing stakeholder engagement, specific project features that consider these restoration constraints will be developed as part of the conceptual design for the living shoreline project. The overarching goals for the project remain:

1. Protect and stabilize the existing shoreline south of the confluence of Sing-Sing Kill and the Hudson River and west of the Ossining Metro-North station;
2. Develop intertidal and subtidal habitat features to benefit fish, shellfish and other wildlife within the Project area, including enhancement/preservation of the sandy beach and ecosystem-friendly modifications/enhancements to the existing multi-use pier and any future pier development alternatives;
3. Maintain and enhance recreational access to the river and its shoreline habitats while including educational and interpretive elements that effectively engage the public.

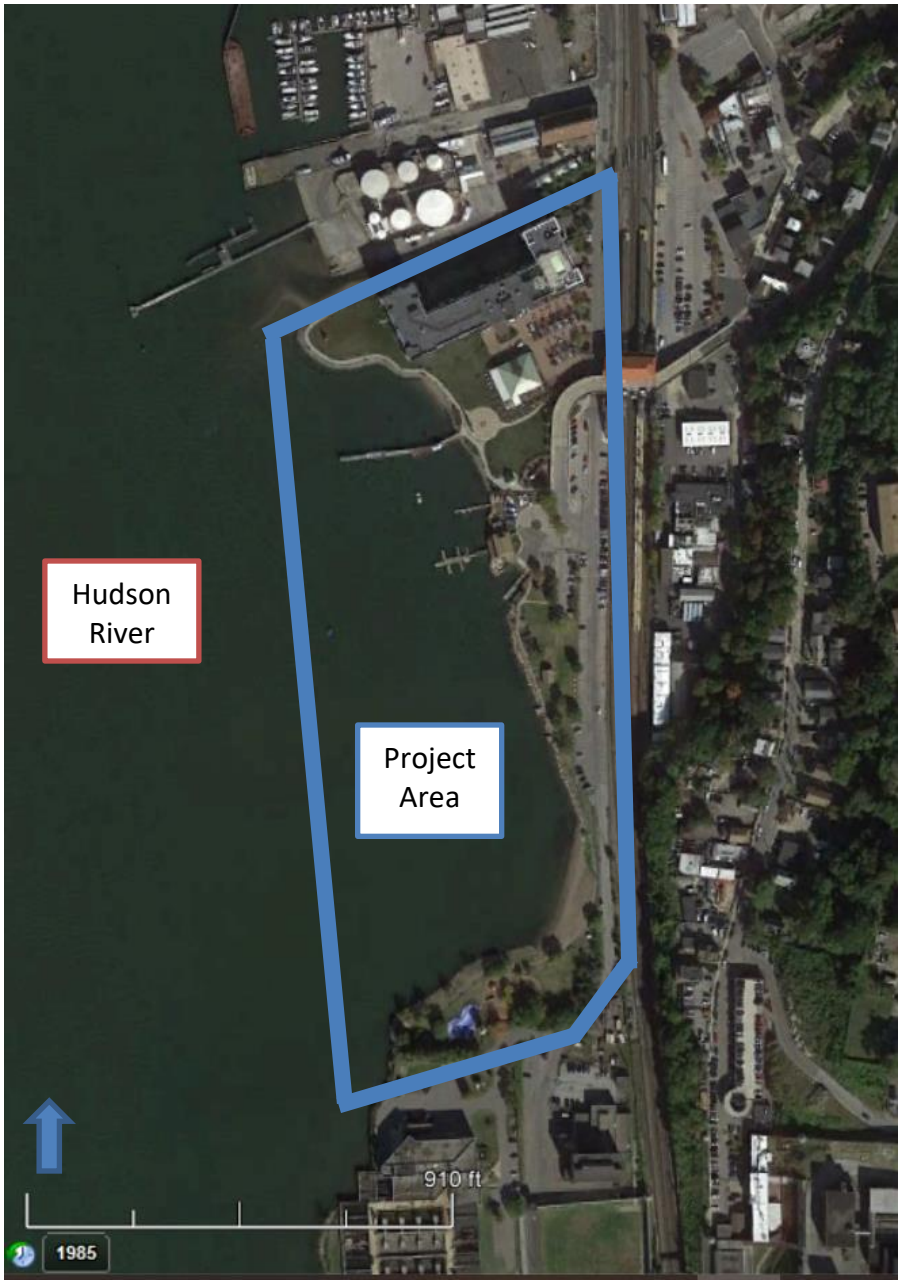


Figure 1: Project Study Area

Figure 2: Transect Locations

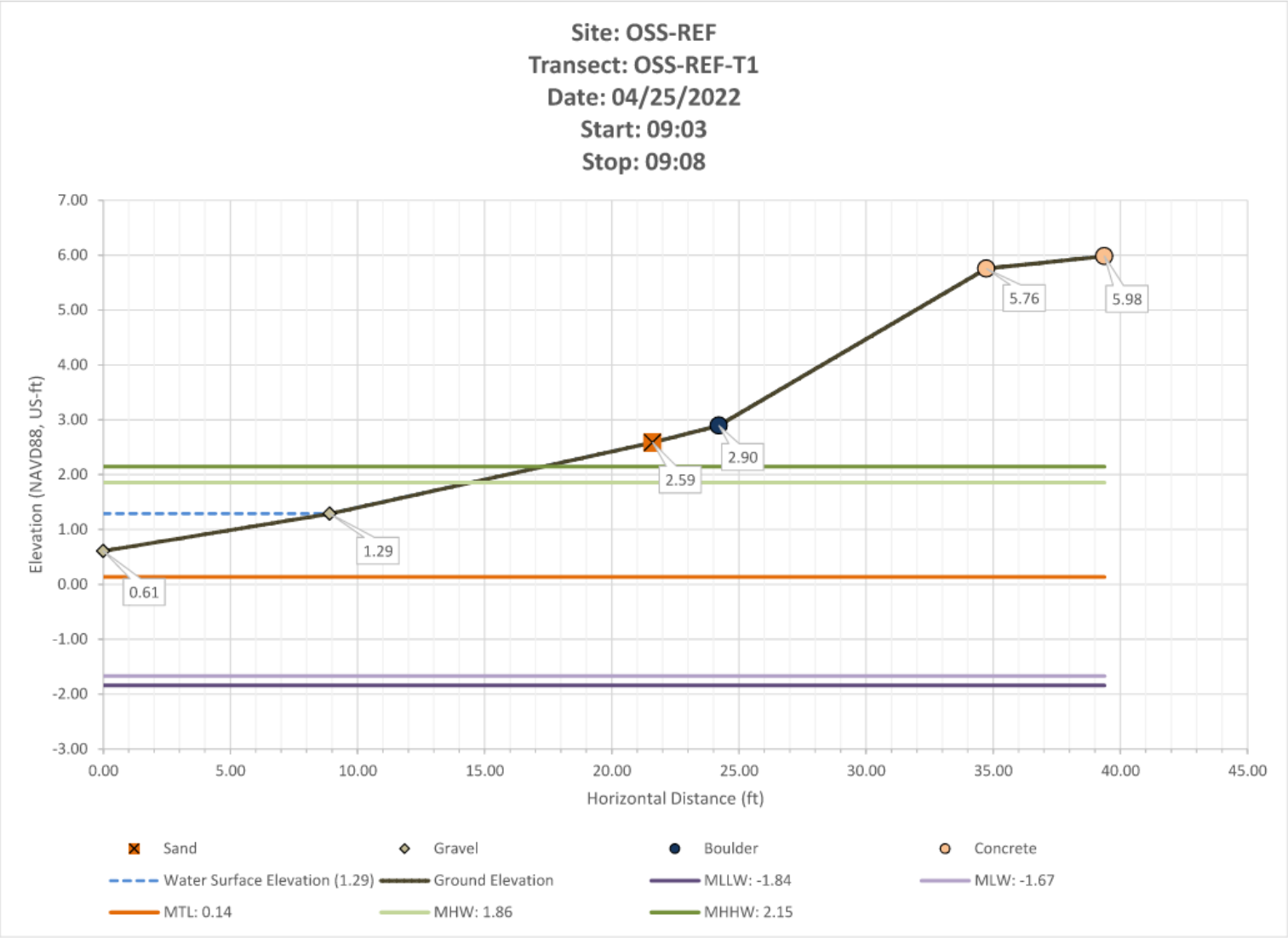


Figure 3: Survey Transect OSS-REF-T1

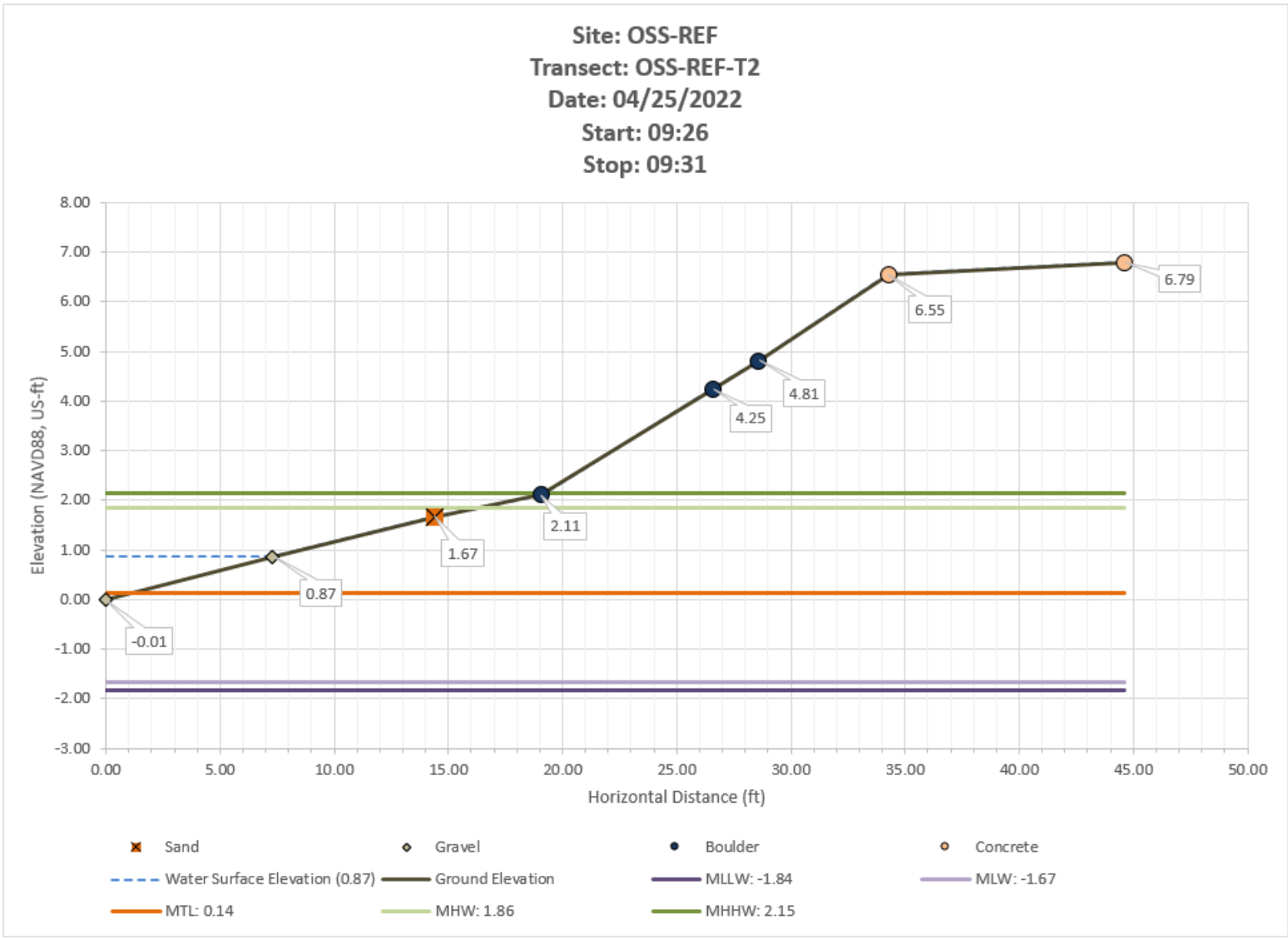


Figure 4: Survey Transect OSS-REF-T2

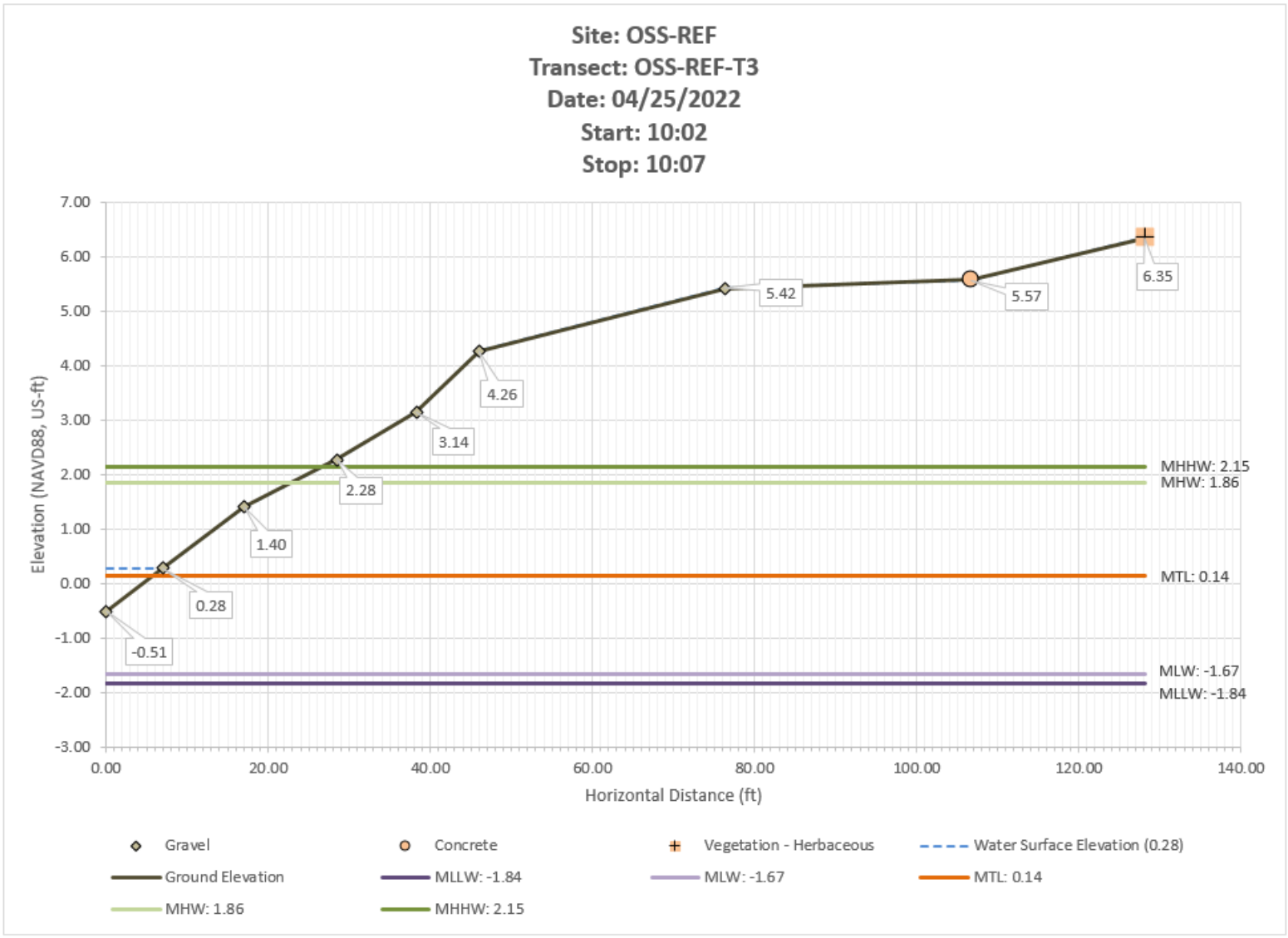


Figure 5: Survey Transect OSS-REF-T3

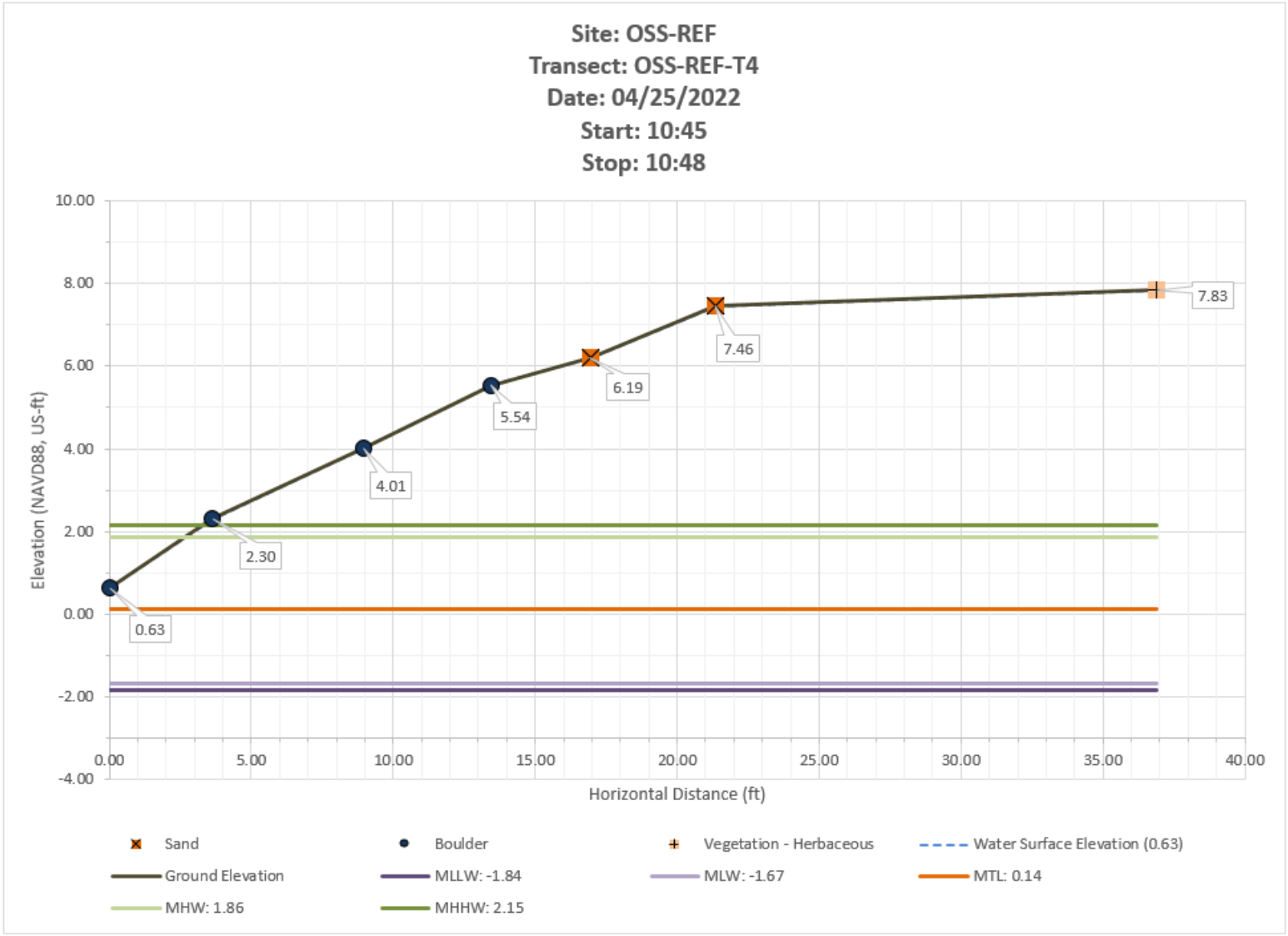


Figure 6: Survey Transect OSS-REF-T4

Attachment A

Site Assessment Photo Log


Ossining Shoreline Revitalization & Community Connectivity Improvements Project
Site Assessment Conducted 25 APRIL 2022

GENERAL SITE AND SHORELINE FEATURES

View of beach area facing south

View of beach area facing north

View of park and waterfront area facing north

Facing west near Louis Engel Playground

Parking area and MetroNorth Train station,
facing north

View of riprap shoreline protection facing south

Piers and public restrooms at Louis Engel Park,
facing north

Ossining Boat & Canoe Club facing south

Ferry pier, facing west

NY Waterways Ferry

View of Henry Gourdine Park area

North end of Henry Gourdine Park; sand bar accumulation, facing north

Sing Sing Kill outlet, facing northeast

SITE ASSESSMENT ACTIVITY


BIGFOOT CREAMERY

REPRESENTATIVE BIOTA

Rib mussels and Atlantic Rangia

Ivory Acorn Barnacles

Japanese knotweed

Mallard

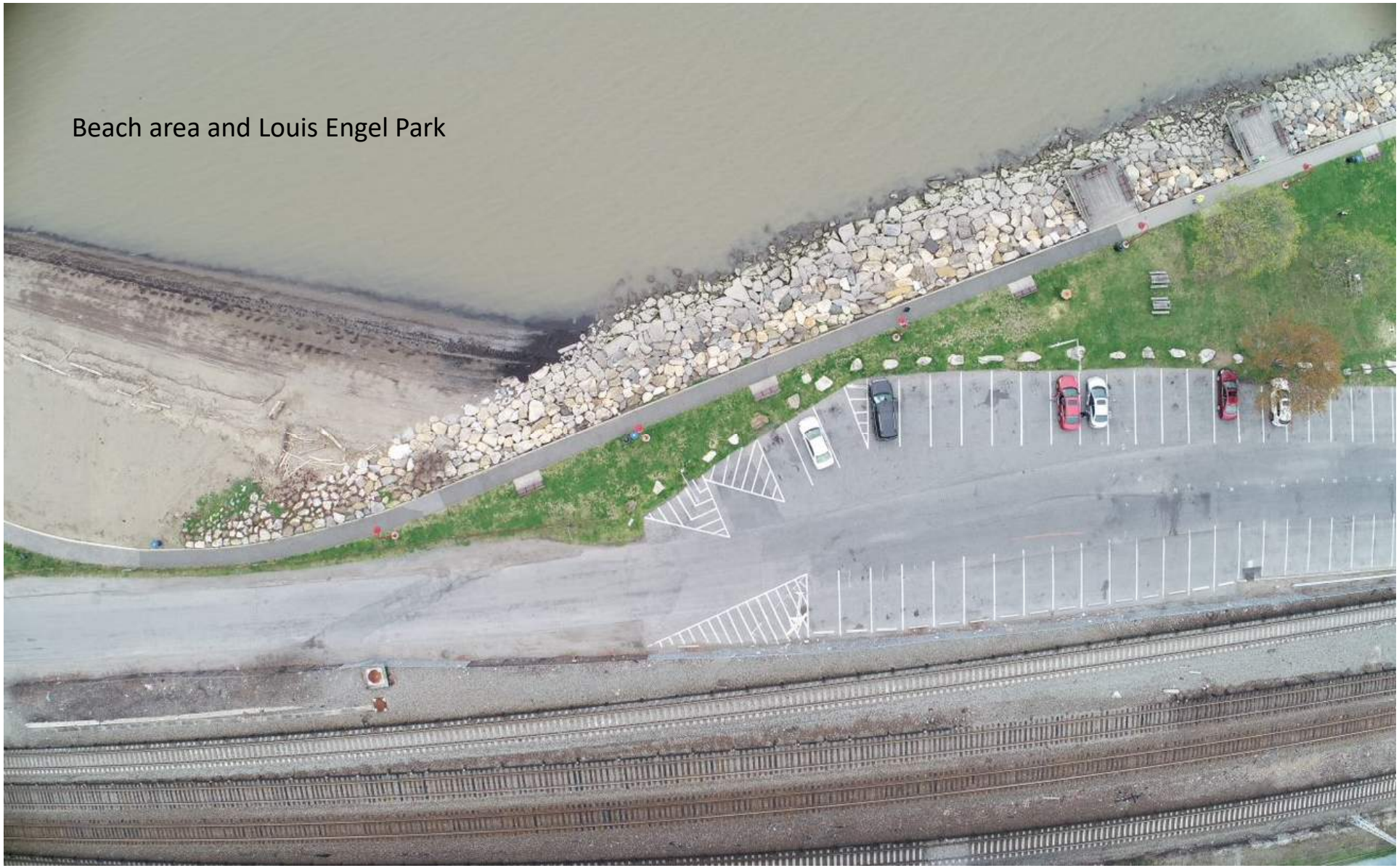

Mugwort


Common Chickweed

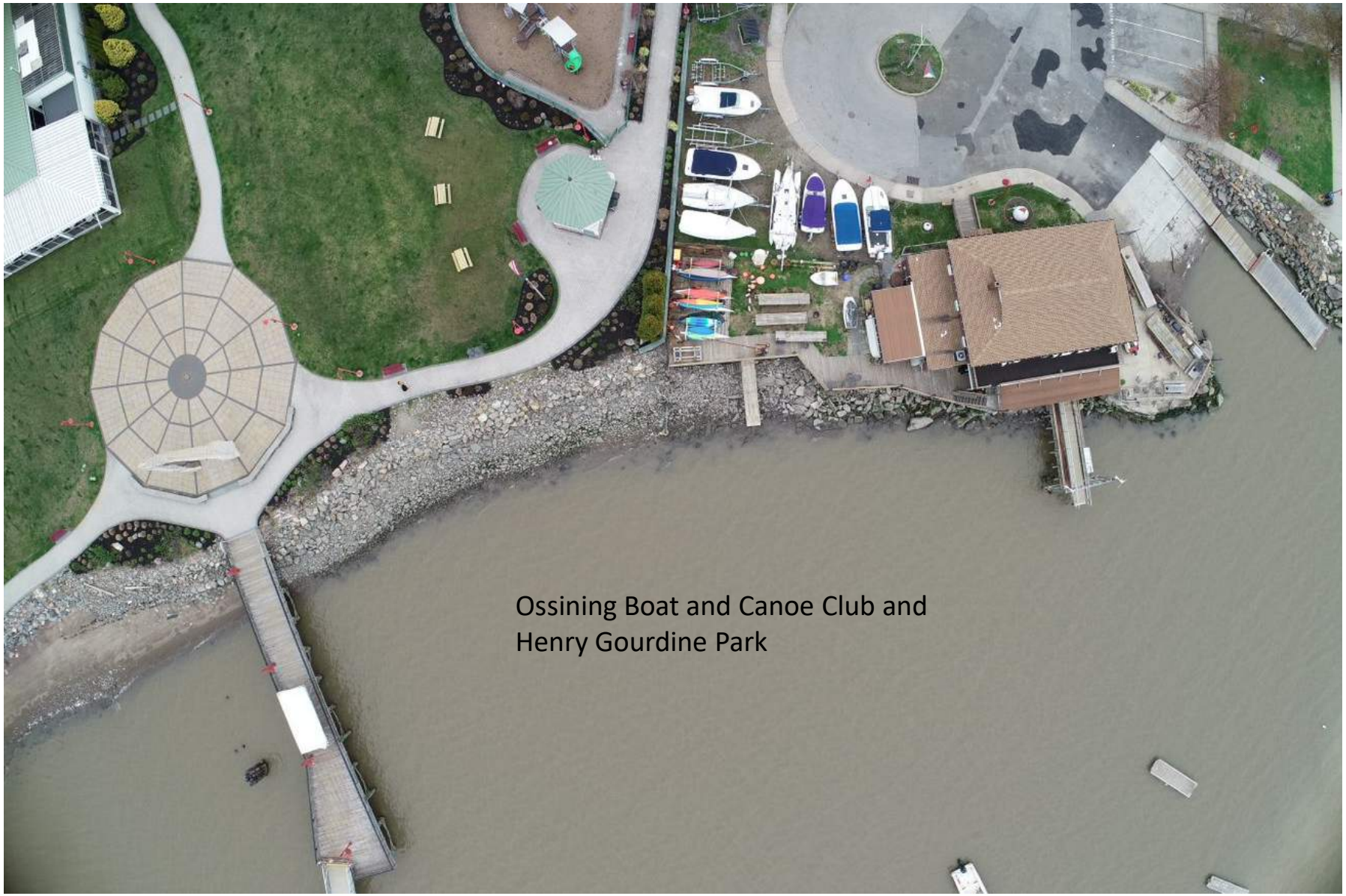
UAS (Drone) Survey – 25 April 2022

Southern extent of Louis Engel Park

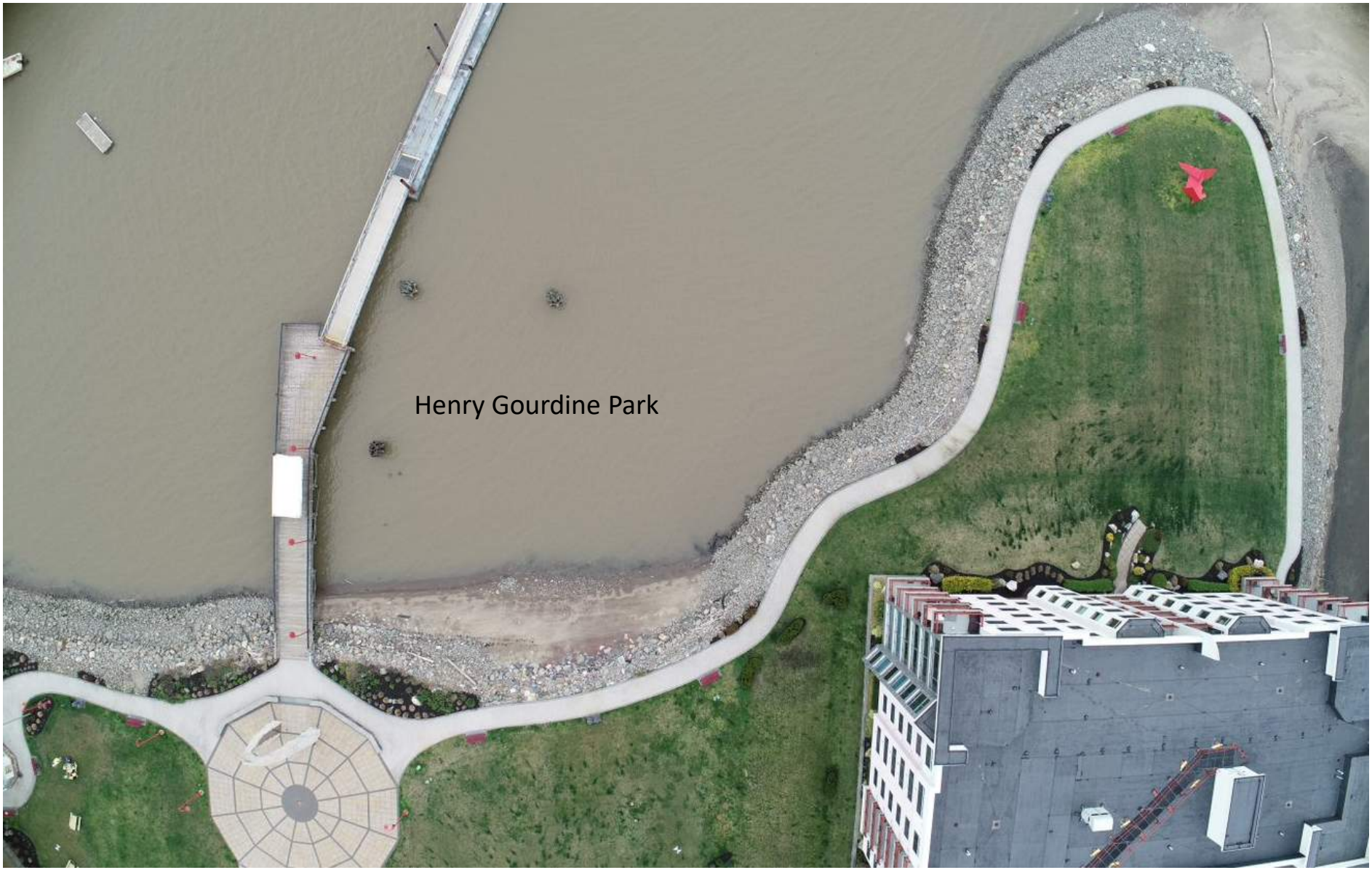
Southern extent of Louis Engel Park and beach area


Beach area and Louis Engel Park


Louis Engel Park Bathrooms and Stage area



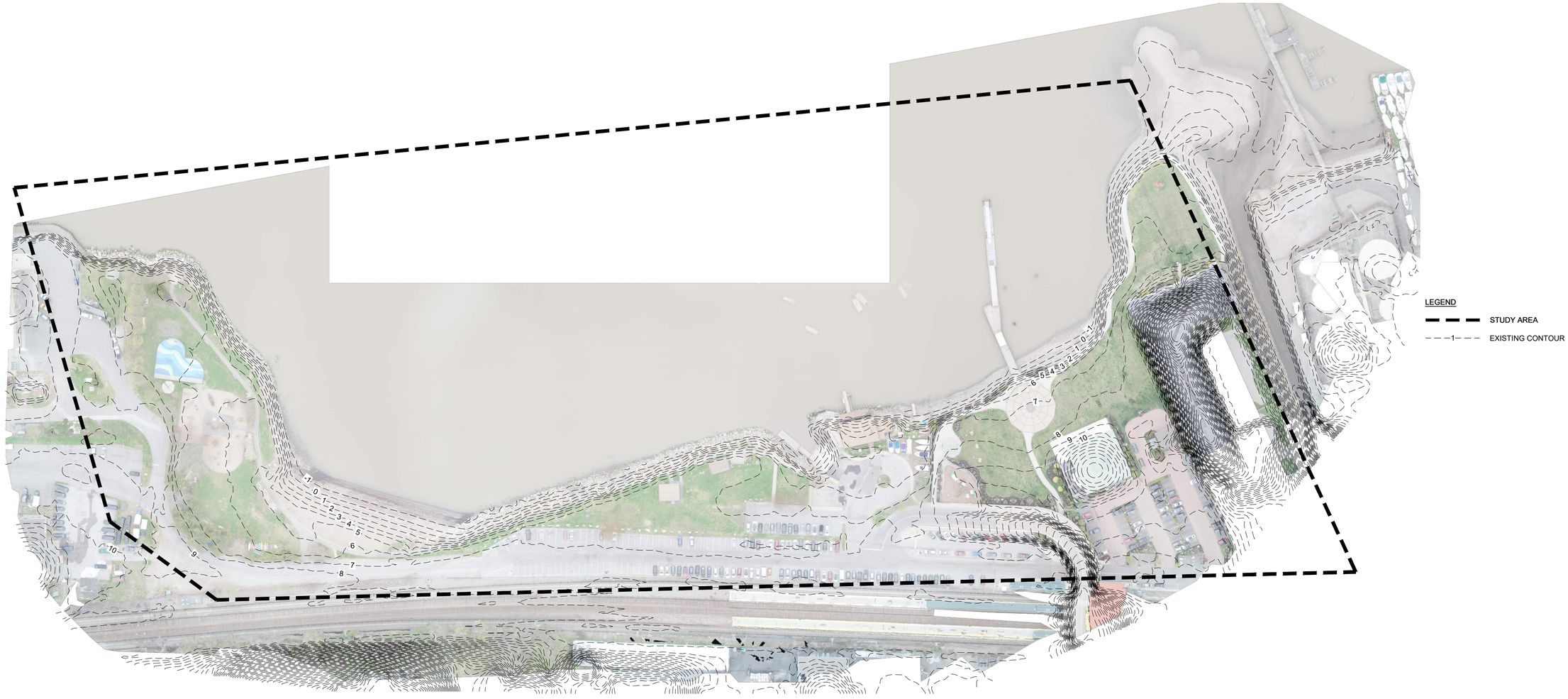
Ossining Boat and Canoe Club and
Henry Gourdine Park


Henry Gourdine Park


Sand bar at mouth of Sing Sing Kill

Attachment B

Elevation Map



ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	K. LUKAS
DESIGNER	K. LUKAS
DRAFTER	J. WYNOHRADNYK
REVIEWER	
PROJECT NUMBER	000000010327005

THESE ARE CONCEPTUAL DRAWINGS AND SHALL NOT BE UTILIZED FOR CONSTRUCTION PURPOSES.

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PHASE II / SHORELINE REVITALIZATION AND COMMUNITY CONNECTIVITY PROJECT / OSSINING, NY

EXISTING CONDITIONS PLAN

0 80' 160'

FILENAME -

SCALE 1" = 80'

SHEET
V-101

Appendix B

Stakeholder Engagement

B1

Earth Day Tabling Event Survey Responses

(April 23, 2022)

Ossining Shoreline Revitalization Survey

What do you enjoy doing at the waterfront?

31 Responses- 2 Empty

Data	Responses
Walking	2
Mixed use, dining, night life, boating, walking, park space. I also live here in Harbor Square	1
Listening to like live music in the summer, summer concert series. Walking the path, enjoying the views of the water, skyline, birds and the beautiful sunsets. Wish there was a way to make the shoreline larger. It can get crowded during the longer summer days and less peaceful with so many people around.	1
Watch the sunset and water, eat waterside, music events	1
Walks, runs and bike rides. Also, access for kayakers and SUPs. I would enjoy a clean and open space w benches for enjoying the amazing views of the Hudson Review.	1
Walking and sitting. Eating	1
taking my kid to the playground, walking & enjoying the river views, relaxing with friends	1

What does a resilient waterfront look like to you? (ex: floodproof the gazebo or add oyster reef balls)

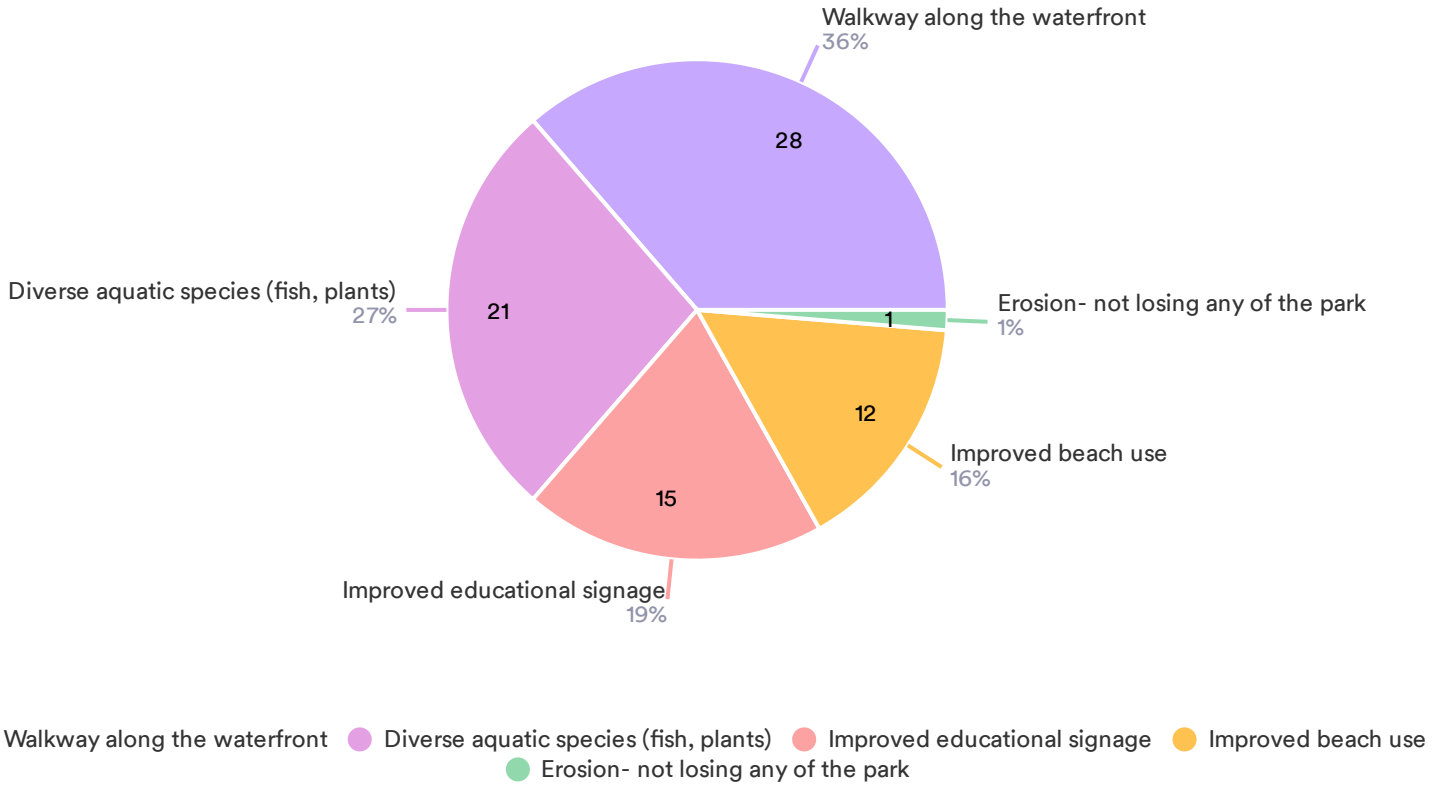
24 Responses- 9 Empty

Data	Responses
Add oyster reef balls, environmental remediation along the waste water treatment plant outlets, a refreshed beach that people could actually swim at, foot connection to the sing sing river walk way through the empty lot on Water Street.	1
Less smell from bathroom, stop waste dumping in the river, cleaning up after fishing etc, more benches, tables, jetties to slow erosion , pet are and pet restriction in most areas	1
Native plants along a multi-use walkway	1
Places with drainage when it floods, higher ground walking path and seating areas still available.	1
would love to see a living shoreline that could be used as an educational opportunity for Ossining residents - reef balls, native plants, etc.; a waterfront designed to flood!; pervious paving in the parking lots & other green stormwater infrastructure elements (bioswales, etc); green roofs on waterfront buildings, including the train station	1

Ossining Shoreline Revitalization Survey

Which resilient design elements are most important to you?

77 Responses- 1 Empty



Ossining Shoreline Revitalization Survey

Enter your email for future project updates.

24 Responses- 9 Empty

Data	Responses
brianmgranoff@gmail.com	2
bknuth12@gmail.com	1
zimanyc@yahoo.com	1
lisaanneoc@yahoo.com	1
ian.japal@gmail.com	1
renoir727@aol.com	1
sara.l.powell@gmail.com	1
katherine.a.friedman@gmail.com	1
joancwaters@gmail.com	1

B2

Stakeholder Workshop #1 Presentation

(June 10, 2022)

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO

Ossining Shoreline Revitalization & Community Connectivity Improvements Project

Stakeholder Engagement Workshop | Joseph G. Caputo Community Center

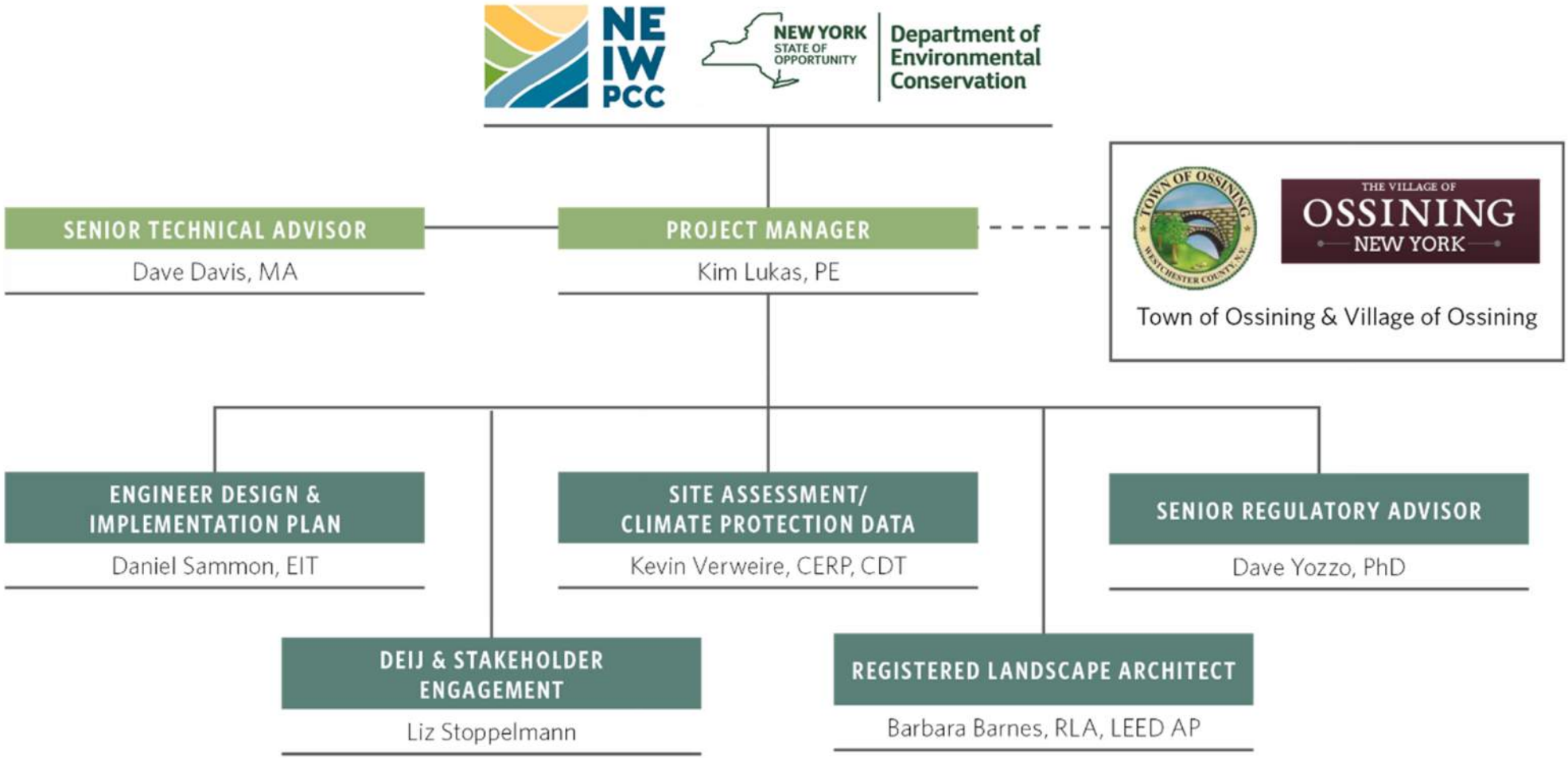
06/10/2022

NEW YORK STATE Department of Environmental Conservation | Hudson River Estuary Program

THE VILLAGE OF OSSINING NEW YORK

NE IW PCC

TOWN OF OSSINING


NE IW PCC
NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation
SENIOR TECHNICAL ADVISOR
Dave Davis, MA
PROJECT MANAGER
Kim Lukas, PE
TOWN OF OSSINING
WESTCHESTER COUNTY, N.Y.
THE VILLAGE OF
OSSINING
NEW YORK
Town of Ossining & Village of Ossining
ENGINEER DESIGN & IMPLEMENTATION PLAN
Daniel Sammon, EIT
SITE ASSESSMENT/ CLIMATE PROTECTION DATA
Kevin Verweire, CERP, CDT
SENIOR REGULATORY ADVISOR
Dave Yozzo, PhD
DEIJ & STAKEHOLDER ENGAGEMENT
Liz Stoppelmann
REGISTERED LANDSCAPE ARCHITECT
Barbara Barnes, RLA, LEED AP

01 Workshop Objectives

02 Project Overview
- Design Objective/Criteria

03 Site Assessment Overview

04 Public Engagement

05 Next Steps/Future Meetings

01

Workshop Objectives

Workshop Objectives

Continue the conversation on what residents would like to see in the future as the waterfront changes

Gain important insight into the varied uses of Gourdine & Louis Engel Park

Review potential measures that could be implemented

02

Project Overview

Project Overview

- Ossining's waterfront will be increasingly challenged by sea level rise and climate change
- Community engagement throughout Phase I & II
- Conduct site assessment to understand the potential constraints / opportunities
- Focused project area to public parcels
- Conceptual design for Henry Gourdine Park & Louis Engel Park area
- Design will keep other park improvement projects / DRI funded projects in mind, providing a staged approach to improving resiliency

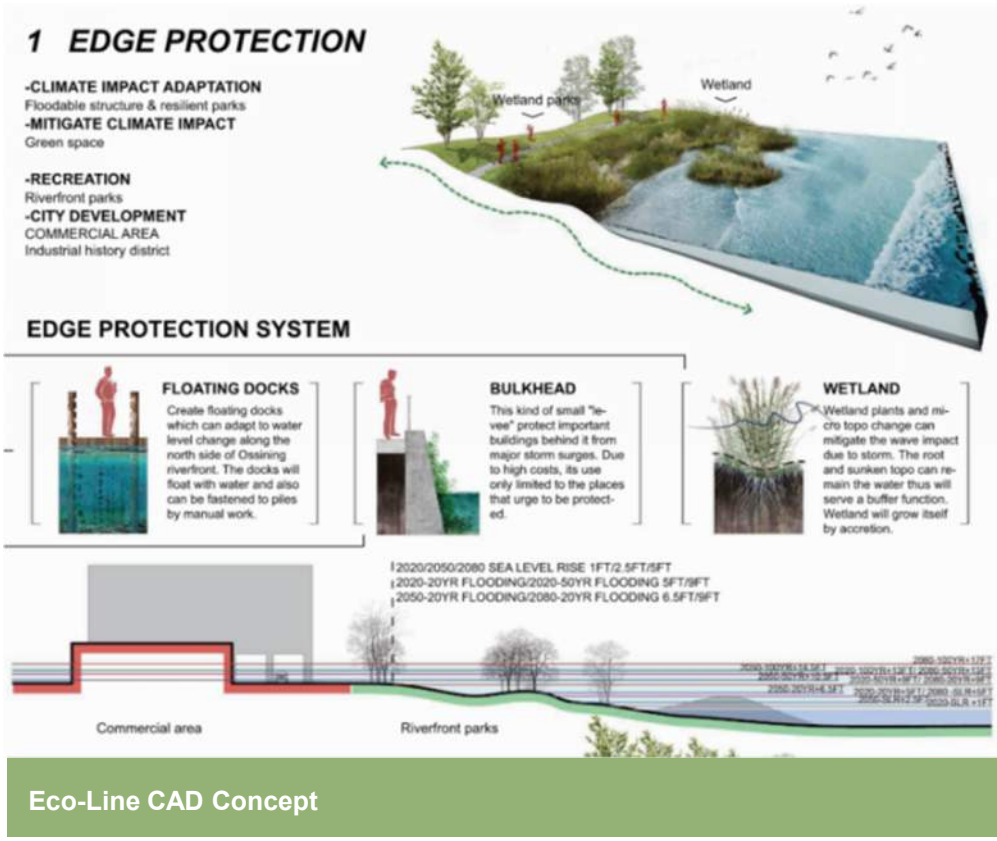
From Patch.com, October 30, 2012

From Grist.org 2012

Design Objective

1. Be cost-effective and permittable
2. Align with Ossining's comprehensive plan and Local Waterfront Revitalization Plan
3. Include coastal resiliency/climate adaptation as well as educational or interpretive elements
4. Serve as a model for Diversity, Equity, Inclusion, and Justice

Sing Sing Fugue CAD Concept



Eco-Line CAD Concept

Climate Change Impacts

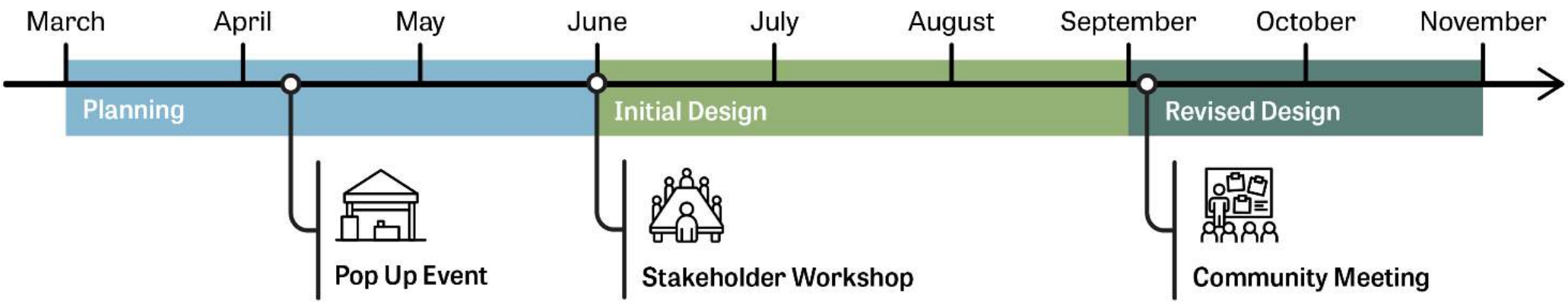
- Sea level rise poses a risk to Ossining's waterfront
- Water elevations projected to rise 0.75 - 2.5 feet by 2050 and 1.25 to 9.5 feet by 2100 in the lower Hudson River Estuary (NYSDEC)
- Increased water level means increased risk of flooding and storm surge with coastal areas of NY

Depths of temporary flooding anticipated in the "100-year" or 1% flood zone on the Ossining waterfront for the present-day baseline condition.

Inundation depths (blue) and temporary flooding depths (green) for the "100-year" or 1% flood condition on the Ossining waterfront with 60"of projected sea-level rise during the 2080's.

Data source: Columbia University Hudson River Flood Impact Decision Support System Version 2

Project Timeline



03

Site Assessment Overview

Site Assessment

- Ecological communities and Functions
- Topographic mapping and collection of aerial imagery, videography, and photogrammetry
- Existing shoreline features and condition with focus on site constraints and opportunities

Key Findings

- Shoreline is primarily riprap and rock revetments with tidally stranded woody debris
- Cobble/gravel with sand substrate
- Typical Mean Higher High Water to Mean Lower Low Water extends 35-40 ft riverward
- Dominant plant species were Japanese knotweed, mugwort, yellow flag iris and cocklebur.

Wildlife

- Atlantic rangia clam shells were abundant along the shore and in shallow water areas
- Small ribbed mussel shells observed along the wrack line, but no live mussels were observed
- Fragments of American oyster shells were found
- Both aquatic and terrestrial bird species were present

Site Constraints

- Site is bound by development, private properties, MetroNorth RR, parking lots, riprap and bulkheads
- Storm driven tides may impact and erode shoreline plantings, if proposed
- Water quality issues in vicinity of the beach area

Ecological Opportunities

- Subtidal (subject to regulatory standards)
  - Concrete reef balls for submerged aquatic habitat enhancement
  - Corrugated pile wraps, potentially part of pier extension project
- Intertidal Living Shoreline
  - Vegetated marsh plantings and other natural elements in combination with harder shoreline structures to stabilize and protect the shoreline
- Additional Benefits
  - Improved water quality
  - Creating habitat for fish, birds and other living resources
  - Promoting recreation and adaptive uses.

04

Public Engagement

CAD Phase 1 Engagement

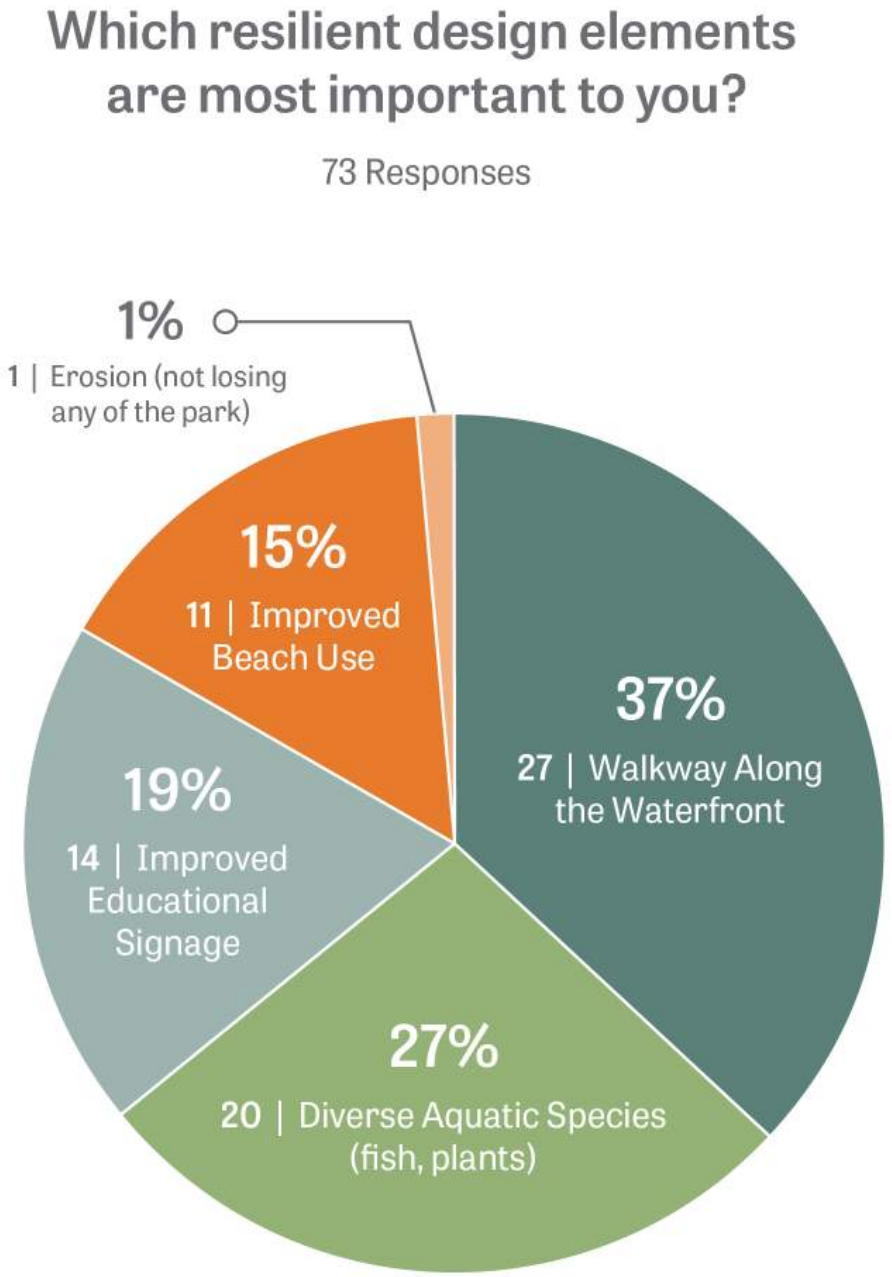
1. Site Visit
2. Community Workshop
3. Refined design based on community feedback
4. Shared final designs with the community

Earth Day Event

- Tabling event at the Green Ossining Earth Day event on April 23, 2022, including a survey
- Spoke with 30+ Ossining residents to hear what is important about the waterfront
- Themes heard:
  - Promote accessibility and walkway connections
  - Consider Boat & Canoe Club and parking lot as they are susceptible to flooding
  - Aware of the MTA ferry route
  - Opportunities to promote in-water activities

Earth Day Survey

- Learned what is important about the waterfront and what should be considered in the design
- Received ~40 responses
  - What does a resilient waterfront look like?
    - Native plants
    - Flood proof the gazebo
    - Drainage for flooding
  - Design considerations
    - Signage
    - Opportunities to integrate schools and community groups
    - Accessibility and ease of use
    - Mix views on businesses and restaurants along the waterfront
    - Covered spaces
    - Parking

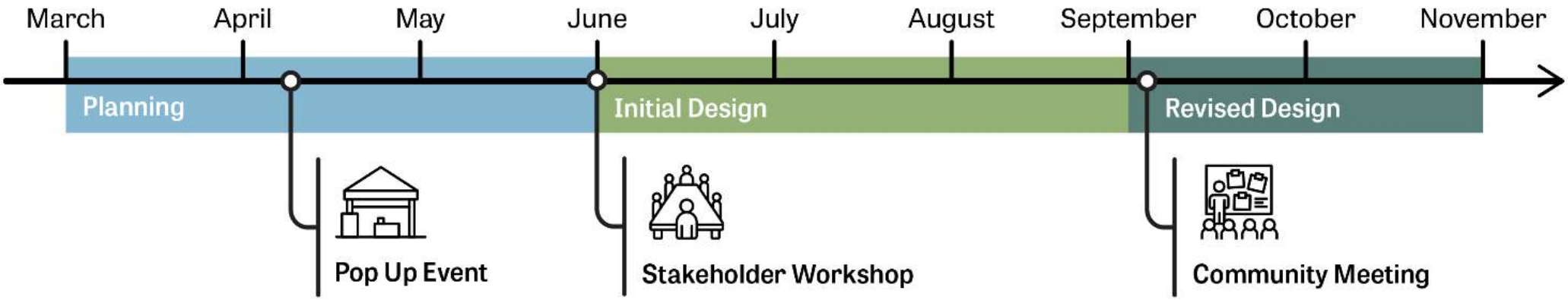


05

Next Steps/Future Meetings

Next Steps

- Virtual open house – July 2022
- 2nd stakeholder engagement meeting – Sept. 2022
- Final conceptual design presentation – Nov. 2022



Workshop Objectives

Continue the conversation on what residents would like to see in the future as the waterfront changes

Gain important insight into the varied uses of Gourdine & Louis Engel Park

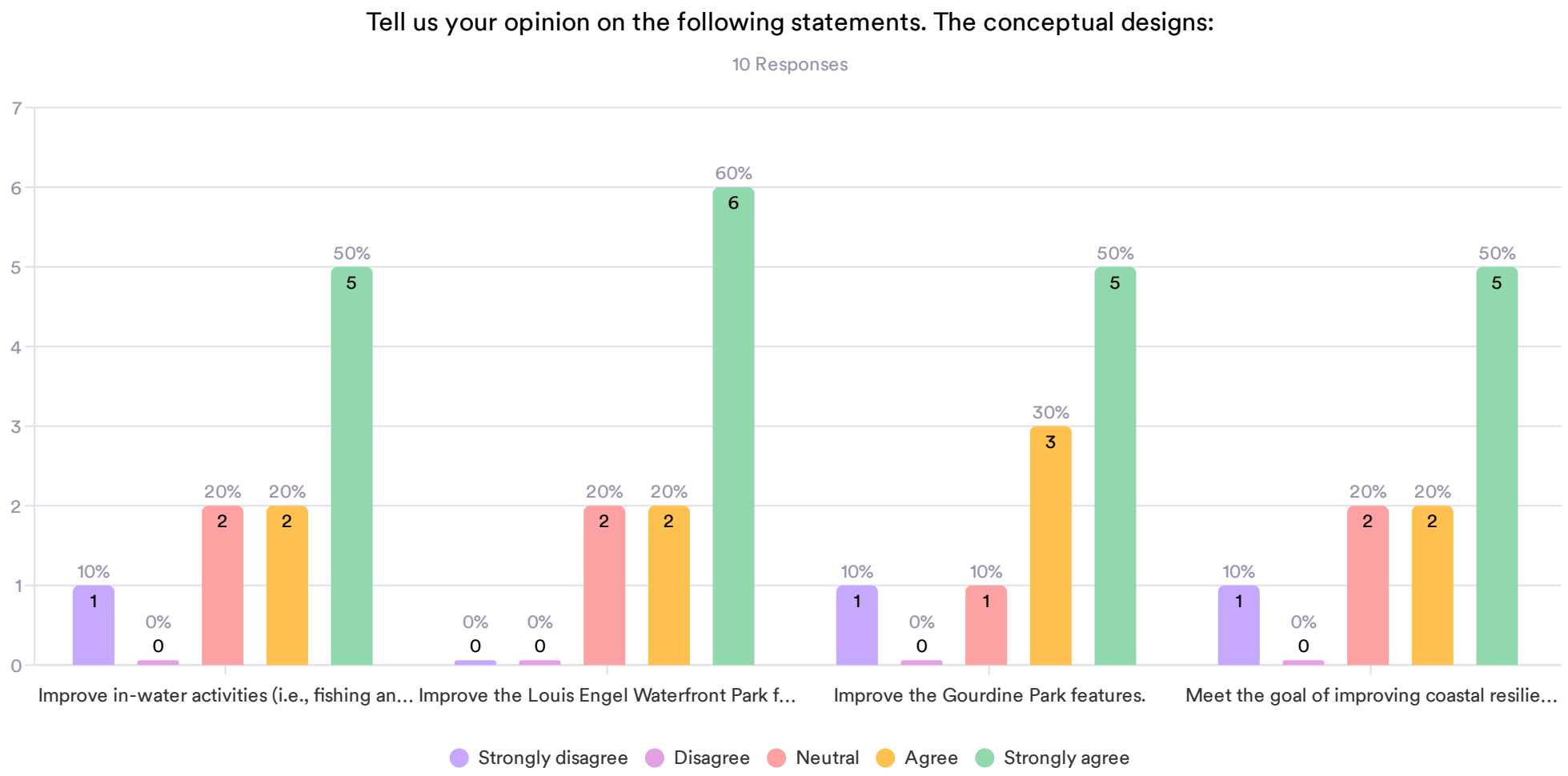
Review potential measures that could be implemented

B3

Virtual Open House Survey Feedback

(August-September, 2022)

Ossining Survey Questions



Ossining Survey Questions

Why do you strongly disagree with one of the following statements?

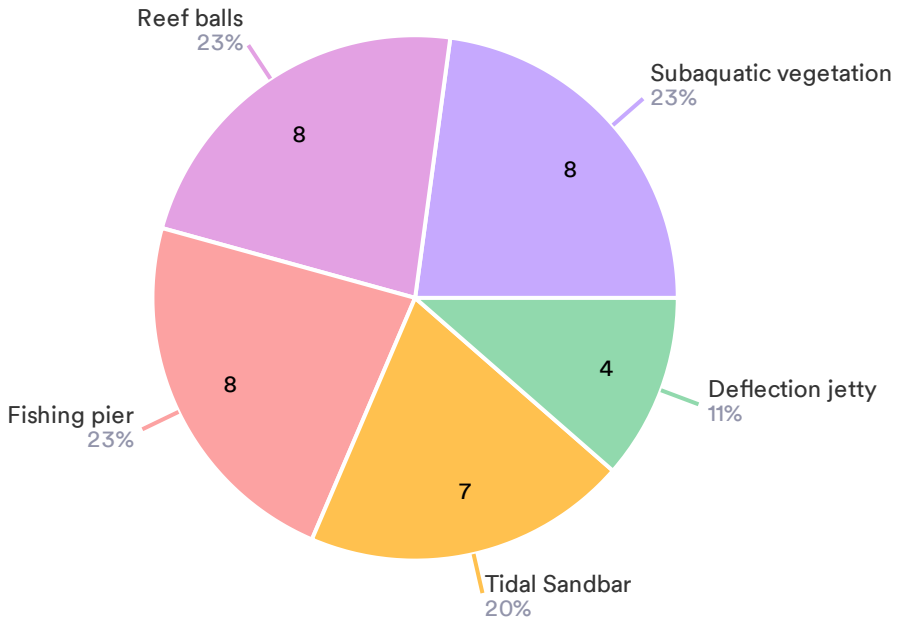
1 Response

Data	Responses
Residents that like to fish & boat already have access & know where to go. Additional fishing piers would be nice down by the water park. Gourdine Park was just recently created & DID NOT preserve Mr. Gourdine's fishing shanty!--A HUGE part of history of our beloved Ossining. Coastal resiliency only in the way of planting native plants & perhaps a few submerged buoys for aqautic life. Do not build so much to inhibit the boating activities of the Oss.Boat & Canoe Club nor narrow those boats access to their historic club! No berth should be built by the taxpayers dollars in front of Harbor Square as they already have a PILOT in place that the taxpayers are footing the bill for! Where are the biblio references for the Columbia Univ. study re: water rising attached?	1

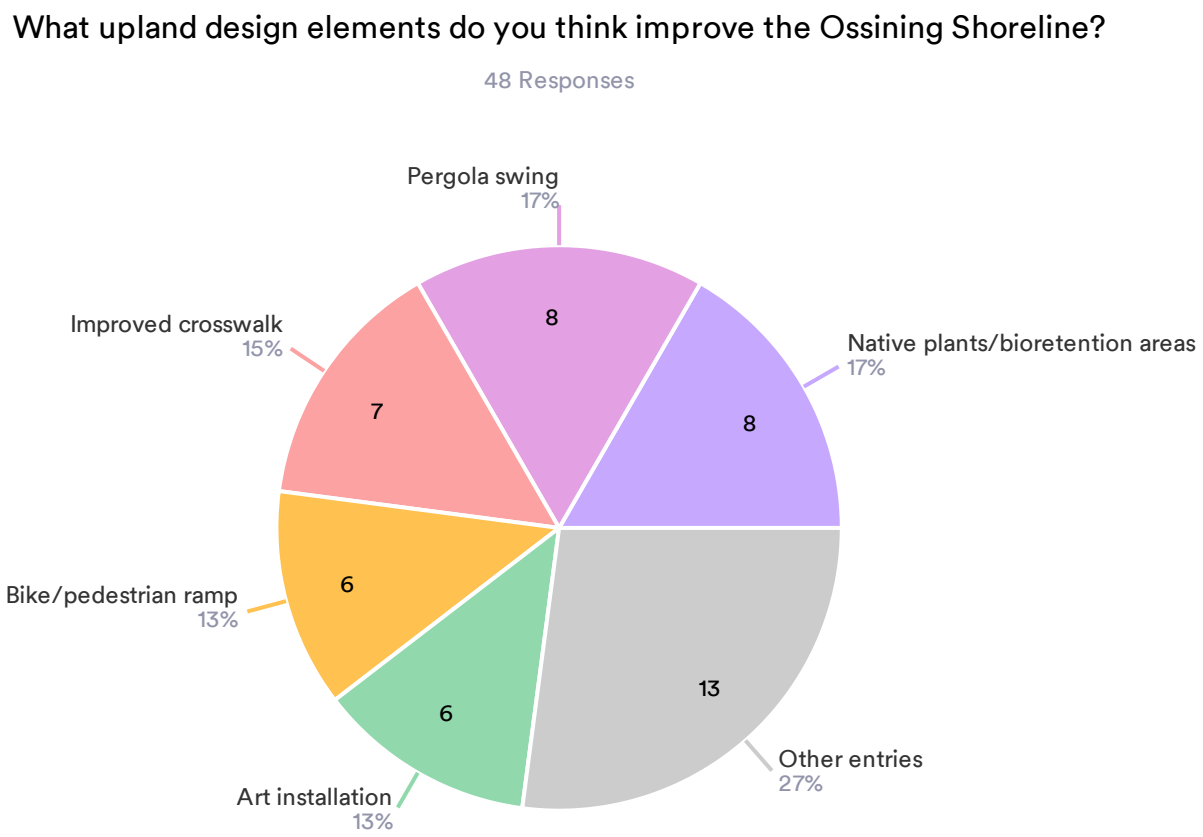
Ossining Survey Questions

What in-water design elements do you think improve the Ossining Shoreline?

35 Responses



Ossining Survey Questions



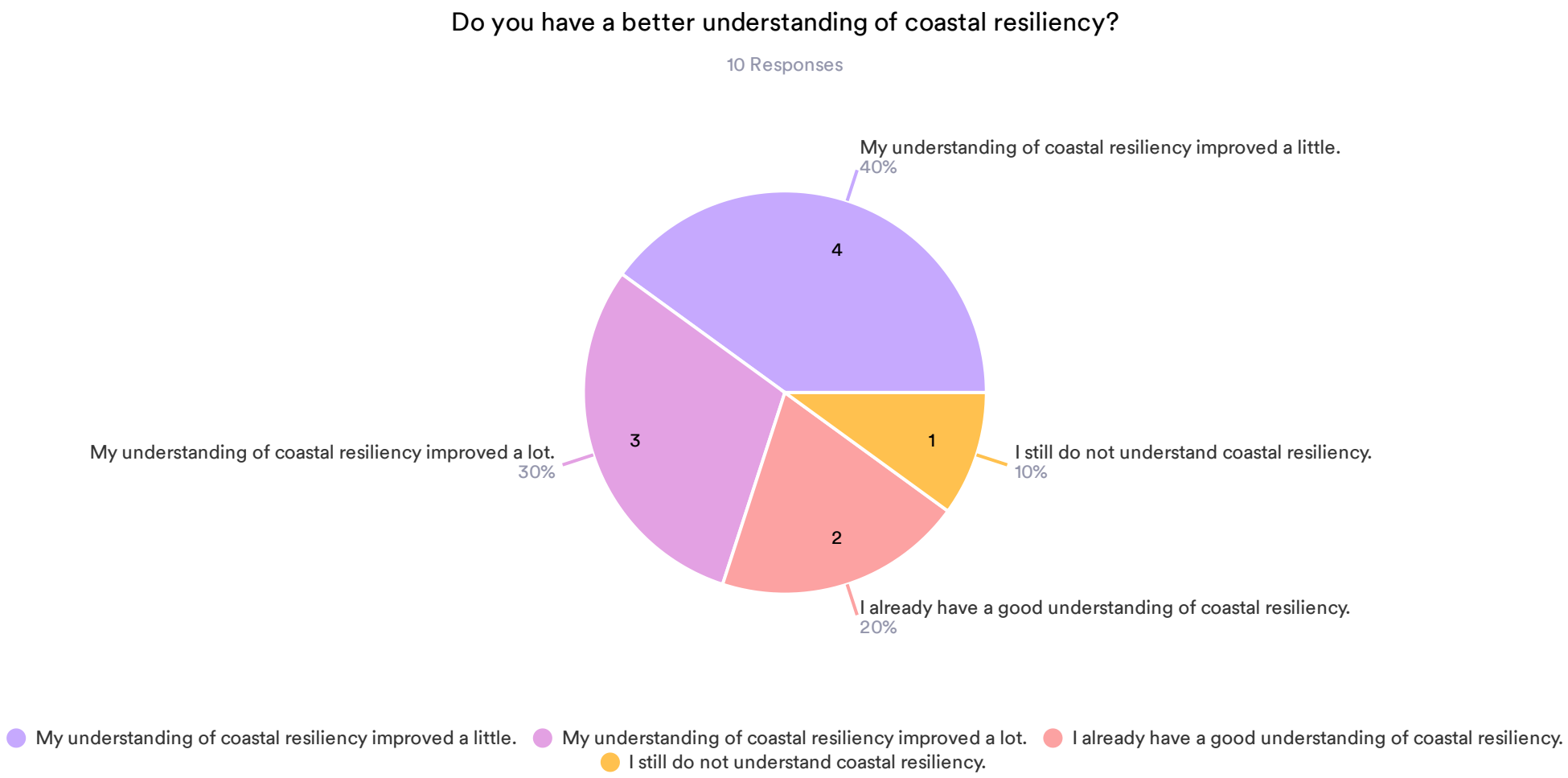
Ossining Survey Questions

Are there other design features that should be considered?

6 Responses

Data	Responses
The park near the waterpark was created & failed as it was not maintained. The trees/flowers there did not survive the harsh coastal winds. Topsoil washed away. Signage should be put on all plants, rocks, fixed mount telescopes as education. Swings are a bad idea as far as liability & weight limits. Some strategically placed art. Dedicated bike lane separate next to pedestrian lane. The parks down there are just hugely neglected as far as proper landscaping.	1
Bike racks and e scooter racks	1
I don't think there is enough space in such a small park to include bikes. Perhaps there could be a bike parking area for those who ride their bikes to the park, and then the riders can just walk the trails like everyone else. It is my experience that when bike riders and walkers have to share a space, the walkers are forced off the path.	1
I think that the mentioned design looks great. There would be a little something for everyone.	1
Just want to reiterate how important it is to focus on a design that encourages walkability and cycling. The shoreline and park will be held back if there is a lot of car traffic — which boosts danger to pedestrians and children, and increases noise pollution.	1
I would most like to see in organic additions rather than "built" ones. We walk the park year round for sunsets and enjoying the myriad activities of our fellow townspeople.	1

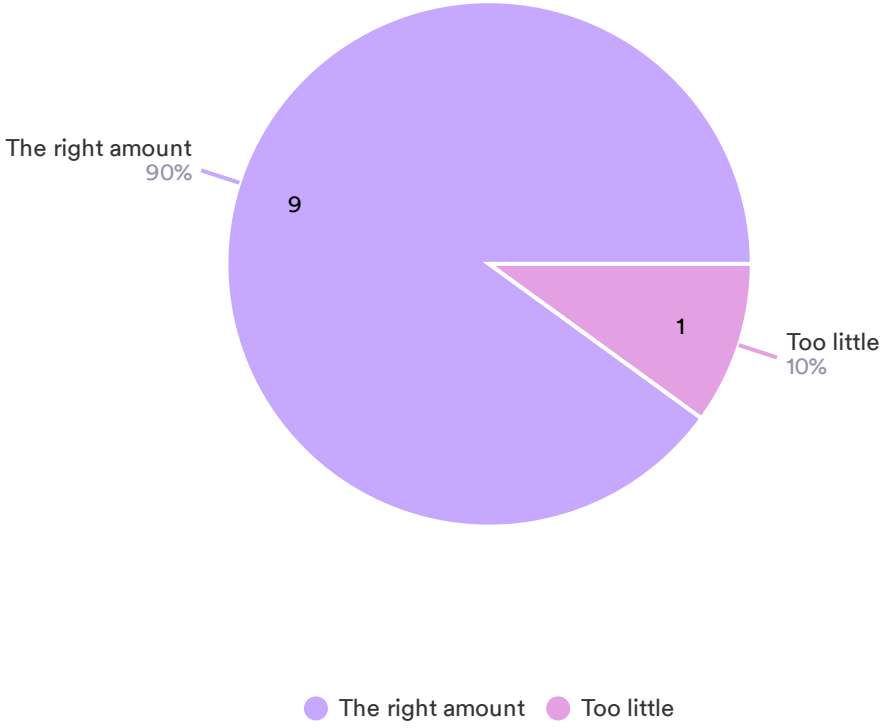
Ossining Survey Questions



Ossining Survey Questions

What do you think about the amount of information presented?

10 Responses



Ossining Survey Questions

Was the information presented helpful? Why or why not?

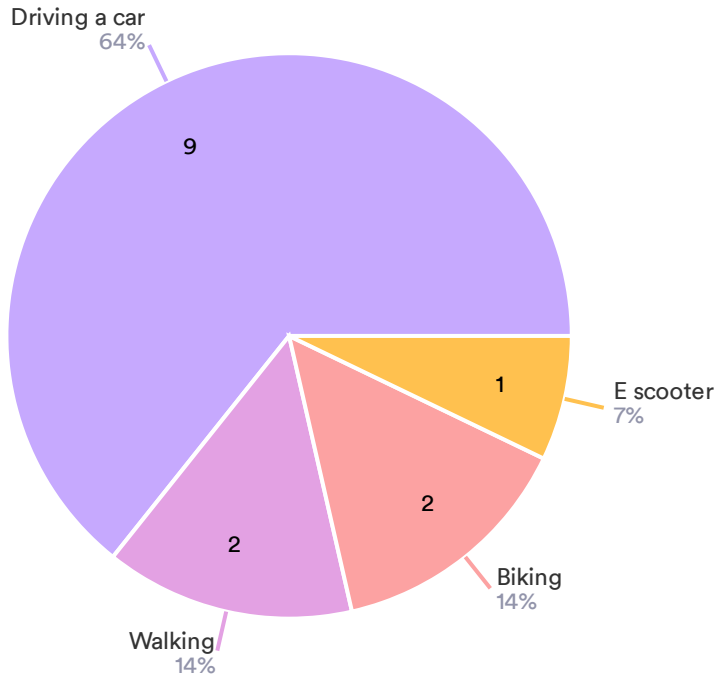
4 Responses

Data	Responses
Info. was lumped for survey answers and doesn't really look at the present situation of what the area has to offer. We certainly do not need a bigger ferry pier--people are not & have not flocked to take the ferry across the river since it's inception nor are people flocking to the Ossining waterfront. Please stop this dream. Fishing & boating cannot be grouped together as a question. Two separate activities. Do not make the parking spots 'greenspace' as plenty of 'greenspace' exists by the waterpark--just need more native growth to make it pretty.	1
The information was explained well, but the presentation didn't need to be so elaborate.	1
yes, it was, thanks	1
Yes, I'm happy to learn about the possibilities and hope that the space will not become overdeveloped with built items, such as the swing pergola. There's usually benches available for sitting. It is a wonderfully natural community space.	1

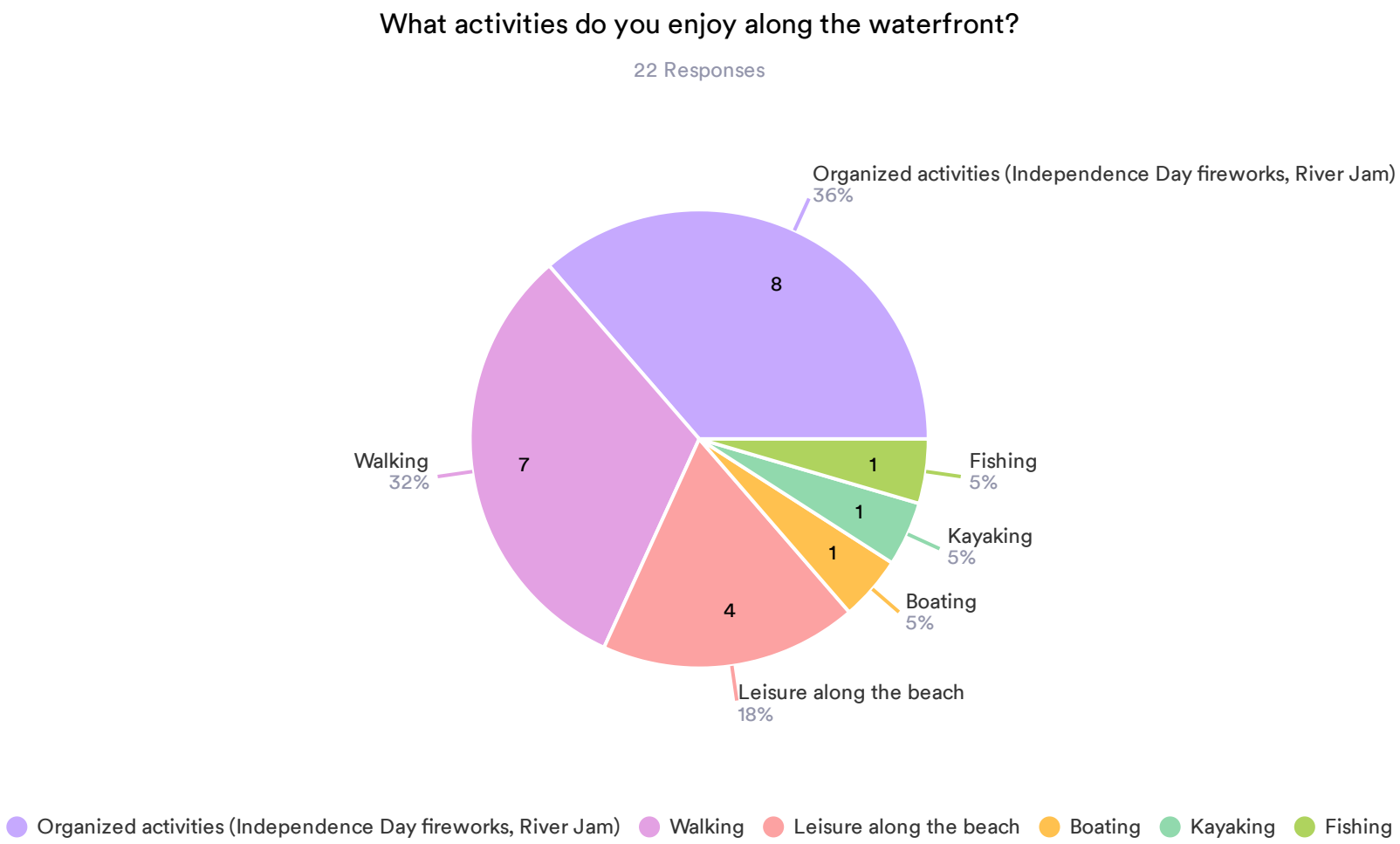
Ossining Survey Questions

How do you usually travel to Ossining's waterfront?

14 Responses



Ossining Survey Questions



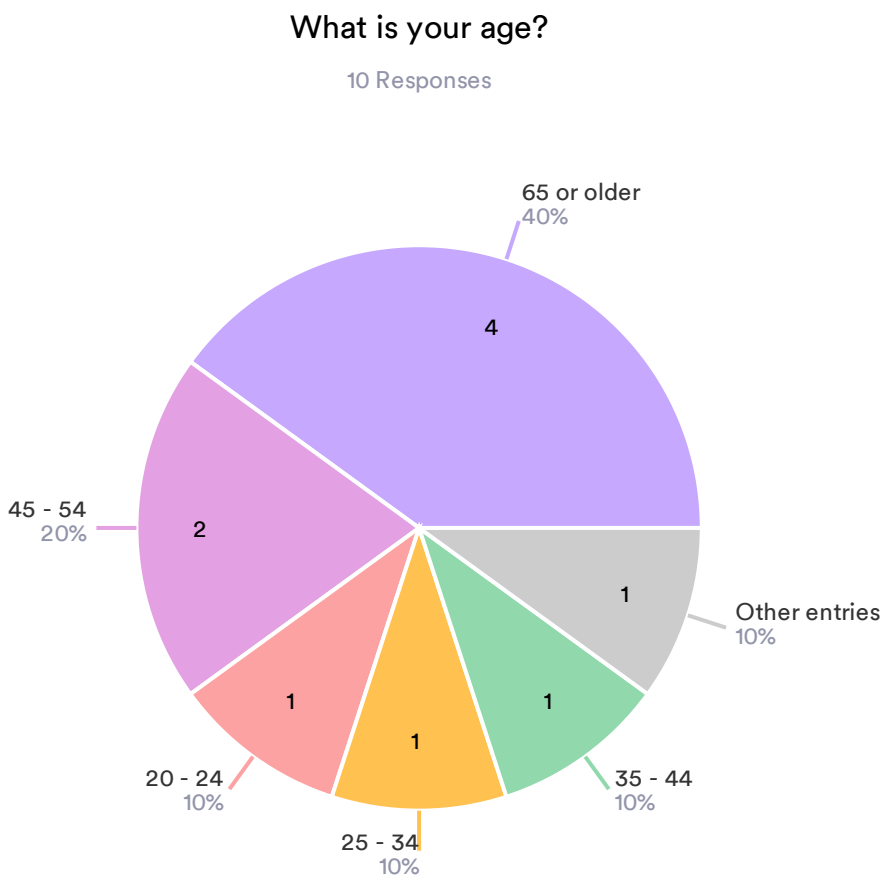
Ossining Survey Questions

What is your ZIP code?

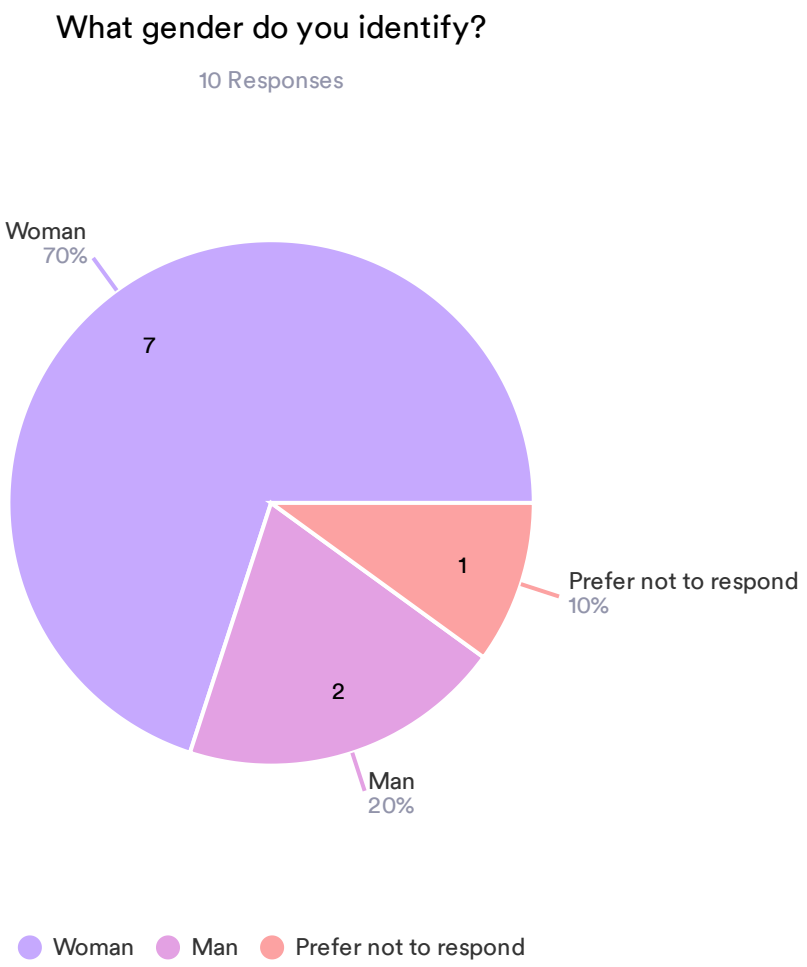
9 Responses

Data	Responses
10562	9

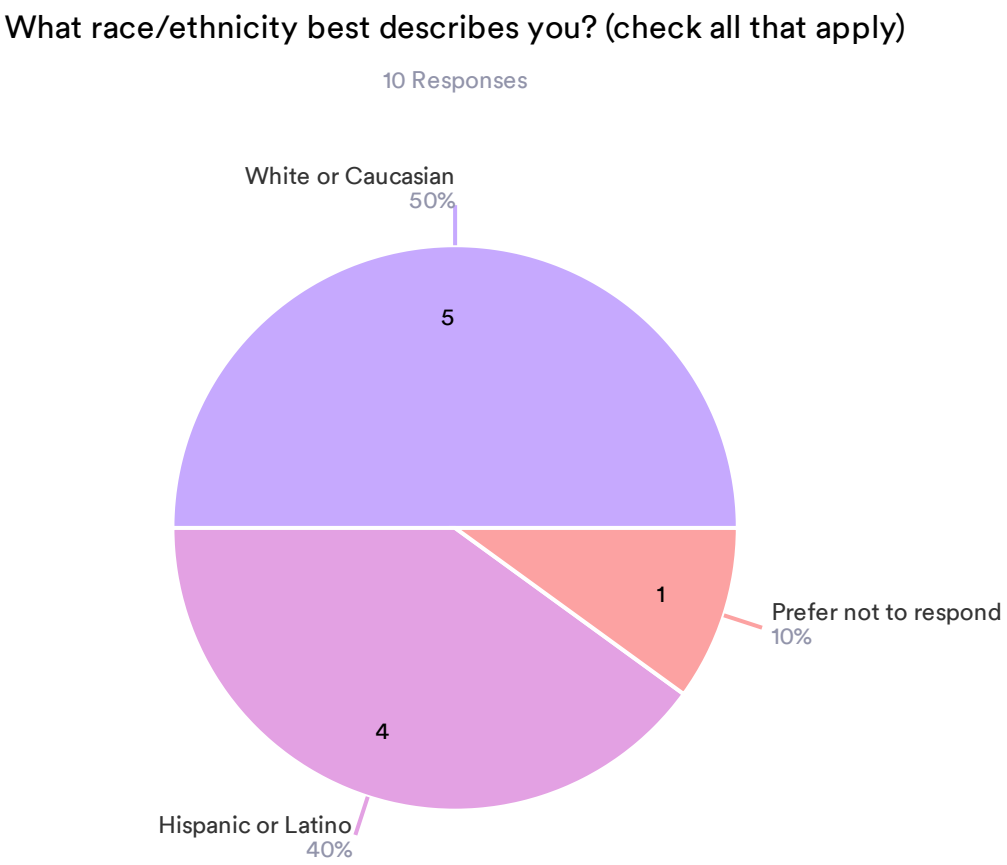
Ossining Survey Questions



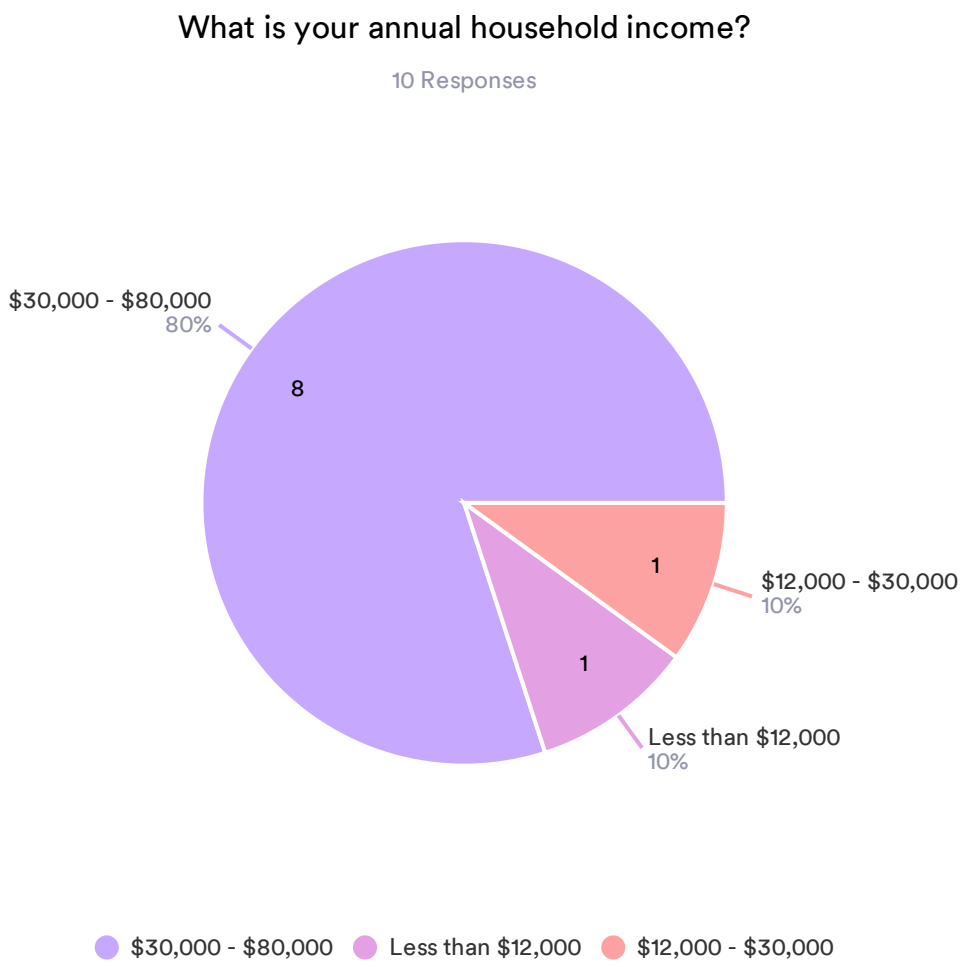
Ossining Survey Questions



Ossining Survey Questions



Ossining Survey Questions



Ossining Survey Questions

If you would like to hear about future project updates, please share your email.

4 Responses

Data	Responses
caitlinpointer@aol.com	1
agarrido1@optonline.net	1
rufinaamadiz@yahoo.com	1
Dariaweb@Verizon.net	1

B4

Stakeholder Meeting #2 Presentation and Poster Boards

(November 3, 2022)

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO

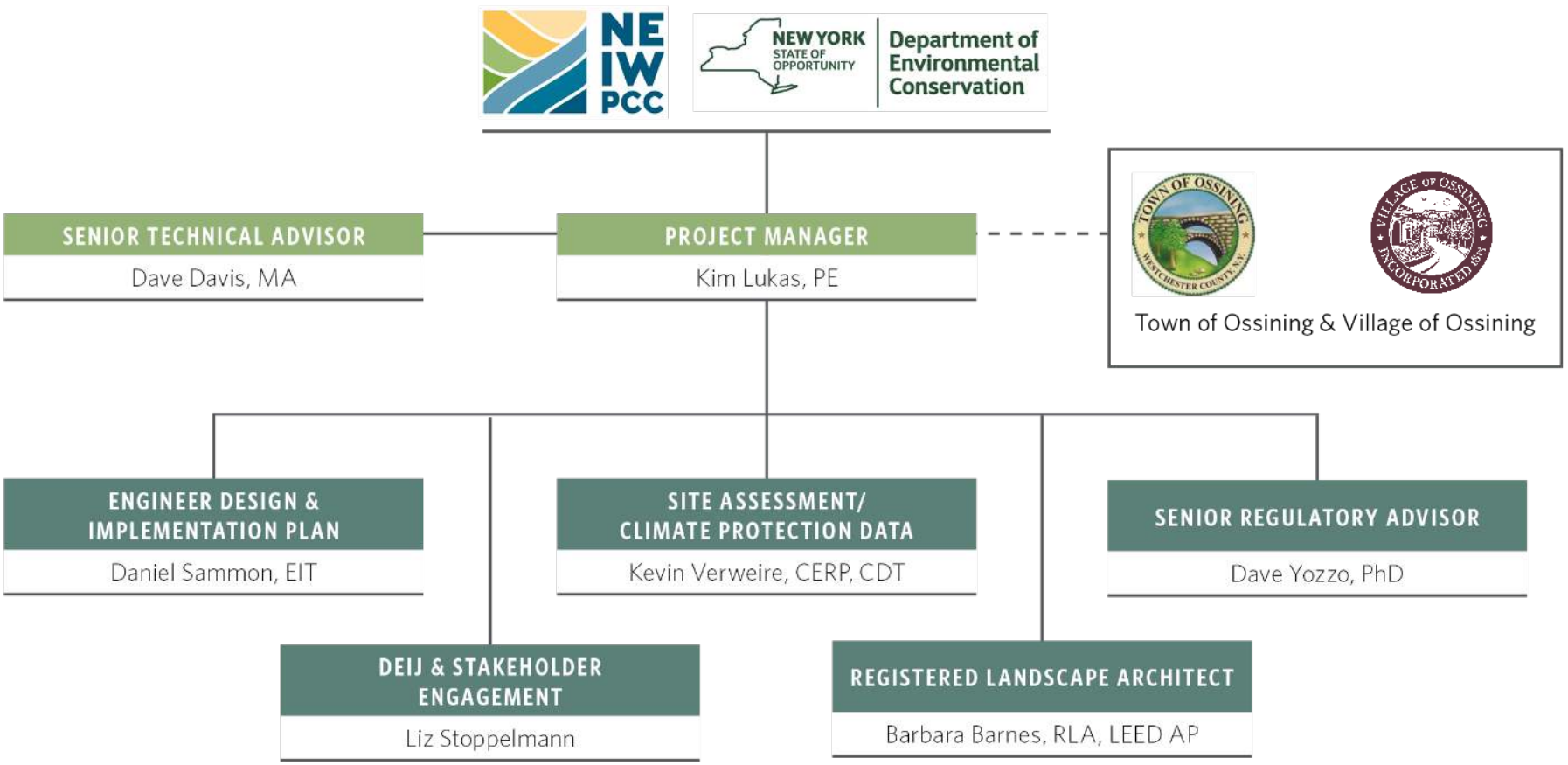
Ossining Shoreline Revitalization & Community Connectivity Improvements Project

Stakeholder Engagement Meeting #2 | Joseph G. Caputo Community Center

11/03/2022

NEW YORK STATE | Department of Environmental Conservation | Hudson River Estuary Program

NE IW PCC


NEIWPCC
NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation
SENIOR TECHNICAL ADVISOR
Dave Davis, MA
PROJECT MANAGER
Kim Lukas, PE
TOWN OF OSSINING
WESTCHESTER COUNTY, N.Y.
VILLAGE OF OSSINING
INCORPORATED 1855
Town of Ossining & Village of Ossining
ENGINEER DESIGN & IMPLEMENTATION PLAN
Daniel Sammon, EIT
SITE ASSESSMENT/ CLIMATE PROTECTION DATA
Kevin Verweire, CERP, CDT
SENIOR REGULATORY ADVISOR
Dave Yozzo, PhD
DEIJ & STAKEHOLDER ENGAGEMENT
Liz Stoppelmann
REGISTERED LANDSCAPE ARCHITECT
Barbara Barnes, RLA, LEED AP

01

Meeting Objectives

Meeting Objectives

Share concepts prepared based on community feedback

Review next steps for design

02

Project Overview

Project Overview

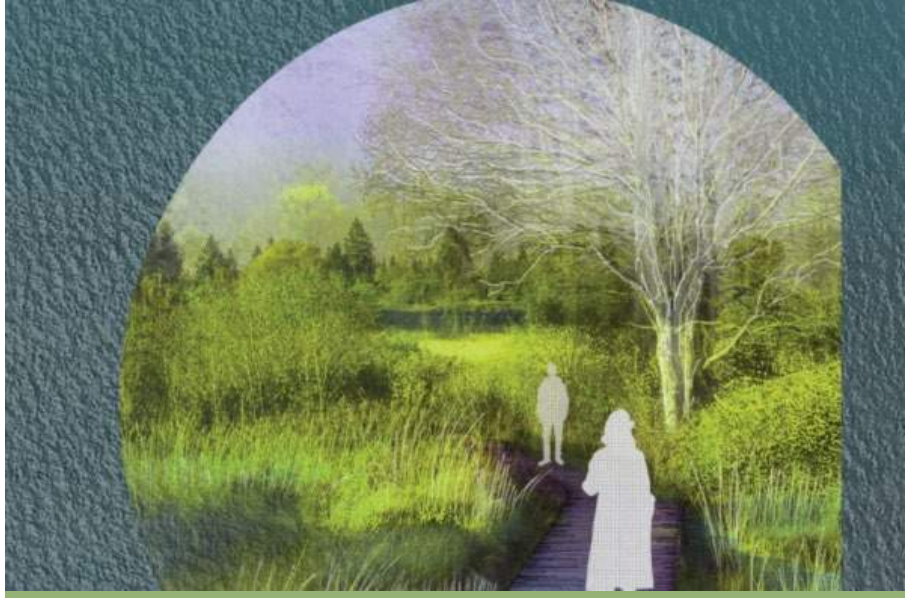
- Ossining's waterfront will be increasingly challenged by sea level rise and climate change
- Community engagement throughout Phase I & II
- Conducted site assessment to understand the potential constraints / opportunities
- Focused project area to public parcels
- Conceptual design for Henry Gourdine Park & Louis Engel Park area
- Design will keep other park improvement projects / DRI funded projects in mind, providing a staged approach to improving resiliency

From Patch.com, October 30, 2012

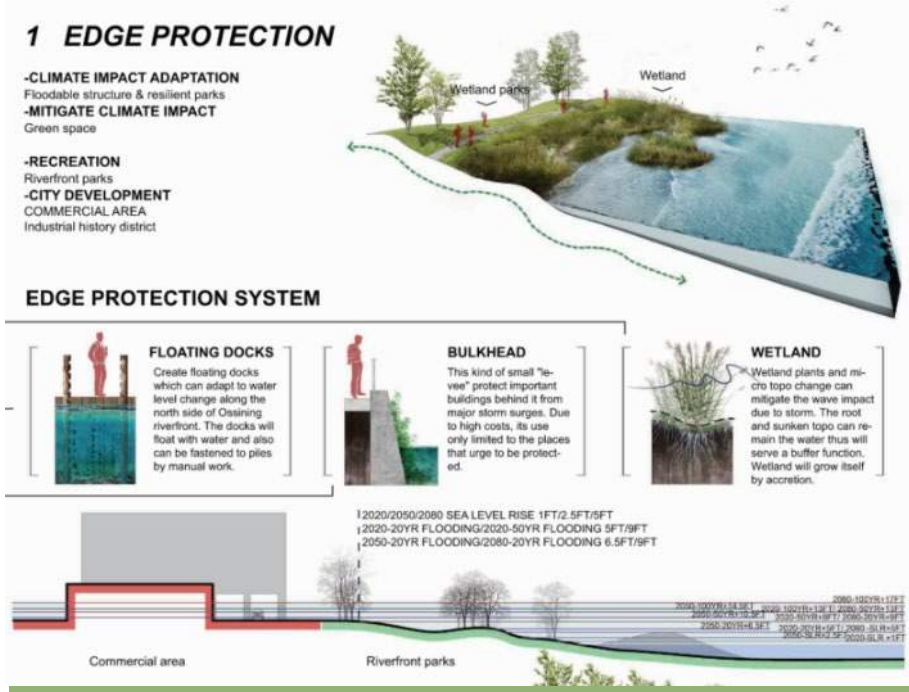
Ossining Flooding

Design Objective

1. Be cost-effective and permittable
2. Align with Ossining's comprehensive plan and Local Waterfront Revitalization Plan
3. Include coastal resiliency/climate adaptation as well as educational or interpretive elements
4. Serve as a model for Diversity, Equity, Inclusion, and Justice



Sing Sing Fugue CAD Concept



Eco-Line CAD Concept

Climate Change Impacts

- Sea level rise poses a risk to Ossining's waterfront
- Water elevations projected to rise 0.75 - 2.5 feet by 2050 and 1.25 to 9.5 feet by 2100 in the lower Hudson River Estuary (NYSDEC)
- Increased water level means increased risk of flooding and storm surge with coastal areas of NY

Depths of temporary flooding anticipated in the "100-year" or 1% flood zone on the Ossining waterfront for the present-day baseline condition.

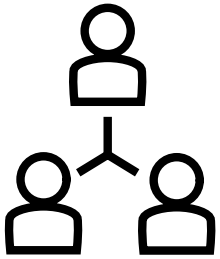
Inundation depths (blue) and temporary flooding depths (green) for the "100-year" or 1% flood condition on the Ossining waterfront with 60"of projected sea-level rise during the 2080's.

Data source: Columbia University Hudson River Flood Impact Decision Support System Version 2

03

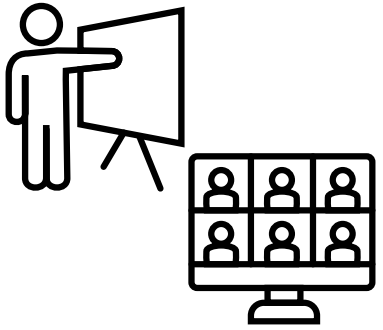
Community Engagement

Diversity, Equity, Inclusion & Justice



Partnership in the community

In-language materials

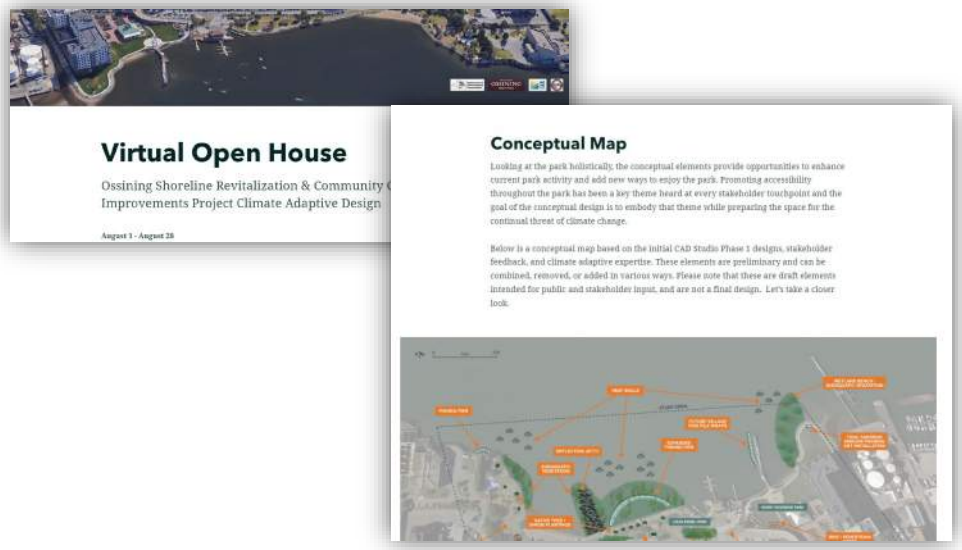


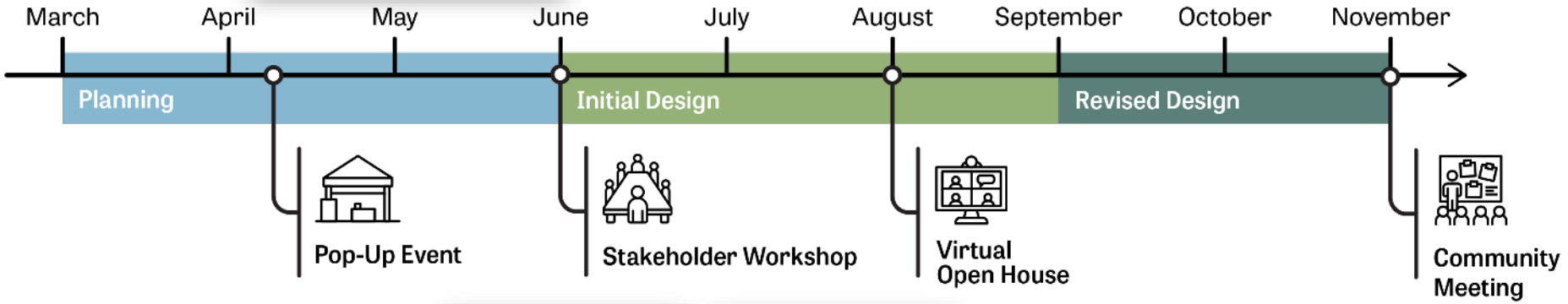
Accessible community engagement opportunities

CAD Phase 1 Engagement

1. Site Visit
2. Community Workshop
3. Refined design based on community feedback
4. Shared final designs with the community

Phase 2 Engagement





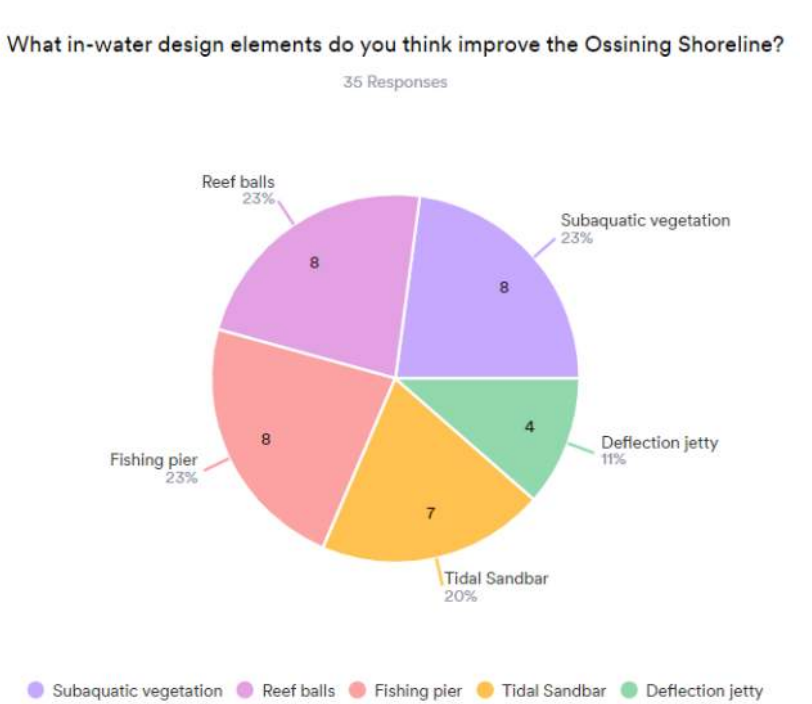
Summary of Community Feedback

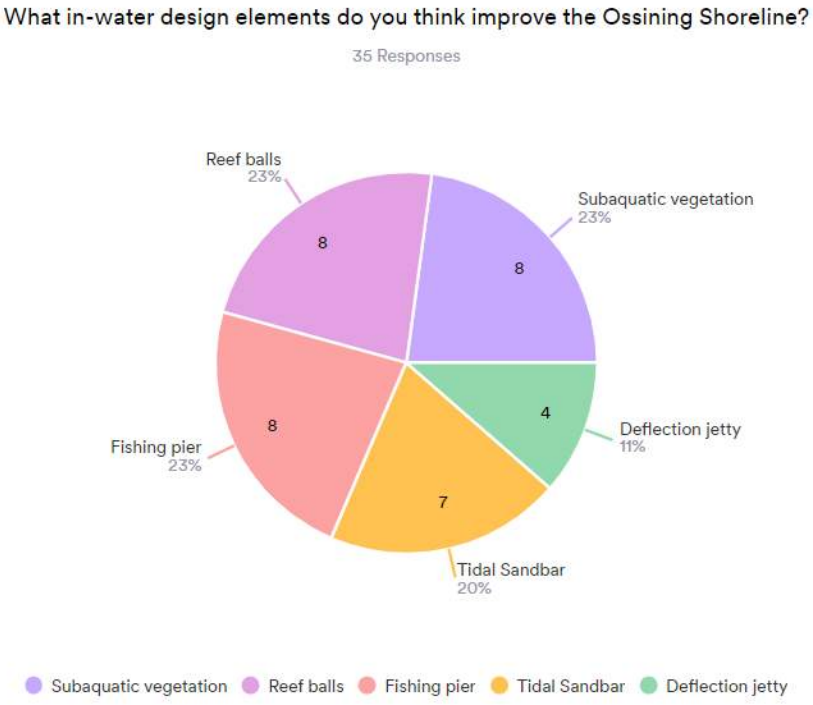
What does a resilient waterfront look like?

- Native plants
- Flood proofed structures
- Drainage for flooding

Themes heard:

- Promote accessibility for all users
- Opportunities to promote in-water activities
- Educational and directional signage
- Promote usable spaces and parking
- Consideration of new and existing structures for climate adaptive design





04

Conceptual Design Update

Conceptual Design Update

Conceptual Design Update: Sheetpile Wall

SHEETPILE WALL

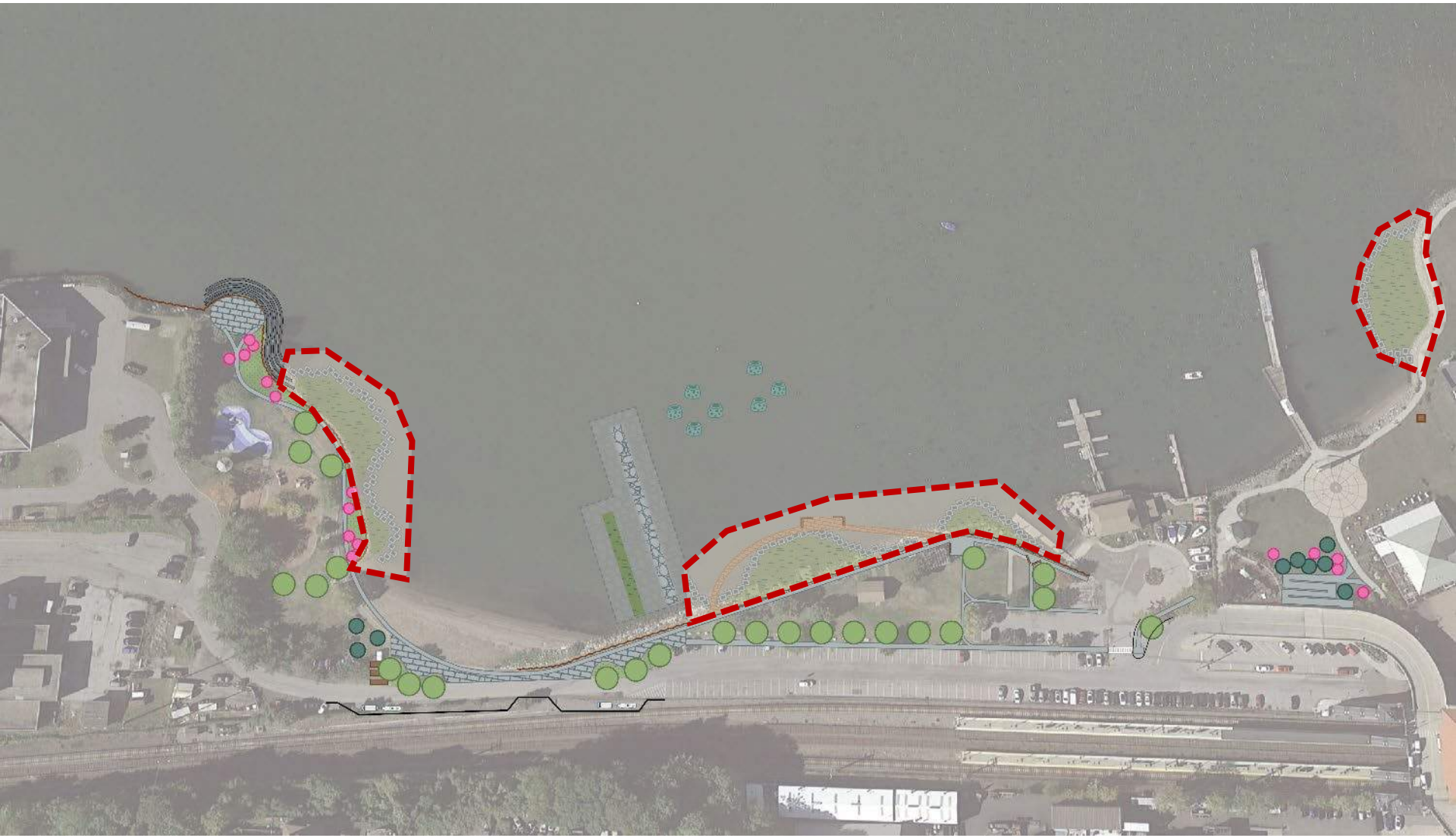
Benefits:

- Allows for installation of marshes without cutting into the slope
- Provides shoreline protection that can be increased in the future by adding height to the wall
- Can provide habitat with concrete hanging applications that add niches for habitat and adhesion of marine species

Next-generation port infrastructure for Living Ports - ECOncrete (econcretetech.com)

Seattle seawall's novel fish features are a potential model for the world | UW News (washington.edu)

Conceptual Design Update: Toe Protection & Emergent Marsh Creation



TOE PROTECTION & EMERGENT MARSH

Benefits of Ecological Toe Protection:

- Provides protection of toe of slope from wave energy
- Tidal pools create unique micro-ecosystems that can allow for educational opportunities
- Concrete supports adhesion of marine species

Benefits of Marsh:

- Dissipates wave amplitude
- Provides water quality improvements
- Supports wildlife

Ecological toe protection for a residential waterfront - ECOncrete (econcretetech.com)

Ecological shorelines for the Port of Rotterdam's infrastructure - ECOncrete (econcretetech.com)

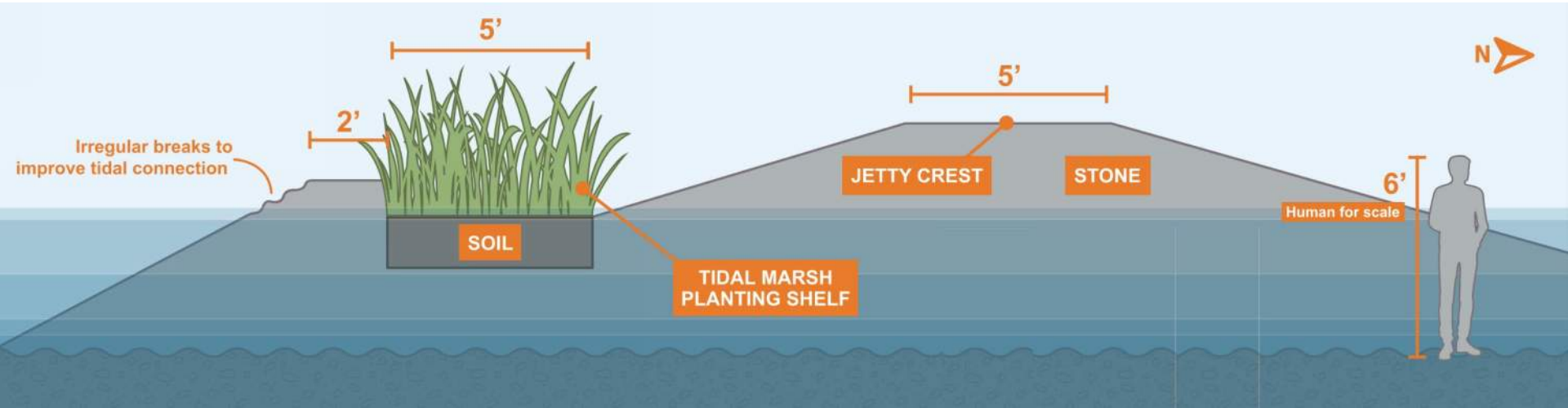
Conceptual Design Update: Rock Jetty

ROCK JETTY

Benefits:

- Limits accumulation of woody debris on beach
- Can be designed with a plantable shelf for emergent marsh species
- Provides wave energy attenuation

Rock jetty at Sandy Point Photograph by Ben Schumin - Fine Art America



Conceptual Design Update: In-Water Habitat

IN-WATER HABITAT

Benefits:

- Reef balls provide shelter for juvenile fish species from predators
- Pile Wraps extend useful life of wooden piles by providing structural support and limiting marine borer intrusion
- Allows for adhesion of mollusks, sponges, and other marine species. These species create building blocks and habit for larger species
- Sessile marine species (fixed and do not travel) often improve water quality as they filter passing water, collect bacteria, and process dissolved chemicals such as nitrogen and phosphorous

A Kayaker Raised Over $3K So These 'Reef Balls Could Save Florida's Barrier Reefs | The Inertia

Brooklyn Bridge Park - ECOncrete (econcretetech.com)

Conceptual Design Update: Community Plaza

COMMUNITY PLAZA

Benefits:

- Celebration of nexus between beach access, playground, and parking areas
- Creates physical and visual separation to parking area

Ketcheson Neighbourhood Park | Richmond, Canada (worldlandscapearchitect.com)

New Ludgate by Gustafson Porter + Bowman « Landscape Architecture Platform | Landezine

Conceptual Design Update: Fishing Plaza

FISHING PLAZA

Benefits:

- Enhanced experience
- Stable access to waterfront for fishing
- Opportunity for context appropriate interpretive signage and elements
    - Hudson River Relationship with Fishing
    - Species Identification
    - Consumption Advisories and Regulations

Discover the Revival of this Lesser-Known Neighbourhood in Stockholm (theculturetrip.com)

Researching Food History : Shad fishing

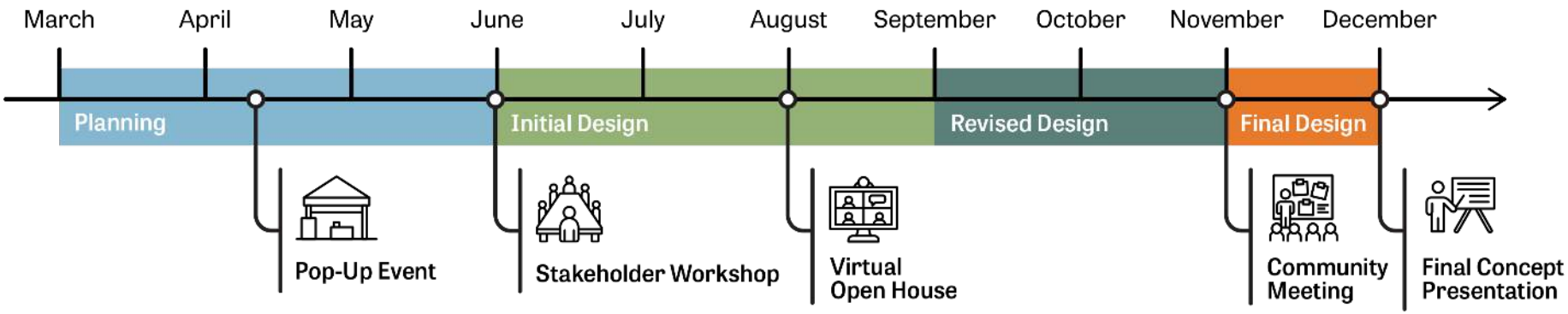
A Fishing Line Stretched Across the Country Gets Recycled | FishingWorld.com

05

Next Steps

Next Steps

- Final conceptual design presentation – Dec. 2022



Questions/Comments

We would like to hear from you.

Explore the designs and provide your input.

Department of Environmental Conservation | Hudson River Estuary Program

SHEETPILE WALL

Allows grades to be lowered to create marsh and in the future the height can be elevated to increase protection.

CONCRETE STEPS

Oversized concrete steps replacing riprap and providing fishing access

WETLAND TOE PROTECTION WITH TIDAL POOLS (ECONCRETE)

REEF BALLS

PILE WRAPS

PUBLIC ART

FISHING PLAZA

Enlarged fishing plaza with educational signage on fishing size/lot limits, consumption advisories, and other regulations

NATIVE FLOWERING TREES

BUTTERFLY GARDEN

Butterfly garden with interpretive signage.

PROPOSED RELOCATED BATHROOMS & OUTDOOR WASHOFF AREA

Separate from CAD Phase II Project.

KAYAK "SHACKS" STORAGE RACKS

PARALLEL TRAILER PARKING

JETTY

Jetty with emergent marsh planting shelf.

COMMUNITY PLAZA

Community plaza with raised pollinator planters and seating.

WATERFRONT ESPLANADE WITH OVERLOOK

Providing seating, open railing section for fishing, and interpretive signage on living shorelines.

NATIVE EMERGENT MARSH VEGETATION

SWING "FRONT PORCH" BENCHES

EVERGREEN SCREENING PLANTINGS

NATIVE SHADE TREES

PROPOSED OUTDOOR EVENT SPACE

Separate from CAD Phase II Project.

PEDESTRIAN CROSSWALK

Extending the existing curbline allows for safe pedestrian movements without inhibiting boat launch access.

ADA PEDESTRIAN RAMP

BE A PART OF THE

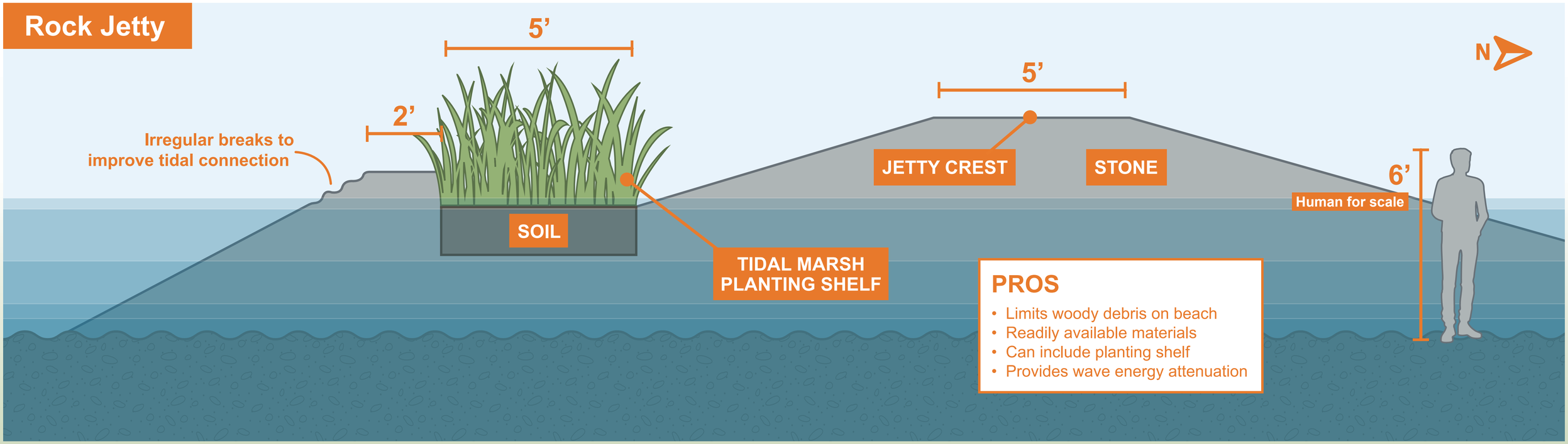
CHANGE

Shoreline Improvements

Ossining Shoreline Revitalization & Community Connectivity Improvements Project

Department of Environmental Conservation | Hudson River Estuary Program

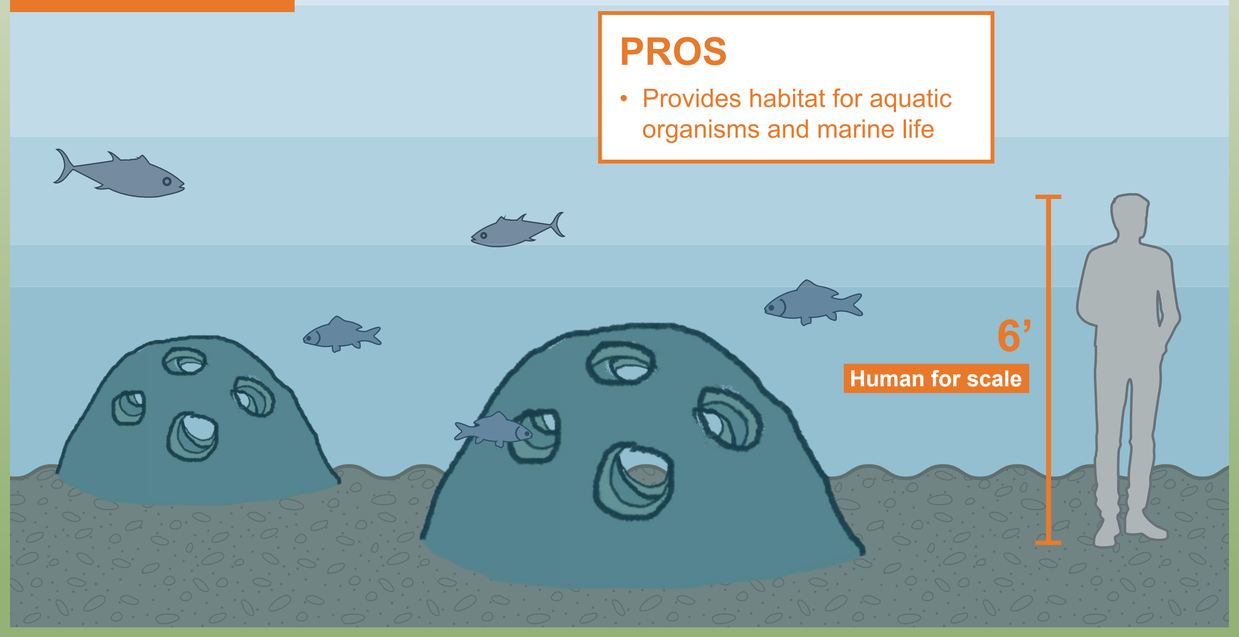
Rock Jetty



PROS

- Limits woody debris on beach
- Readily available materials
- Can include planting shelf
- Provides wave energy attenuation

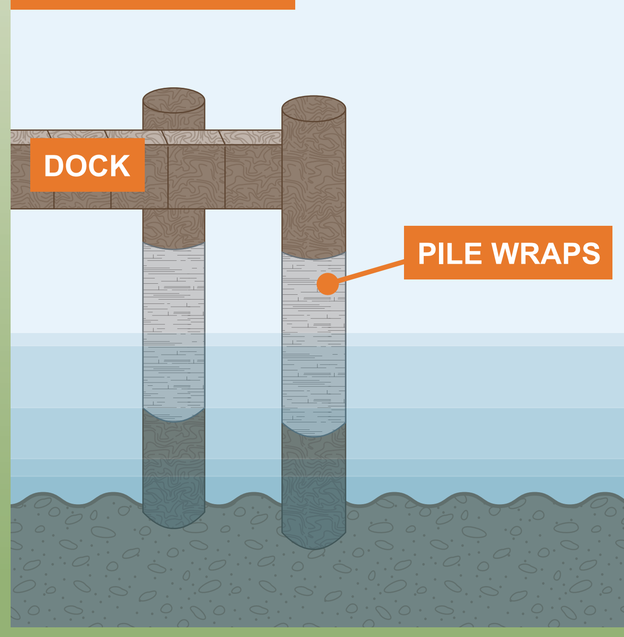
Reef Balls



PROS

- Provides habitat for aquatic organisms and marine life

Pile Wraps



PROS

- Encasement of piles increases the lifespan by limiting marine borers and provides habitat for marine organisms, including crustaceans and mollusks

BE A PART OF THE

CHANGE

In-Water Features

Ossining Shoreline Revitalization & Community Connectivity Improvements Project

Appendix C

Preliminary Design Drawings

SITE AERIAL
SCALE: N.T.S.

Contract Drawings For

Climate Adaptive Design (CAD) Studio Phase II / Shoreline Revitalization and Community Connectivity Project

Preliminary Conceptual Design

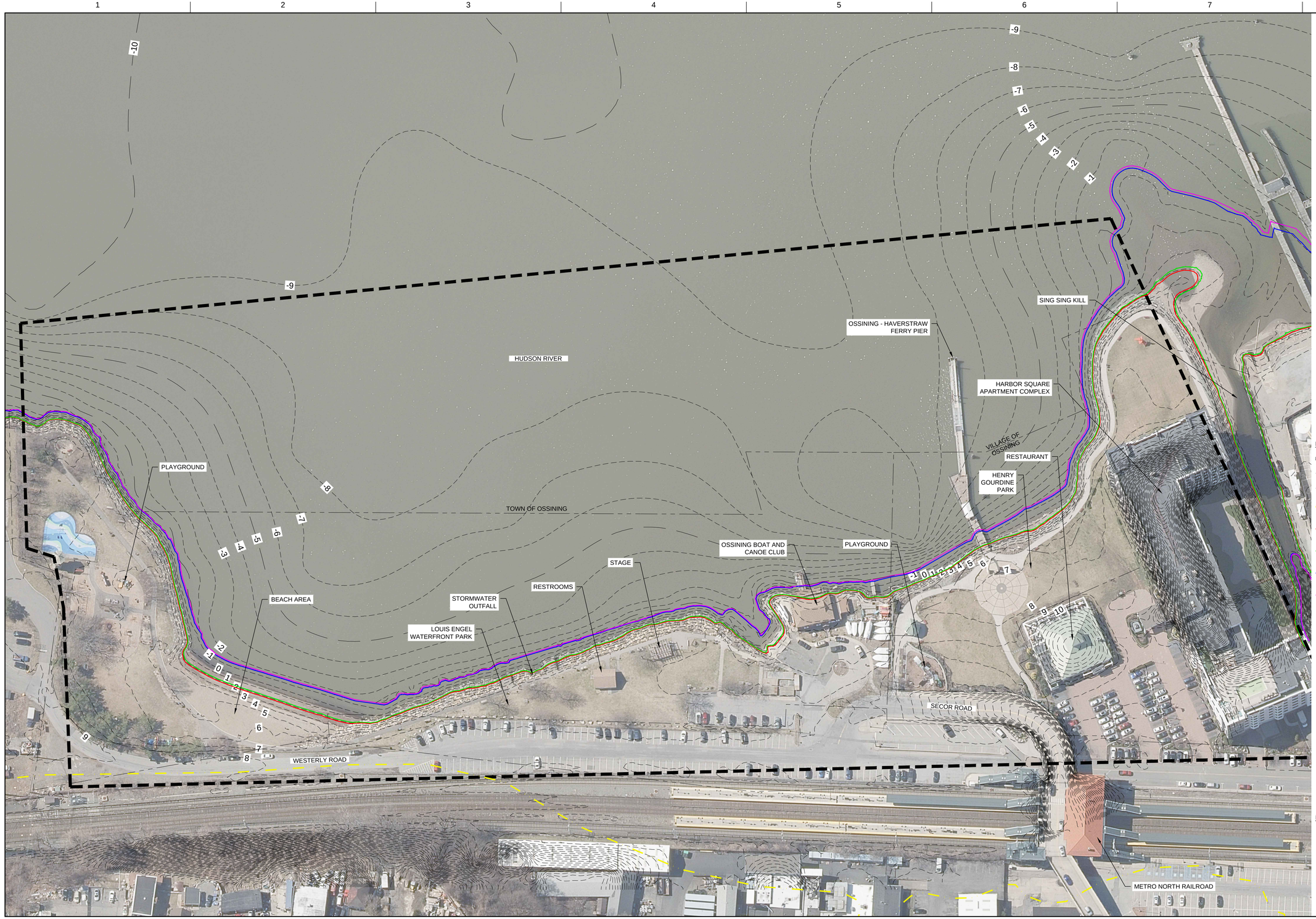
Project No.
000000010327005

Ossining, New York
May 2023

INDEX OF DRAWINGS

THIS DOCUMENT WAS PREPARED FOR THE HUDSON RIVER ESTUARY PROGRAM, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, WITH SUPPORT FROM THE NEW YORK STATE ENVIRONMENTAL PROTECTION FUND, IN COOPERATION WITH NEIWPCC. THE VIEWPOINTS EXPRESSED HERE DO NOT NECESSARILY REPRESENT THOSE OF NEIWPCC OR NYS DEC, NOR DOES MENTION OF TRADE NAMES, COMMERCIAL PRODUCTS, OR CAUSES CONSTITUTE ENDORSEMENT OR RECOMMENDATION FOR USE.

THESE CONCEPT PLANS HAVE BEEN PREPARED USING THE INFORMATION AVAILABLE AT THE TIME OF THEIR PREPARATION. THE PROPOSED PLANS ARE CONSISTENT WITH ENGINEERING INDUSTRY STANDARDS, ADAPTED TO LOCAL CONDITIONS, AND MEETS THE PROJECT GOALS.



LEGEND

- STUDY AREA
- EXISTING CONTOUR
- PROPERTY PARCEL
- FEMA 0.2% ANNUAL CHANCE FLOOD HAZARD AREA ZONE X
- MEAN HIGH HIGH WATER LINE (MHHW) ELEV. = 2.15
- MEAN HIGH WATER LINE (MHW) ELEV. = 1.86
- MEAN LOW WATER LINE (MLW) ELEV. = -1.67
- MEAN LOW LOW WATER LINE (MLLW) ELEV. = -1.84

NOTES:

1. MEAN WATER ELEVATIONS ARE BASED ON DATA COLLECTED VIA DRONE SURVEY ON APRIL 25, 2022 BY HDR ENGINEERING, INC. ELEVATIONS ARE PROVIDED IN FEET NAVD88.
2. TIDAL ELEVATIONS ARE BASED ON DATA COLLECTED FROM NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION'S VDATUM TOOL IN OCTOBER 2022. ELEVATIONS ARE PROVIDED IN FEET NAVD88 AND SHOULD BE CONSIDERED AN ESTIMATE.

ISSUE	DATE	DESCRIPTION
1	03/2023	DRAFT SUBMITTAL FOR CLIENT REVIEW

PROJECT MANAGER	K. LUKAS
DESIGNED BY	K. LUKAS
DRAFTED BY	J. WYNOHRADNYK
PROJECT NUMBER	000000010327005

PROGRESS DRAWINGS
NOT FOR CONSTRUCTION

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PHASE II / SHORELINE REVITALIZATION AND COMMUNITY CONNECTIVITY PROJECT / OSSINING, NY

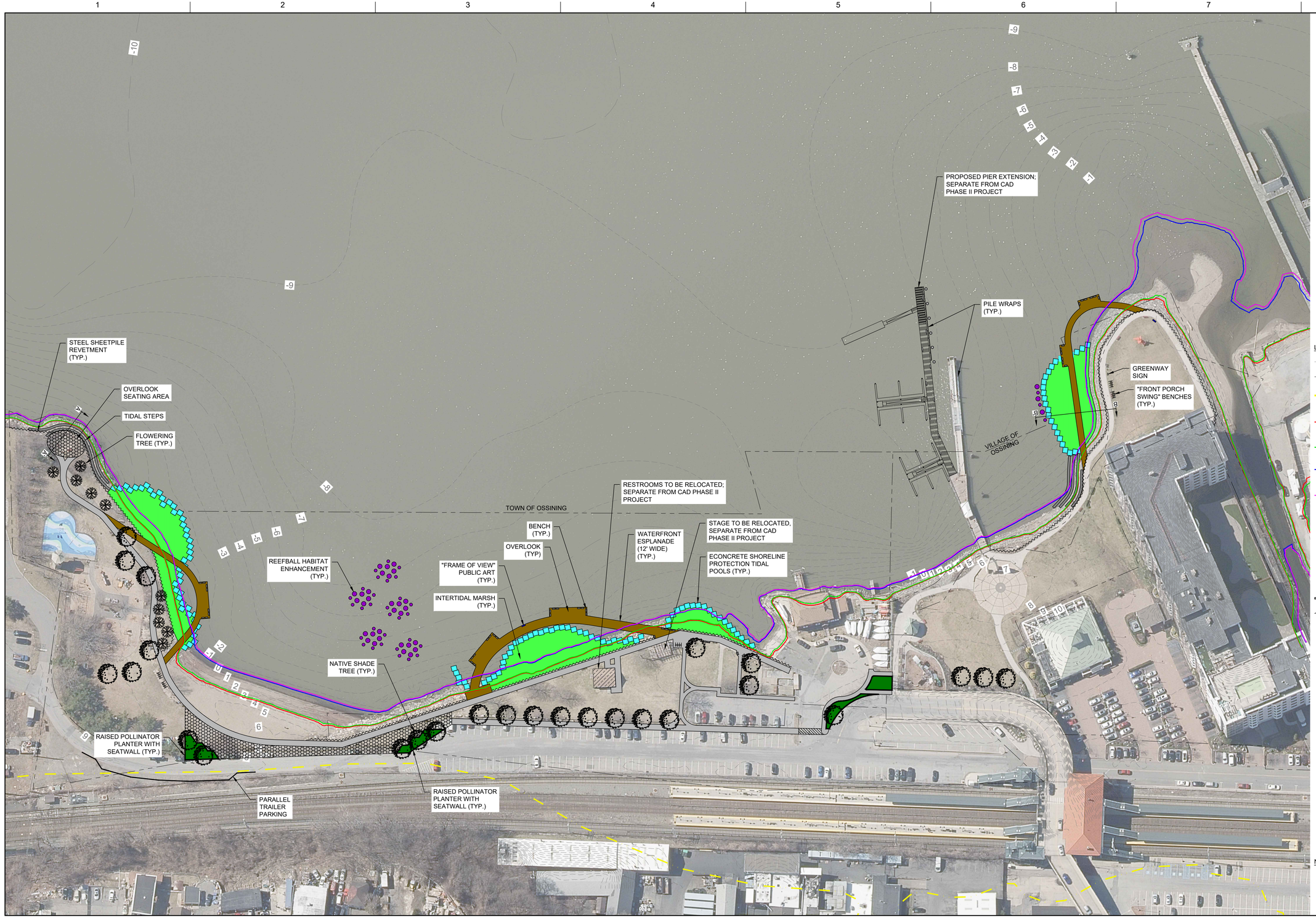
EXISTING CONDITIONS PLAN

0 60' 120'

FILENAME -

SCALE 1" = 60'

SHEET
V-101



LEGEND

- EXISTING CONTOUR
- PROPERTY PARCEL
- FEMA 0.2% ANNUAL CHANCE FLOOD HAZARD AREA ZONE X
- PROJECTED MEAN HIGH HIGH WATER LINE (MHHW) ELEV. = 3.45 (SLR 2050)
- PROJECTED MEAN HIGH WATER LINE (MHW) ELEV. = 3.16 (SLR 2050)
- PROJECTED MEAN LOW WATER LINE (MLW) ELEV. = -0.37 (SLR 2050)
- PROJECTED MEAN LOW LOW WATER LINE (MLLW) ELEV. = -0.54 (SLR 2050)
- PROPOSED PATH
- PROPOSED PLAZA
- PROPOSED ESPLANADE
- PROPOSED MARSH
- PROPOSED ECONCRETE SHORELINE PROTECTION TIDAL POOLS
- PROPOSED TIDAL STEPS
- PROPOSED SHEETPILE WALL
- PROPOSED BENCH
- PROPOSED "FRONT PORCH SWING" BENCH
- PROPOSED SIGN
- PROPOSED "FRAME OF VIEW" PUBLIC ART
- PROPOSED NATIVE SHADE TREE
- PROPOSED FLOWERING TREE
- PROPOSED RAISED POLLINATOR PLANTER WITH SEATWALL
- PROPOSED CROSSWALK
- TO BE REMOVED
- PROPOSED REEF BALL

NOTES:

1. SEA LEVEL RISE PROJECTIONS ARE BASED ON NYS CLIMAID REPORTS, NEW YORK SEA LEVEL RISE MEDIUM PROJECTION. ELEVATIONS ARE PROVIDED IN FEET NAVD88.

ISSUE	DATE	DESCRIPTION
1	03/2023	DRAFT SUBMITTAL FOR CLIENT REVIEW

PROJECT MANAGER	K. LUKAS
DESIGNED BY	K. LUKAS
DRAFTED BY	J. WYNOHRADNYK
PROJECT NUMBER	000000010327005

PROGRESS DRAWINGS
NOT FOR CONSTRUCTION

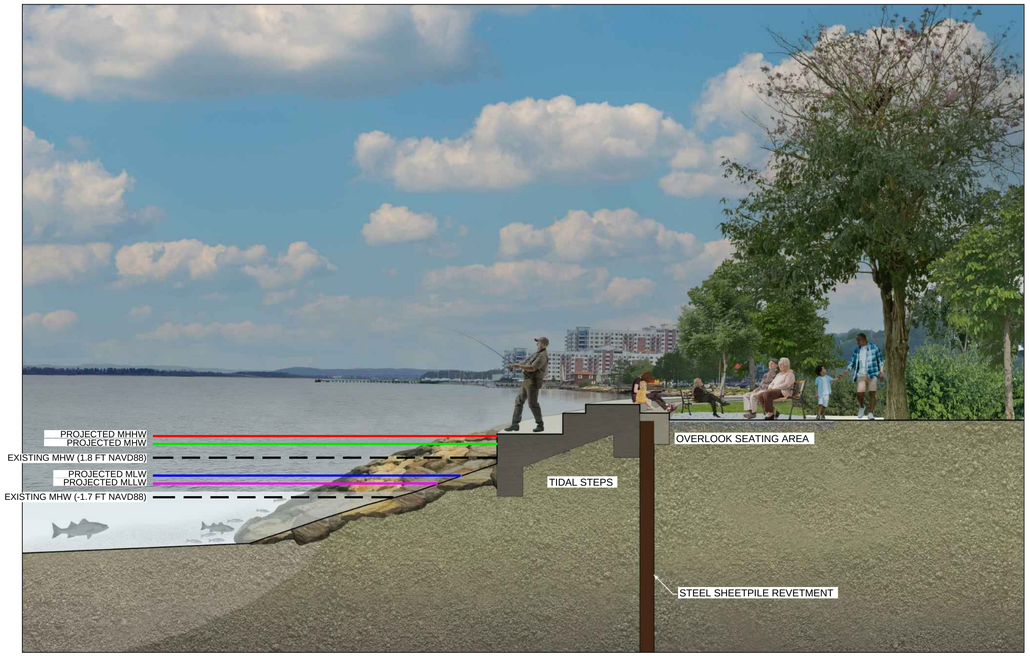
CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PHASE II / SHORELINE REVITALIZATION AND COMMUNITY CONNECTIVITY PROJECT / OSSINING, NY

PROPOSED SITE PLAN

0 60' 120'

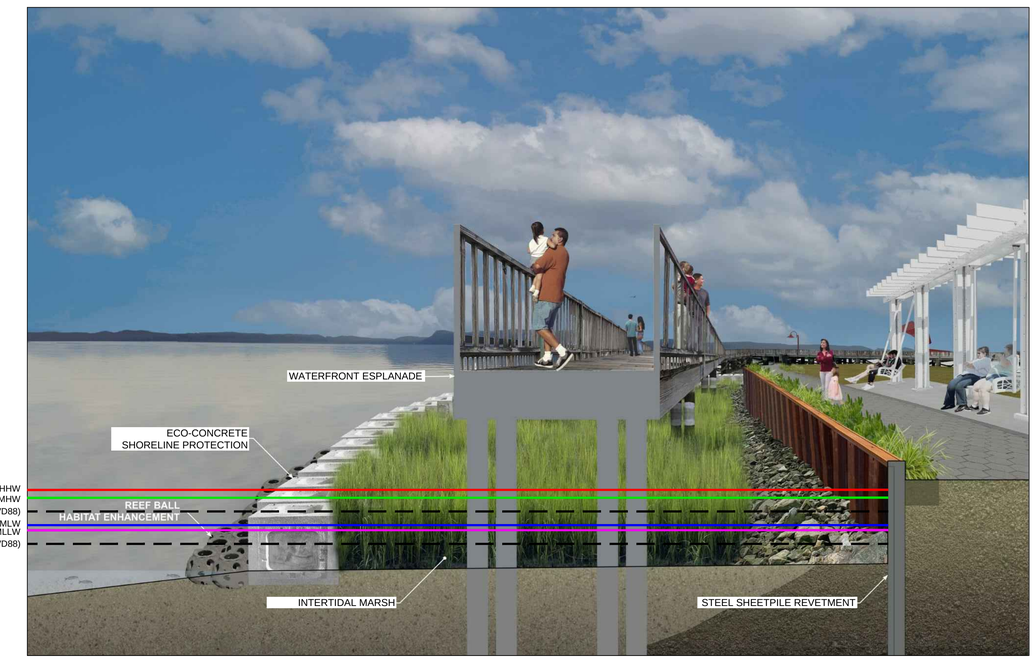
FILENAME -
SCALE 1" = 60'

SHEET
C-101



SECTION A - A'

SCALE: NTS



SECTION B - B'

SCALE: NTS

LEGEND

- PROJECTED MEAN HIGH HIGH WATER LINE (MHHW) ELEV. = 3.45 (SLR 2050)
- PROJECTED MEAN HIGH WATER LINE (MHW) ELEV. = 3.16 (SLR 2050)
- PROJECTED MEAN LOW WATER LINE (MLW) ELEV. = -0.37 (SLR 2050)
- PROJECTED MEAN LOW LOW WATER LINE (MLLW) ELEV. = -0.54 (SLR 2050)

ISSUE	DATE	DESCRIPTION
1	03/2023	DRAFT SUBMITTAL FOR CLIENT REVIEW

PROJECT MANAGER	K. LUKAS
DESIGNED BY	K. LUKAS
DRAFTED BY	J. WYNOHRADNYK
PROJECT NUMBER	000000010327005

PROGRESS DRAWINGS
NOT FOR CONSTRUCTION

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PHASE II / SHORELINE REVITALIZATION AND COMMUNITY CONNECTIVITY PROJECT / OSSINING, NY

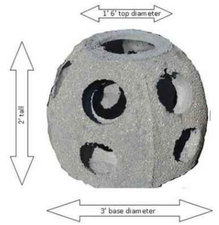
SECTIONS

0 60' 120'

FILENAME -
SCALE NTS

SHEET
C-301

Bay Ball Module

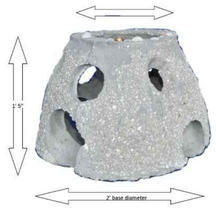


- 2' tall
- 3' feet base diameter
- surface area 40 sq ft
- average number of holes 14
- wavy bottom
- interconnecting holes
- aggregated exposed outside surface texture
- Weight 500 lbs
- Easy to deploy
- Great for shallow water
- Works well with docks

Source: Reef Innovations: https://reefinnovations.com/products-specs/reef-balls/198-2

1 - BAY BALL MODULE
N.T.S.

Lo-Pro Reef Ball



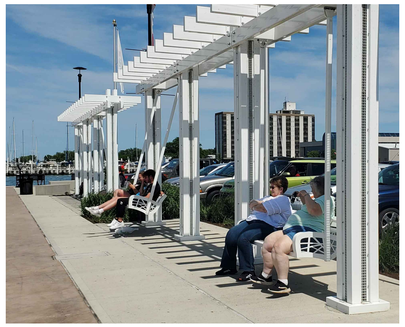
- 1' 5 "tall
- 2' diameter
- surface area 17 sq ft
- weight 200 lbs.
- average number of holes 12
- wavy bottom
- interconnecting holes
- fiber reinforced marine grade concrete
- pH is neutralized or adjusted to request
- aggregated exposed outside surface texture

Modules may vary in weight and height, from the production process.

Source: Reef Innovations: https://reefinnovations.com/products-specs/reef-balls/lo-pro

2 - LO-PRO REEF BALL
N.T.S.

3 - PILE WRAP
N.T.S.

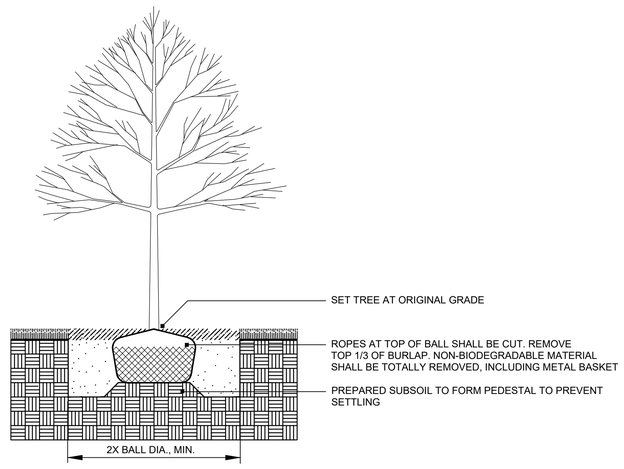


4 - FRONT PORCH SWING
N.T.S.

Source: VIMS. Sept. 2017. Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments.

5 - LOW MARSH
N.T.S.

6 - ECOCRETE BLOCK
N.T.S.



7 - TREE PLANTING DETAIL
N.T.S.

ISSUE	DATE	DESCRIPTION
1	03/2023	DRAFT SUBMITTAL FOR CLIENT REVIEW

PROJECT MANAGER	K. LUKAS
DESIGNED BY	K. LUKAS
DRAFTED BY	J. WYNOHRADNYK
PROJECT NUMBER	000000010327005

PROGRESS DRAWINGS
NOT FOR CONSTRUCTION

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PHASE II / SHORELINE REVITALIZATION AND COMMUNITY CONNECTIVITY PROJECT / OSSINING, NY

DETAILS

0 60' 120'

FILENAME -
SCALE -

SHEET
C-501

Appendix D

NYSDEC Pre-Application Meeting

(February 13, 2023)

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO

Ossining Shoreline Revitalization & Community Connectivity Improvements Project

Permitting Strategy Meeting

13 Feb 2023

NEW YORK STATE | Department of Environmental Conservation | Hudson River Estuary Program

NE IW PCC

AGENDA

01 Intros

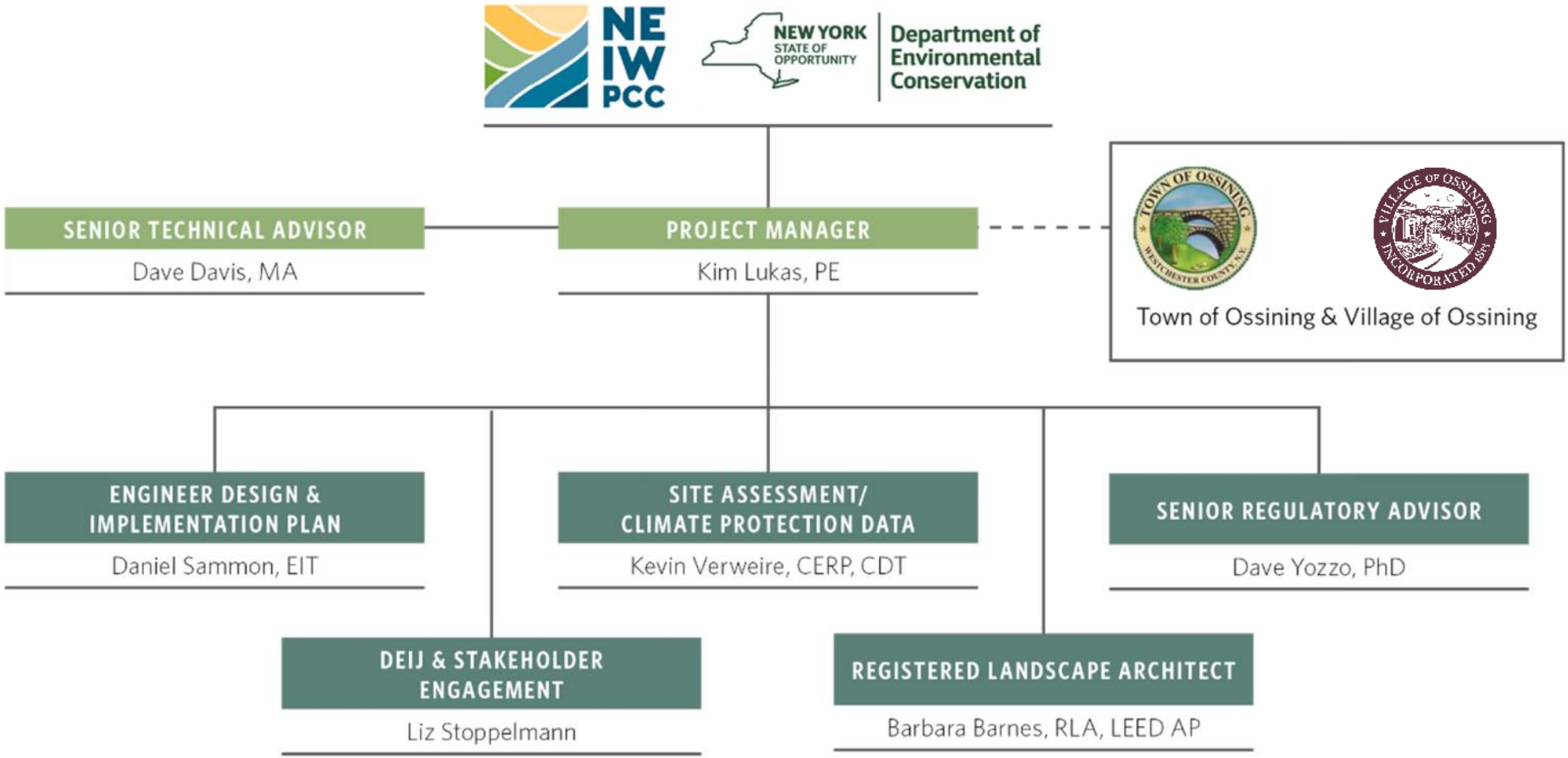
02 Overview of CAD program

03 Design Goals

04 Review Preliminary Drawings

05 Permitting Discussion

06 Next steps


NE IW PCC
NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation
SENIOR TECHNICAL ADVISOR
Dave Davis, MA
PROJECT MANAGER
Kim Lukas, PE
Town of Ossining & Village of Ossining
ENGINEER DESIGN & IMPLEMENTATION PLAN
Daniel Sammon, EIT
SITE ASSESSMENT/ CLIMATE PROTECTION DATA
Kevin Verweire, CERP, CDT
SENIOR REGULATORY ADVISOR
Dave Yozzo, PhD
DEIJ & STAKEHOLDER ENGAGEMENT
Liz Stoppelmann
REGISTERED LANDSCAPE ARCHITECT
Barbara Barnes, RLA, LEED AP

CAD Phase 1 Engagement

1. Site Visit
2. Community Workshop
3. Refined design based on community feedback
4. Shared final designs with the community

Phase 2 Engagement

Virtual Open House

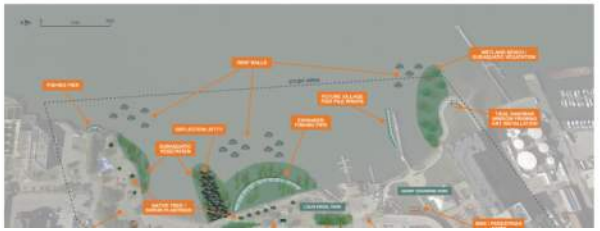
Ossining Shoreline Revitalization & Community (
Improvements Project Climate Adaptive Design

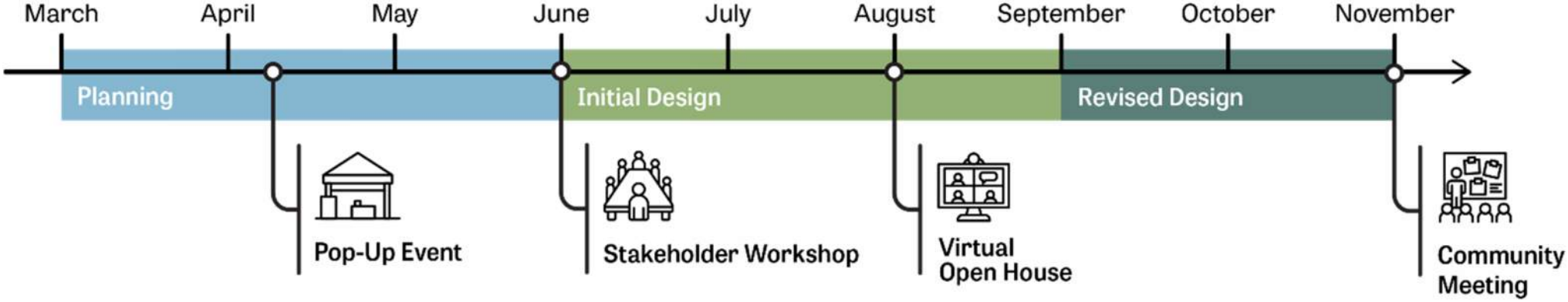
August 1 - August 28

Conceptual Map

Looking at the park holistically, the conceptual elements provide opportunities to enhance current park activity and add new ways to enjoy the park. Promoting accessibility throughout the park has been a key theme heard at every stakeholder touchpoint and the goal of the conceptual design is to embody that theme while preparing the space for the continual threat of climate change.

Below is a conceptual map based on the initial CAD Studio Phase 1 designs, stakeholder feedback, and climate adaptive expertise. These elements are preliminary and can be combined, removed, or added in various ways. Please note that these are draft elements intended for public and stakeholder input, and are not a final design. Let's take a closer look.





Project Overview

- Ossining's waterfront will be increasingly challenged by sea level rise and climate change
- Community engagement throughout Phase I & II
- Conducted site assessment to understand the potential constraints / opportunities
- Focused project area to public parcels
- Conceptual design for Henry Gourdine Park & Louis Engel Park area
- Design will keep other park improvement projects / DRI funded projects in mind, providing a staged approach to improving resiliency

From Patch.com, October 30, 2012

Ossining Flooding

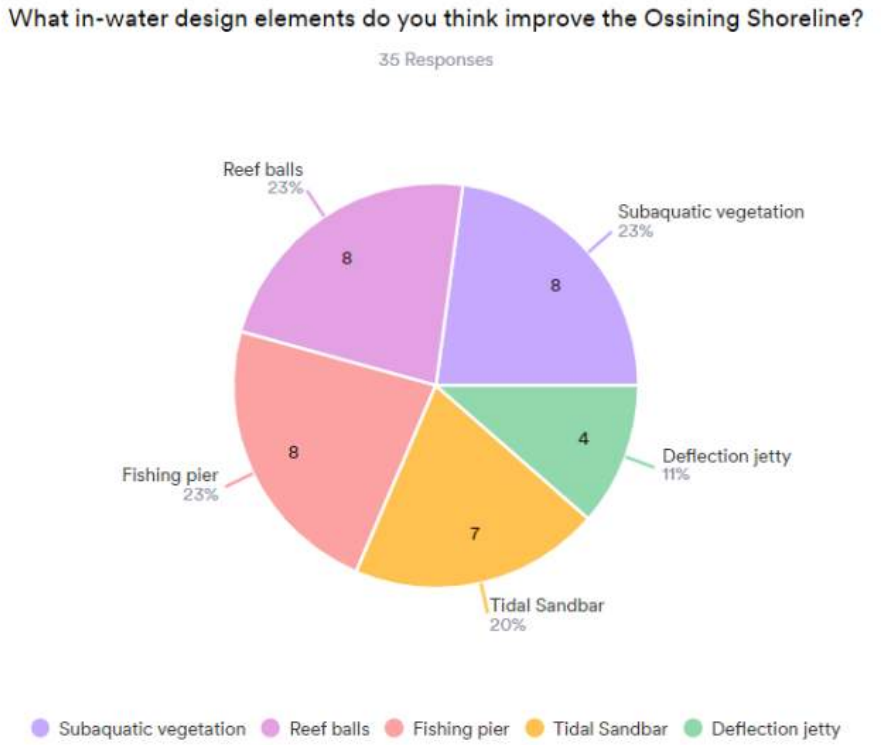
Summary of Community Feedback

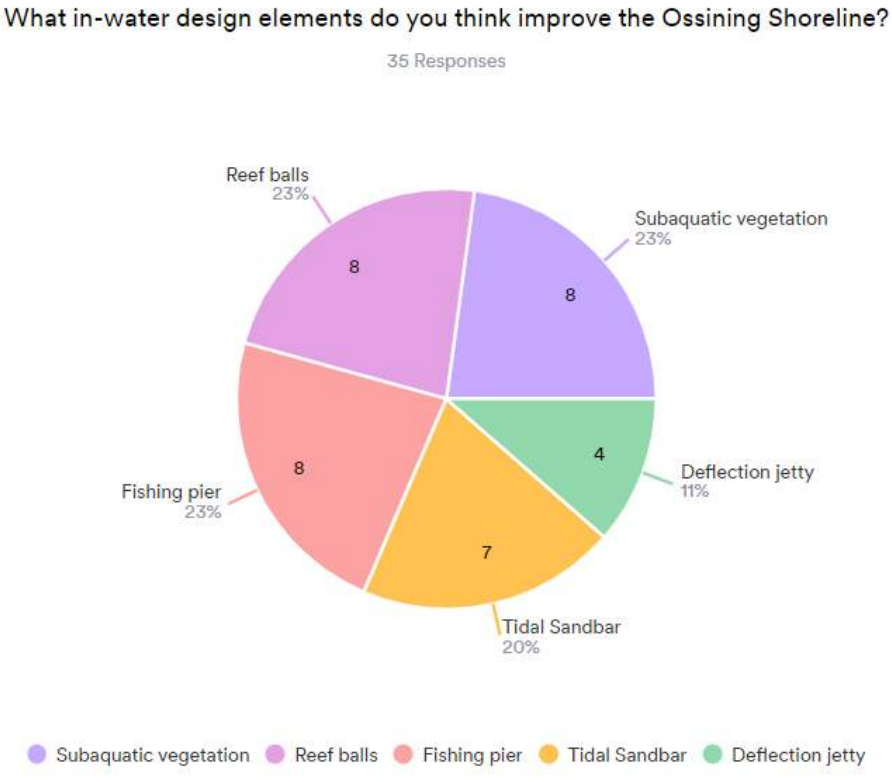
What does a resilient waterfront look like?

- Native plants
- Flood proofed structures
- Drainage for flooding

Themes heard:

- Promote accessibility for all users
- Opportunities to promote in-water activities
- Educational and directional signage
- Promote usable spaces and parking
- Consideration of new and existing structures for climate adaptive design

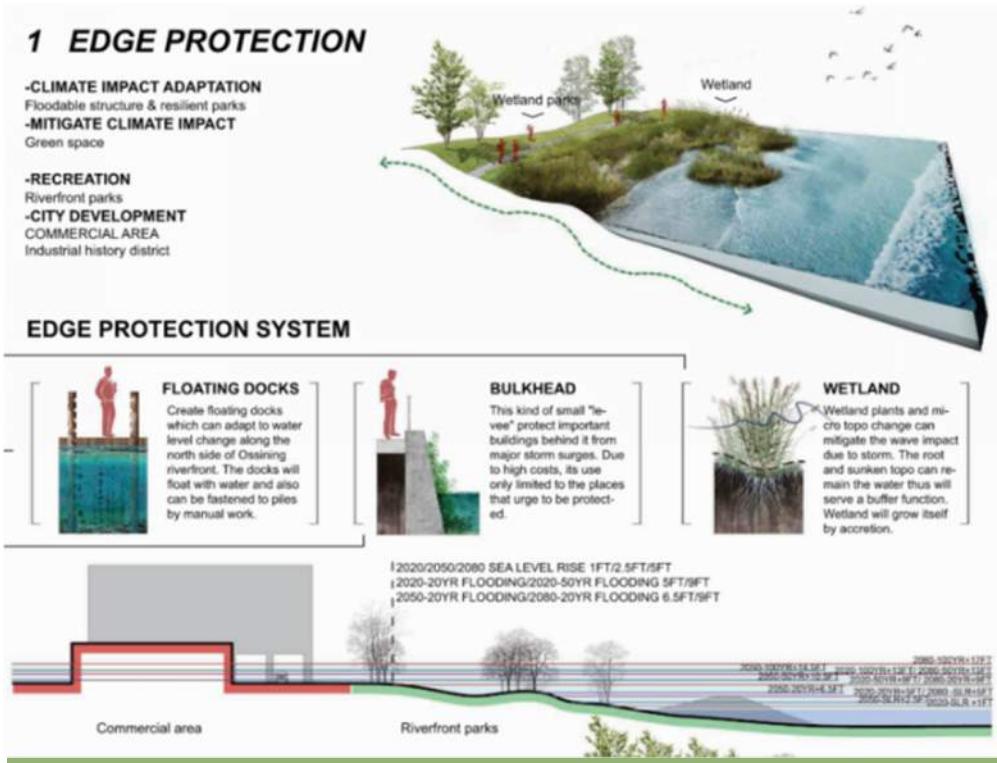




Design Objectives

1. Be cost-effective and permittable
2. Align with Ossining's comprehensive plan and Local Waterfront Revitalization Plan
3. Include coastal resiliency/climate adaptation as well as educational or interpretive elements
4. Serve as a model for Diversity, Equity, Inclusion, and Justice

Sing Sing Fugue CAD Concept



Eco-Line CAD Concept

Meeting Minutes

Project:	Ossining CAD Phase II
Subject:	Permitting Strategy Meeting – Task 7
Date:	Monday, February 13, 2023
Location:	Webex

Attendees:

HDR:
Dave Davis
Barbara Barnes
Kim Lukas

NYSDEC:
Dan Miller
Libby Zemaitis
Angela Schimizzi
Heather Gierloff
Lyndsey Cooper

1. Introductions
2. Overview of the Cornell Climate Adaptive Design (CAD) Studio program
    a. Phase I
        i. Cornell University landscape architecture students prepared high level concepts to improve the resiliency of the Ossining shoreline
        ii. site visit, community workshop, refined designs based on community feedback
    b. Phase II (current)
        i. Pop up event at the Ossining earth day festival
        ii. 2 stakeholder workshops
        iii. Virtual open house
        iv. Permitting strategy meeting
3. Design goals for the Ossining Shoreline Revitalization and Community Connectivity Project
    a. Be cost-effective and permittable.
    b. Align with Ossining's comprehensive plan and Local Waterfront Revitalization Plan.
    c. Include coastal resiliency/climate adaptation as well as educational or interpretive elements.
    d. Serve as a model for Diversity, Equity, Inclusion, and Justice.
4. This permitting review is focusing on the habitat aspect; will require additional permitting reviews in the future, as the design progresses. This meeting is the first step of a much larger process.
5. Review of the project's preliminary drawings & permitting discussion:
    a. Concrete steps
        i. May attract the public to enter the water in an area of swift currents. Should be designed in a way to consider safety issues.
        ii. Consider different materials for concrete steps so not slippery when wet
        iii. Consider how it will hold up over time. Will see a lot of flow / wave action from boat traffic. Would need to evaluate different products / rock sizes (later phase).

b. Sheetpile walls
    i. DEC has not previously encouraged their use. Where existing in parks, they have been cut down and capped with fill.
    ii. Main benefit for sheetpile is reducing in-water fill. Consider how to balance the cut/fill concern.
    iii. Sheetpile wall typically used to contain contaminated sites, confirm if a cutoff wall exists on the Village property.
    iv. Concrete curtains or facia can be attached to sheetpile to extend its useful life and provide texture to increase habitat; however this practice isn't well tested along the Hudson River.
c. Proposed reef ball fields used to protect in-water plantings and for habitat creation.
d. Suggest adding NOAA bathymetry data to show elevations in water, see how it has changed in past 10 years – GIS layer is available from NYSDEC Clearinghouse.
e. DEC has issued permits for fill below MHW for fill at 1:1.5 slope.
f. Identify key locations that provide access to water (dock, pier, boardwalk, etc.) that provides most benefit to all (fishing, ADA accessible, etc.).
g. Everything needs to have a purpose/goal to be permitted; needs to be feasible for the goal to get approved. Multiple boardwalks in the water, may raise the question if it is necessary or if they are a water-dependent use.
h. No real existing subaquatic vegetation due to dynamics of the river and industrial history of the site and adjacent area.
i. Permit application will require cross sections showing sizes and extents of fill / riprap.
j. Marsh areas and boardwalks
    i. Suggest implementing the marsh areas in phases (i.e., one at a time) to ensure there's a benefit after creating one, and the design can be successful, instead of all 3 at once.
    ii. Consider partially filling the wetland creation areas, allowing the river to naturally drop sediment, creating a substrate more suitable for local species and limiting importation of off-site fill.
    iii. Consider removing the center boardwalk to reduce amount of impact to the shoreline; would likely remove the marsh area, as the boardwalk is protecting the marsh from large woody debris and wave energy.
k. Identify existing infrastructure including outfalls especially when designing intertidal plantings that depend on freshwater input
    i. Might be difficult to control flow from stormwater outfalls from roads or parking areas. Outfall volumes are usually unpredictable.
    ii. Typically riprap would remain around outfalls to limit potential erosion.
l. Village property is a cleanup/remediation site; would need to coordinate with the Dept. of Environmental Remediation before doing any excavation.
m. Emphasize that benefit needs to be there in order to be permitted. Must be reasonable and necessary.
n. Consider adding an ADA kayak launch ramp to improve in-water access as opposed to so many boardwalk features.

6. Next steps/Action Items
    a. Finalize preliminary design report and drawings
    b. Coordinate next steps with Ossining
    c. Finalize and distribute permitting meeting notes

Appendix E

Reasonable Order of Magnitude - Opinion of Probable Final Design and Construction Costs

Ossining Climate Adaptive Design
Class V Reasonable Order of Magnitude - Opinion of Probable Construction Costs - April 2023

Category	Item No.	Task	Quantity	UOM	Unit Rate (2023$s)	Total Cost (2023$s)	Assumptions & Notes
Soft Costs							
Site Assessment / Investigation	**1**	Delineation of Wetlands and Waters/Functional Assessment	1	EA	$ 15,000	$ 15,000	Delineation for approx. 1 acre acre site and preparation of stand-alone wetland delineation report
	2	Section 106	1	EA	$ 20,000	$ 20,000	Includes Phase 1A/B archeological survey and coordination with SHPO.
	3	Threatened and Endangered Species Consultation	1	EA	$ 15,000	$ 15,000	Basic habitat assessment, coordination with USFWS and NYSDEC
	4	Phase 1 Environmental Site Assessment	1	EA	$ 25,000	$ 25,000	
	5	State Environmental Quality Review	1	EA	$ 200,000	$ 200,000	Type 1 Action with Full Environmental Assessment Form, but no EIS
	6	Sediment / Geotechnical Sampling	1	EA	$ 180,000	$ 180,000	Sediment sampling to confirm material classification and required management during construction and geotech samples for evaluating esplanade locations
	7	Site survey (property lines, utilities, topography)	1	EA	$ 50,000	$ 50,000	For approx. 1 acre site
		Subtotal				$ 505,000	
Permitting & Engineering Design Development	**8**	Engineering Design Services		POC	10%	$ 655,092	Design 30% through 100%
	9	U.S. Army Corps of Engineers Permitting	1	EA	$ 100,000	$ 100,000	Includes a joint permit with USACE and NYSDEC to address: • Article 25- Tidal Wetlands Permit • Article 15 – Excavation & Fill in Navigable Waters with Water Quality Certification • Coastal Zone Consistency – 15 CFR Part 930 and 19 NYCRR Part 600 • NYS Office of General Services (NYSOGS) – Public Land Law, Article 6 • Essential Fish Habitat (EFH) consultation with National Marine Fisheries Service
	10	NYSDEC Stormwater Permit preparation	1	EA	$ 40,000	$ 40,000	Preparation of SWPPP, NOI, MS4 Acceptance Form, and NOT for SPDES General Permit for Construction
	11	Local Permits and/or Site Plan Review	1	EA	$ 50,000	$ 50,000	
	12	Stakeholder Engagement During Design	1	EA	$ 25,000	$ 25,000	
		Subtotal				$ 870,092	
Engineering Services for	**12**	Design and Engineering During Bid Phase		POC	3%	$ 196,528	Conctractor selection, Contractor interviews, Bid Assistance
	13	Design and Engineering During Construction		POC	4%	$ 262,037	Request for information responses, site visits, coordination with Owner
		Subtotal				$ 458,565	
Construction Costs							
In Water Materials & As Built	**14**	Low Marsh Construction	2603	CYD	$ 72	$ 186,535	Comprised of Clean Sand Fill. 3 ft depth
	15	Overlook Boardwalk	10895	SF	$ 450	$ 4,902,750	Includes pile supports
	16	Sheetpile	1750	LF	$ 30	$ 52,885	RS Means VLF using 30 ft depth
	17	Reef Balls - Low Pro	33	EA	$ 144	$ 4,739	Unit cost estimate provided by supplier
	18	Reef Balls - Bay Ball	33	EA	$ 245	$ 8,084	Unit cost estimate provided by supplier
	19	Eco-Concrete Block Toe Protection	136	EA	$ 2,000	$ 272,000	Unit cost estimate provided by supplier
	20	Permanent Vegetation - Spartina	23427	SF	$ 3	$ 69,591	Plantings for low and high marsh areas
	21	Sediment Excavation & Relocation on Site	1952	CYD	$ 13	$ 25,136	75% of excavated sediment volume can be reused on site. Dpeth of 1 foot
	22	Removal & Disposal of Unusable Sediment / Materials	716	Tons	$ 107	$ 76,873	25% of excavated sediment volume will be disposed of offsite
	23	Pile Wraps	80	EA	$ 117	$ 9,360	10 foot spacing between piles laterally and longitudinally (~386 LF of dock, x2 for # of piles)
	24	Tidal Steps	548	CYD	$ 79	$ 43,079	Assuming Cross sectional area of 61SF
		Subtotal				$ 5,651,032	
Upland Materials and As Built	**25**	Sidewalk	18032	SF	$ 28	$ 507,781	Concrete, 6"x18"
	26	Sidewalk Curb	1503	LF	$ 20	$ 29,745	Concrete
	27	Hexagonal Pavers	9035	SF	$ 18	$ 165,883	RS Means precast concrete patio blocks
	28	Educational Signage/Public Art	3	EA	$ 15,000	$ 45,000	
	29	"Front Porch Swing" Benches	5	EA	$ 4,800	$ 24,000	8 ft Bench at $600/LF
	30	Tree Plantings - Shade / Ornamental	36	EA	$ 2,402	$ 86,460	
	31	Benches	41	EA	$ 660	$ 27,079	
	32	Planter Benches	77	CYD	$ 38	$ 2,945	3 ft high, 75% of block is not solid (planter space); Concrete
	33	File Notice to Mariners During Construction and for Proposed Conditions	1	EA	$ 1,000	$ 1,000	
	34	Metes and Bounds Description for Easements and As-Built Conditions	1	EA	$ 10,000	$ 10,000	To be prepared by a licensed surveyor
		Subtotal				$ 899,892	
General Reqts & Contractor Costs	**35**	Contractor Management		POC	6%	$ 503,075	
	36	Mobilization & Demobilization		POC	5%	$ 419,229	
	37	Soil Erosion and Sediment Control During Construction		POC	0.2%	$ 16,769	
	38	Contractor Bonds & Insurance		POC	1.5%	$ 125,769	
	39	Contractor Profit		POC	8.0%	$ 670,767	
	40	Contractor Direct Expense		POC	5%	$ 419,229	
		Subtotal				$ 2,154,838	
		Total Estimated 2023 Project Cost (without Contingency)				**$ 10,539,419**	
		Contingency		POC	30%	$ 3,161,826	Approx 30% for Class V
		Estimated Potential Cost				**$ 13,701,245**	

DEFINITIONS

CYD	Cubic Yards
EA	Each
FT	Feet
LF	Linear Feet
POC	Percentage of Cost
SF	Square Feet
UOM	Unit of Measure