Climate Adaptive Design (CAD) Studio - Piermont Living Shoreline Project

Village of Piermont, Rockland County, New York

Preliminary Design Report – Version - Final

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1 Project Background

In the fall of 2017, 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 Village of Piermont, New York. Working with the Village, the students developed five independent designs that envisioned a process for future possibilities in Piermont as climate conditions change and flooding and other climate risks pose increasing threats to this community of 2,500 residents located along the Hudson River.

Piermont's location at the confluence of the Sparkill Creek and the Hudson River is understood to be both a great asset and a significant challenge, as it experiences periodic waterfront flooding due to storms, high tides, and sea level rise (NYSDEC 2017a). In 2011, storms Irene and Lee caused significant flooding resulting from stormwater flows in the Sparkill Creek and storm surge in the Hudson River. In the fall of 2012, an historic coastal storm surge from Sandy resulted in severe damage to homes, marinas, boats, and businesses.

Through the community's experience with these storms and the collective planning for risk reduction and greater resilience, the Village of Piermont has a solid foundation of knowledge regarding sea level rise and floodplain adaptation approaches (NYSDEC 2017a). The Village of Piermont wishes to move forward to reduce risk and improve resilience with professional engineering support. In May 2019, 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 feature with cultural/educational amenities on the north side of the existing pier (Figure 1) that would build upon the concepts and design ideas developed by the CAD Studio students.

Figure 1. Aerial Photograph of the Proposed Project Area in Piermont.

2 Review of Existing CAD Concepts

Each of the original CAD Studio designs offered innovative ideas for improving Piermont'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 a permitting, high-level cost-effectiveness and community perspective (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[1] project that aligns with Piermont's existing Waterfront Resiliency Program and Local Waterfront Revitalization Plan (LWRP) (Piermont 2017).

Table 1. Overview of Climate Adaptive Design Concepts.

	Climate Adaptive Design Concepts				
	Piermont Nexus	**Evolve/ Connect/Redefine**	**Re-Appearing Piermont**	**Cultural-Led Adaptation**	**Piermont: The New Beginning**
Measures					
Elevated promenade	x		x	x	
Living shoreline/Ecological buffer	x	x	x		x
Seawalls / berms w/paths	x	x	x		x
Neighborhood relocation		x		x	x
Amphibious / floodproof neighborhoods or facilities	x	x	x	x	x
Break-waters					x
Traffic / Pedestrian improvements	x	x	x	x	x
Stormwater: Green Infrastructure	x (detention pond)			x (green roof)	x (rain garden)

[1] Enhancing coastal resilience is widely recommended as a means of preparing for uncertain future changes while maintaining opportunities for coastal development. However, the term "coastal resilience" is over-used, and poorly defined in the scientific and coastal zone management literature, including guidance documents and resources for restoration practitioners and coastal communities. Masselink and Lazarus (2019) offer the following definition of coastal resilience - "Coastal resilience is the capacity of the socioeconomic and natural systems in the coastal environment to cope with disturbances, induced by factors such as sea level rise, extreme events and human impacts, by adapting while maintaining their essential functions."

	Climate Adaptive Design Concepts				
	Piermont Nexus	**Evolve/ Connect/Redefine**	**Re-Appearing Piermont**	**Cultural-Led Adaptation**	**Piermont: The New Beginning**
Measures					
Educational component	x	x		x (museum)	x (museum)
Resilient marina				x (floating)	
Relocation of critical facilities		x			
Habitat / natural area improvements	x		x	x	x (wetland connections)
Regulatory update regarding construction in flood zone					x

Piermont Nexus proposes a new urban hub with a community park/program space near Flywheel Park, an elevated promenade on the Piermont Pier, and a protective terrace at Ferry Road and Piermont Avenue. Concepts worthy of future consideration include the re-use of construction materials to create a "living edge" along the waterfront and pier for wildlife habitat, the establishment of cultural trails connecting the pier to the old train station and Sparkill Creek, and the creation of car-free spaces north of the pier.

Evolve/Connect/Redefine proposes the creation of a new elevated commercial pier with an ecological buffer located at the north end of the Village as well as the use of seawalls and berms that are also purposed as walking paths to enhance the existing pier. Concepts worthy of additional evaluation include the idea of using an ecological buffer integrated with a pedestrian walkway to protect against wave erosion and reduce potential sediment deposition along the north side of the existing pier.

Re-Appearing Piermont proposes a retreat from southeastern neighborhoods of the Village to allow Piermont Marsh to migrate and expand. It also proposes a walkway through the marsh and elevated walkways on Piermont Avenue with a floodable green corridor below. Concepts worthy of additional consideration include the idea of incorporating green infrastructure into existing buildings such as creating a public green space atop an existing parking garage and incorporating pedestrian walkways into reinforced shoreline features such as floodwalls.

Cultural-Led Adaptation proposes to protect Piermont Avenue with an elevated roadway and to relocate housing on its northern end that are near the water as well as create "amphibious" and flood-proof housing in Bogertown. Concepts worthy of additional evaluation include the creation of a waterfront park along the northern end of Piermont Avenue, the use of green roofscape, and the idea of creating a cultural/educational attraction that links the community to the water.

Piermont: The New Beginning proposes the creation of a resilience museum near Flywheel Park that demonstrates resilience techniques on the pier and solidifies the idea that Piermont is a leader in climate adaptation. Concepts worthy of additional evaluation include the idea of using a cultural/educational attraction as a center point for resilient design and the use of levees and breakwaters to protect the northern end of the pier with a circular bike/walking path on top that bounds the community around the pier.

3 Site Assessment

In advance of the preliminary design development, HDR conducted a detailed site investigation of the proposed project area on September 23, 2019 and on October 4, 2019 (Unmanned Aerial System (UAS), or “drone” survey only). 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 five original CAD Studio concepts (see Section 2) and input from the stakeholder engagement process (see Section 4) were used to identify the potential study area located adjacent to and centered on the water-ward side of Flywheel Park and Parelli Park in the Village of Piermont.

The following activities were conducted during the site assessment in accordance with the approved Quality Assurance Project Plan (QAPP), Version 1 dated August 13, 2019:

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.

In addition, a reference shoreline was surveyed at the southeast end of Piermont Pier (reference site) on September 23, 2019. The objective of the reference site survey was to record the elevation of substrate and shoreline vegetation communities along transects perpendicular to the shore. The data collected from the reference site were used during the development of the preliminary design to specify target plant communities and aid in the understanding of local tidal datums.

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 vertical seawall 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 schools of juvenile Atlantic menhaden (a.k.a. “peanut bunker”), and blue crabs (both live animals, carcasses, and carapace sheds present). Atlantic rangia clam shells were abundant along the shore and in shallow water areas. A few small ribbed mussel shells were observed, but no live mussels were present in the intertidal zone. A single American eel was observed in a tide pool under a rock in 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

During the 15-months of the project development, HDR in conjunction with its project partners (NEIWPCC and NYSDEC) and the Village of Piermont developed and implemented a stakeholder engagement strategy designed to identify appropriate community, municipal and state regulatory staff to engage during the design development. This included regular engagement and coordination with the NYSDEC HREP and Hudson River National Estuarine Research Reserve (HRNERR) staff as well as New York State Department of State (NYSDOS), New York Office of General Services (OGS), and other relevant state and federal regulatory staff. A database of key stakeholders and contact information was maintained by the project partners on a shared website during the course of the project that included summaries of discussions held and information shared with or provided by each key stakeholder.

A stakeholder kick-off meeting was held at the Piermont Village Hall on August 22, 2019 to introduce the HDR design team, review the previous CAD concepts and potential achievable goals of shoreline restoration, discuss the logistics of the site assessment, and discuss the overall goals of the stakeholder and permitting strategies for consideration in the draft preliminary design. The PowerPoint presentation from the stakeholder kick-off meeting is provided in Appendix B of this report.

In addition, the HDR project management team coordinated with the Village of Piermont and the Piermont Waterfront Resiliency Commission (PWRC) to engage local stakeholders on a regular basis that included participation in a public meeting held at the Piermont Village Hall on October 29, 2019 to discuss the living shoreline project as well as other sustainable and waterfront resiliency initiatives being conducted in the village.

On February 20, 2020, HDR and the project partners held a preliminary design workshop with key stakeholders at the Piermont Village Hall. 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. Other topics discussed at the workshop included a review of CAD concept incorporation, review of the design criteria, a discussion of permitting requirements and review of the proposed upcoming schedule. Resolutions to the key design comments received during the workshop are summarized below in Section 5.1.1.

5 Preliminary Design

5.1 Design Approach

The preliminary design (Appendix C) for the proposed living shoreline project followed the overall guidance outlined in NYSDEC (2017b) for the issuance of permits for living shoreline techniques in the Marine and Coastal District Waters of New York including the Hudson River south of the Tappan Zee Bridge. The preliminary design was also informed by the experience garnered from other HDR ecological engineering projects as well as from larger coastal civil work projects that HDR has implemented. Lastly, the preliminary design was developed with input from the stakeholder engagement and in consultation with the PWRC as well as other the coastal experts involved as stakeholders in the project.

Living shorelines use vegetation and other natural elements, such as oysters or mussel beds, often in combination with harder shoreline structures to stabilize and protect coastlines 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 four of the CAD Studio designs suggested some form of natural shoreline protection as part of their overall plan (Table 1). In particular, Piermont: The New Beginning articulated a design that would incorporate shoreline protection features integrated with recreational and educational elements that would serve to highlight Piermont's desire to become a model community for climate adaptation along the Hudson River.

The upfront stakeholder input and data review for the project included an identification of native marsh and upland plant species that will be expected to thrive along the Piermont coastline north of the existing pier. A focus on native and sustainable plantings will improve connectivity between the terrestrial and estuarine environments and promote biodiversity along a shallow-sloped and non-homogenous 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.

Based on this articulated design approach, four fundamental and overarching design goals emerged for the project:

1. Design a self-sustaining living shoreline feature that serves as a model for other communities along the Hudson interested in climate adaptation.
2. Stabilize the existing shoreline north of the Piermont Pier and East of Parelli Park to Flywheel Park;

3. Develop intertidal and subtidal habitat features to attenuate wave energy and simultaneously benefit fish, shellfish and other wildlife within the project area;

4. Maintain and enhance recreational access to the river and its shoreline habitats while including educational and interpretive elements that effectively engage the public.

Table 2 summarizes the criteria that were considered for this project and the overall projected outcome from the preliminary design.

Table 2. Summary of Preliminary Design Criteria.

	Preliminary Design Summary
Criteria (from RFP)	
Ability to obtain local agency support and permits	Yes
Consider up to date maps and data on current / future conditions	Yes - proposed plan based on drone survey data collected in 2019
Reduce shoreline / stormwater flooding	Yes - design considers
Reduce erosion risk	Yes - jetty improvements
Cost-Effective over long term (O&M, replacement, etc.)	Yes - proposed materials are readily available for purchase and likely available on 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
Educational / Interpretive Elements / Public access	Yes - educational signage is proposed with a boardwalk overlook of the river
Address contaminated soils, brownfields, etc.	N/A
Aligns with Local Waterfront Revitalization Plan (items listed are summarized from LWRP policies)	
Concentrate development in or adjacent to traditional waterfront communities, and take appropriate advantage of waterfront locations	Yes - the project location is in the area of the existing boat launch and adjacent to Parelli Park, in a highly visited / pedestrian traffic area
Protect stable residential areas	N/A
Maintain / enhance natural areas, recreation and open space	Yes - promotes the use of the river for recreational purposes, and does not inhibit the use of Parelli Park
Minimize adverse impacts on new and re-development	N/A
Preserve historic nature of waterfront area, culture, and archaeological resources	N/A
Enhance visual quality of waterfront area	Yes - replaces neglected shoreline areas with visually pleasing habitat features
Minimize loss of human life and structures from flooding and erosion	Yes - erosion mitigation measures are part of the design, including the reinforced jetty
Preserve / restore natural protective features	Yes - rock sills will help preserve the low marsh areas and still allow water access
Protect public lands and use of these lands	Yes - rock sills will help preserve the low marsh areas and still allow water access

	Preliminary Design Summary
Criteria (from RFP)	
Manage navigation infrastructure to limit adverse impacts on coastal processes	Yes - multiple boat launch and river access points are proposed
Ensure expenditures of public funds for flooding / erosion control projects result in public benefit	Yes
Protect and improve water quality and supply	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 and improve air quality, limit greenhouse gases	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 boat launch and river access points are proposed
Protect existing water-dependent uses	Yes - multiple boat launch and river access points are proposed
Promote sustainable use of living marine resources	Yes
Promote appropriate use of energy resources	N/A
Aligns with Waterfront Resiliency Program goals (summarized from task force vision statement & objectives)	
Adapt gradually to avoid and minimize risks	Yes
Help residents and businesses recover quickly from floods and storms	N/A
Maintain village's relationship with the Hudson River	Yes - through educational and recreational uses
Maintain vibrant business district and local economy	N/A
Foster and build community	Yes - shoreline can be a central meeting point for educational and recreational opportunities as well as a source of pride for the community
Be environmentally responsible	Yes - creates habitat areas
Be a model for others	Yes - through educational and recreational uses
Bring community together	Yes - through educational and recreational uses
Create foundation of analysis, data and communal knowledge about SLR and flooding adaptation approaches	Yes
Produce locally specific, phased recommendations for policy improvements, capital investments, open space / access opportunities, and future studies that will help Piermont improve resilience	Yes
Position Piermont to prioritize and begin implementing the task force's recommendations and attract funding for waterfront improvements	Yes
Build the community's capacity and experience in planning for waterfront resilience	Yes

5.1.1 February 2020 Design Workshop Outcomes

1. General Design Considerations:
    a. Locations of the existing outfall near the beach area, and the whistle tower were added to the existing conditions drawing
    b. Reevaluated whether coir logs were the most appropriate material and determine whether other substrate-filled measures are better suited for this application
    c. The design (boardwalk, access points, etc.) was reevaluated for ADA accessibility where possible
    d. Access areas were clearly marked to limit / avoid pedestrian foot traffic in the vegetated or stabilized areas
    e. Removed the boardwalk overhang and used the existing boardwalk footprint with some enhancements
    f. Design was reevaluated to secure access for boaters and others to the beach area:
        i. Improved the boat access near the existing beach to accommodate the rowing team by widening and straightening the path. Some of the plantings on the existing beach were removed; the beach area was called out as a distinct area on the drawings.
    g. The functionality of the rock sill was clarified and its design revisited to confirm it will serve its function of protecting the vegetation plantings
    h. Improved design to better withstand significant wave action and erosive forces
    i. Oyster gabions at the foot of the jetty were removed from the proposed design as oysters may not be sustainable in the low salinity and shallow water of the project area
    j. Evaluated whether another form of wave breakwater is necessary to help protect the shoreline towards the beach area. Possible approaches include:
        i. A submerged or partially submerged breakwater (would need to address issues of navigation hazards to kayakers, etc.)
        ii. Increase size or length of proposed breakwater
        iii. Additional reinforcement / revetments in erosion prone areas against the sea wall

5.2 Shoreline Features

5.2.1 Sub-tidal 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 were included in the preliminary design including the use of concrete “reef balls” and rock revetments (Figure 3). The idea of using a variety of features installed in an aggregated, “nature-like” configuration were included, where appropriate. However, linear shoreline protection features were also included in the design, to stabilize and enhance areas where shoreline vegetation plantings were deemed suitable. The potential to support native shellfish (e.g., Tappan Zee oysters) 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, oysters will not be 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. These features provide optimal habitat for a variety of resident, as well as transient/migratory fishery species. In addition, low profile sills made of broken rock, bagged mixed mollusk shells and concrete reef balls (Figure 4) will be used to create fish habitat and would be placed parallel to the shore at approximately mean low water (MLW) elevation to protect the fringing marsh plantings and provide additional habitat for aquatic organisms which rely on the structure complexity of intertidal marsh vegetation (e.g., juvenile killifish, grass shrimp, and ribbed mussels).

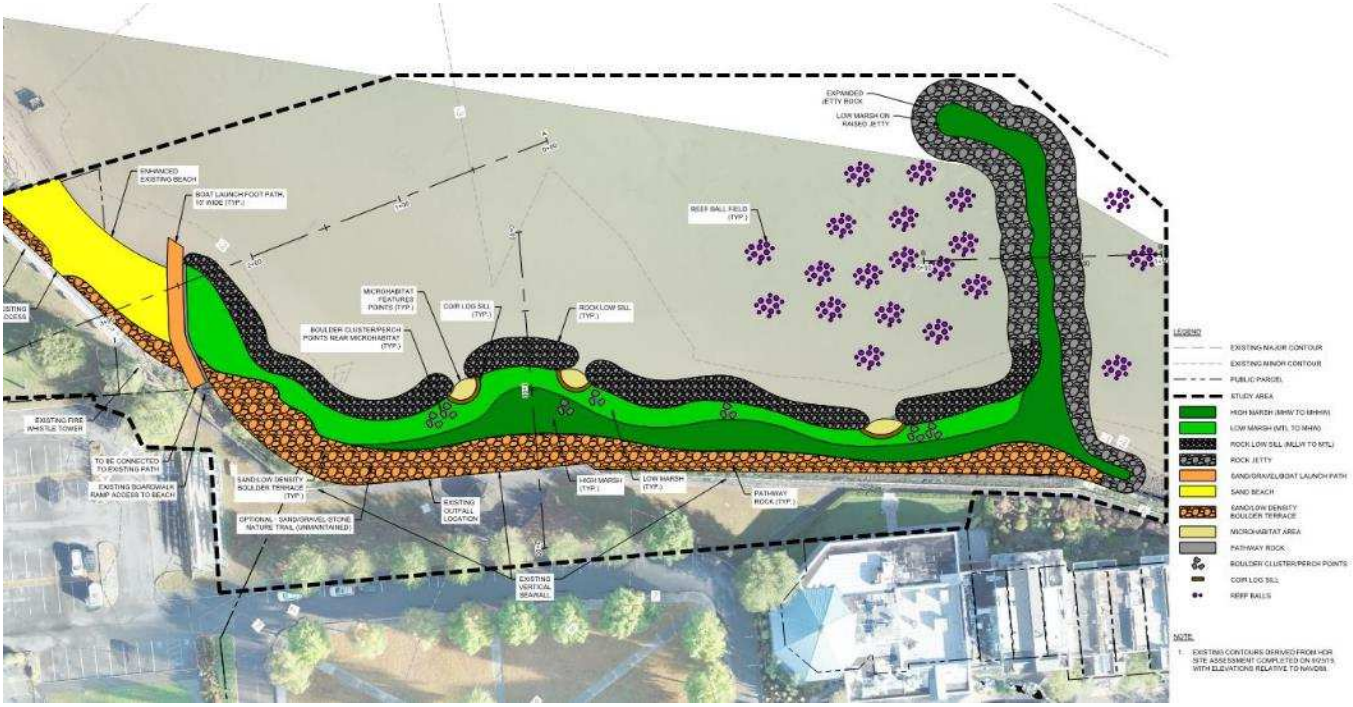

Figure 3. Proposed Piermont Living Shoreline Site Plan.

Figure 4. Example Photos of Concrete Reef Balls Pre-Installation (Left) and Rock Sill with Microhabitat Features and Low Marsh (Right) – NYSDEC (2017).

One key design feature proposed in the shallow subtidal (and a portion of the intertidal) zone is the use of an existing submerged jetty which extends into the river to the north of the Piermont Pier, east of the project area. This structure is indicated by the presence of exposed rocks at low tide, but is clearly visible in aerial (drone survey) photography conducted during the field assessment (Figure 5). The location of the relic jetty should promote wave attenuation and shore protection if reinforced, expanded horizontally and elevated through placement of additional hard substrate (e.g., rocks and boulders). If elevated to a height which provides suitable inundation frequency/depth for the establishment (via transplants from a suitable local donor site or nursery) of native marsh vegetation (e.g., saltmeadow cordgrass), a further reduction in wave energy transmission could be expected, should vegetation become established, achieve natural stem height and density and persist on an annual basis without human intervention (re-planting).

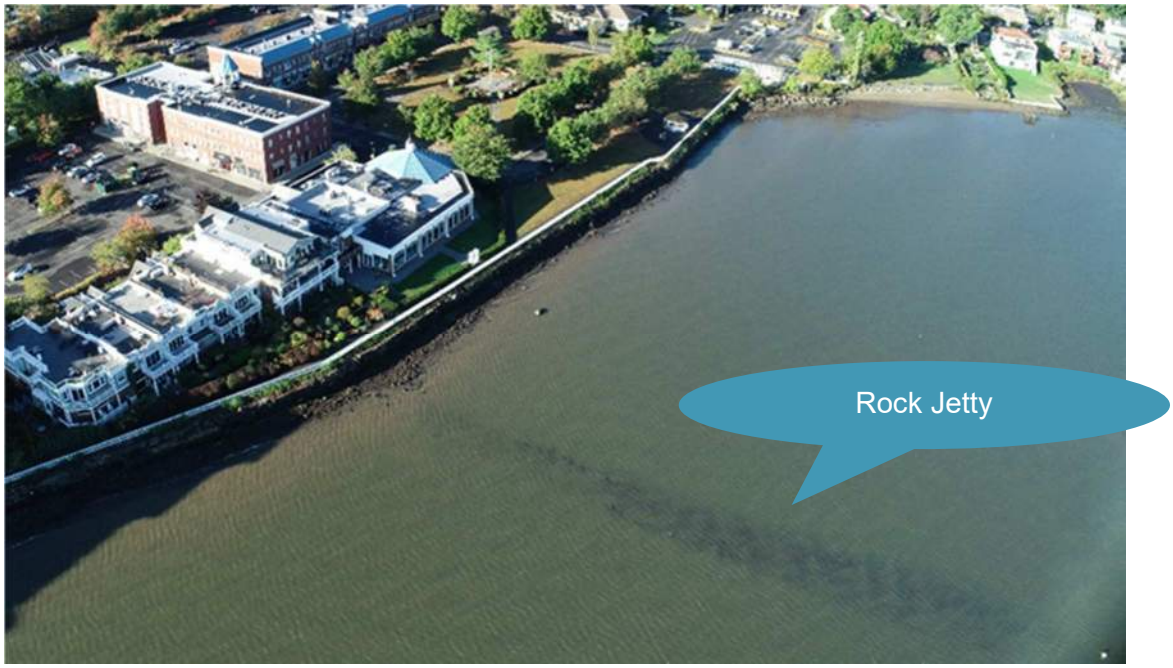

Figure 5. Submerged Rock Jetty as Seen from October 2019 Aerial Drone Survey.

Offshore, and adjacent to the reinforced jetty structure, a series of twenty 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 organisms would also be expected to colonize and use the submerged rock structure of the reinforced breakwater/jetty. 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.

An additional option for the reinforced jetty feature was considered during the design phase but was eliminated based upon feedback received during the February 2020 design workshop, and follow-up analysis of salinity data. This would be to incorporate cages (or “gabions”) containing either reproductively viable live oysters, or NYSDEC-approved recycled oyster shell (or a combination of the two) along the edges of the jetty structure, where sufficient depths are available to maintain permanent inundation. These gabions would be of similar size and construction to those currently placed at three locations (designed and built by the Billion Oyster Project and encompassing approximately 5 acres) in the vicinity of the new Governor Mario M. Cuomo Bridge spanning the Hudson River on the eastern shoreline. A review of the annual salinity record (HRECOS 2016) showed the average annual salinity at the site (end of pier monitoring station, 5-6 feet average water depth) is 6.8 ppt. The average salinity for the spawning season (June – September) is 8.9 ppt. In general, oysters are tolerant of a range of salinities, however, growth is stunted at sustained salinities below 7.5 ppt. Oysters will not feed or grow in waters of less than 5 ppt or above 32 ppt. Therefore, the proposed project area would be considered “marginal” for

oyster survival, feeding, and growth. Yet, they do persist in the nearby Tappan Zee, and the population there may have evolved adaptations to low salinity (which could include a late spawn and preference for deeper, more saline waters). Native oysters do not recruit to hard substrate in shallow water (i.e., <10 feet) in the Tappan Zee area (B. DeGasperis, NYSDEC, pers. comm).

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 signage would be placed at the kayak launch 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. The concept of using subtidal structures for the creation of aquatic habitat and enhancing recreational opportunities was considered in several of the original CAD concepts including Evolve-Connect-Redefine, Piermont Nexus and Piermont: The New Beginning. Notably, the Northern Pier Ecological Buffer concept in Evolve-Connect-Redefine is very similar to the reinforced jetty concept described above; however the CAD concept proposed an entirely new structure constructed to the north of the project area – along with pedestrian access via a walkway at the centerline of the jetty.

5.2.2 Intertidal Areas

Opportunities for vegetated marsh plantings focus on existing sandy substrate areas along the existing viewing area adjacent to Parelli Park and potentially into an area of privately owned shoreline to the north of the site (Figure 6). Plant species selection, substrate type and planting elevation ranges were based on bio-benchmarking data gathered during the site assessment (Appendix A) from a reference shoreline site to the south of the pier and east of the Piermont Marsh reserve, along with literature and case study review. The concept of using intertidal native vegetation plantings to promote resiliency and habitat enhancement was considered in all of the original CAD concepts. Notably, the wetland terracing concept/illustration depicted along the southern portion of the existing Piermont Pier in Piermont Nexus is similar to that described above for areas along the northern shore of the existing pier, and shoreline areas to the north of the pier (Figure 7). Finally, the proposed encapsulation of portions of the existing intertidal and shallow subtidal zones located north of the Pier as depicted in Piermont- the New Beginning and Re-Appearing Piermont (to promote the development of intertidal vegetation) is a proposed element of the present concept, where a prominent bathymetric feature, or “mound” has been mapped. Encapsulation of the perimeter of this feature, via installation of a rock sill, or wave break, is intended to promote additional sedimentation, minimizing the need for extensive fill placement, and promote the establishment of native salt marsh vegetation (*S. alterniflora*).

Figure 6. Existing Park Viewing Area and Shoreline Looking North.

Figure 7. Wetland Terracing Concept/Illustration Depicted in CAD Studio Design: Piermont Nexus.

To maintain structural integrity and protect vegetated and other living shoreline features from wave-induced erosion, especially during storm events, rock sills are proposed for construction along the present sand/gravel beach in front of the park. 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 and terraces. The largest boulders could be placed in the low to mid-intertidal zone, as an additional habitat feature (potentially for use by birds), and for aesthetic purposes. This eliminates the need for removing these structures from the site and disposing of them elsewhere. Additional rock material would need to be brought to the site to supplement the existing rock, but nearly all of the existing material is anticipated to be suitable for beneficial re-use as components of the rock sills/terraces. 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).

At supra-tidal elevations, a mix of salt-tolerant native coastal meadow species, and possibly dune species (assuming suitable substrate conditions) may be specified along a narrow elevation band at the seaward edge of the park. Elsewhere in the vicinity of the project area, extending to the north to the private property boundary, and along the shoreline of the Pier from the existing rock pile to the relict submerged jetty, additional opportunity exists to stabilize the shoreline, minimize erosion and promote the establishment of native, fringing intertidal marsh vegetation via placement of rock sills/terraces and elevation/substrate re-grading and planting. 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).

5.2.3 Vertical Seawall and Upland Areas

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. The concept of restoring the existing concrete and boulder seawall along Flywheel Park by creating a gradually sloping revetment that would be planted with native vegetation and by acquiring the existing paved pathway (and potentially moving the existing gazebo to the south) could be considered as a future phase of the proposed project should the property ownership of the vertical seawall and upland areas be resolved to allow for shoreline habitat development. The concept of improving the seawall and upland areas to promote resiliency was included in all of the original CAD concepts including most prominently in Evolve/Connect/Redefine, Cultural-Led Adaptation and Piermont: The New Beginning.

5.3 Recreational and Educational Opportunities

An approximately 10-feet wide vertical buffer zone is proposed along the base of the existing vertical seawall would provide multiple access points to the river. The buffer zone would be constructed of sand, gravel, cobble, and boulders, and provide close-up viewing opportunities of the shoreline's various micro-habitat features. The buffer zone would be an unmaintained feature that would tie back to Parelli Park where an educational exhibit describes the habitat enhancement features and resiliency benefits of the living shoreline project. These

recreational/educational opportunities may engage additional stakeholders and help promote the foundations for additional coastal resiliency design projects should the Village desire to consider them as part of separate design initiatives or contracts.

In addition, the preliminary design proposes a residential demonstration planting garden in Parelli Park with native species, interpretive signage and other recreational upgrades to the park (Figure 8). Educational signage describing the purpose and benefit of living shorelines will be placed along the existing viewing area in Parelli Park. The signage will describe the importance of climate adaptation and resiliency within the context of the lower Hudson River estuary as well as the background of the CAD program and NYSDEC HREP funding grant. Opportunities for restoring, moving or incorporating the existing fire whistle/cell tower were also considered (note that a separate Piermont Lighthouse project is also considering this). The existing kayak launch is being replaced within its existing same footprint and is incorporated into the preliminary design. As mentioned above, signage would be placed at the kayak launch and buoys or other navigation aids would be situated in the river to note submerged habitat structures placed offshore of the existing launch area.

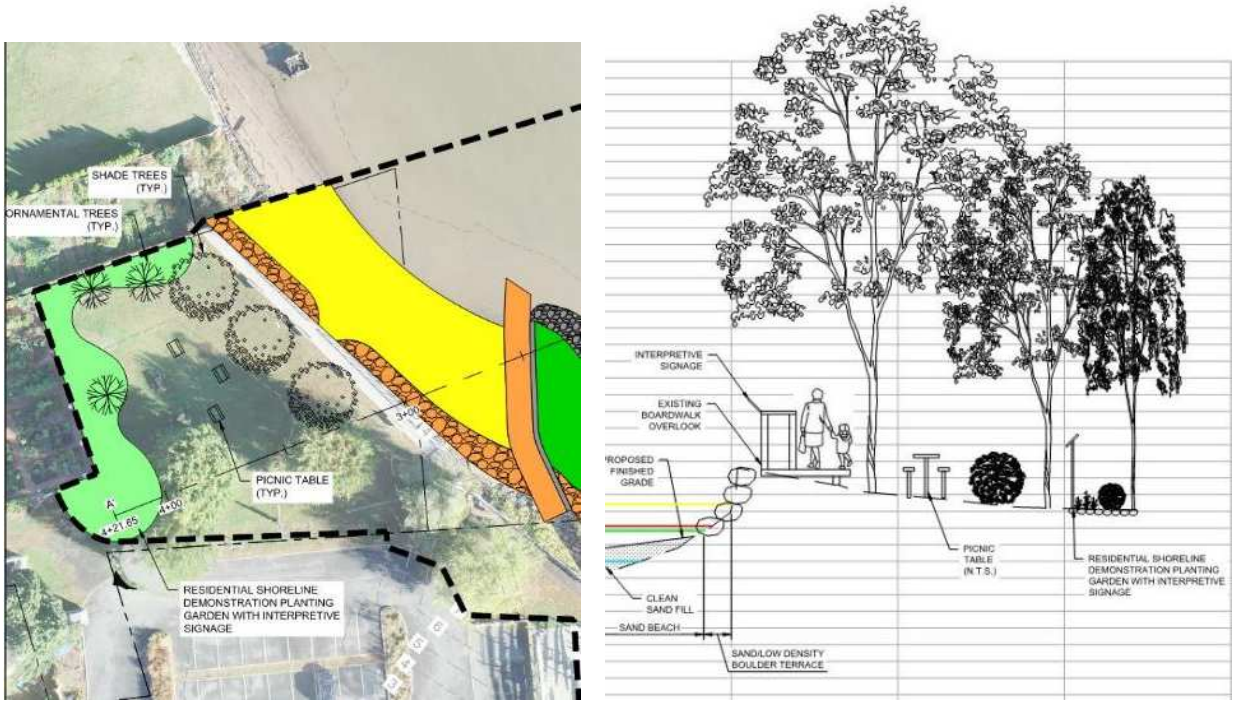

Figure 8. Proposed Demonstration Planting Garden in Parelli Park.

5.4 Coastal Engineering Evaluation

The preliminary design was developed to ensure feasibility, constructability and using sound engineering practices. The primary engineering design objectives require that the proposed design is cost-effective, able to attain state and local agency support and permits, and reduce the

risk of shoreline erosion. A summary of the major engineering practices proposed for this project are summarized within this section.

5.4.1 Jetty

There is an existing partially submerge jetty located at the eastern end of the project area. Proposed project activities would include the addition of approximately 5 feet of rock fill on top of the jetty to increase wave attenuation properties. The engineered service life of the jetty to function per its intended design is approximately 20 years. A high marsh area is proposed within the top of the jetty for habitat enhancement (Figure 9). The jetty rock will also serve as a protective barrier around the high marsh sand and resist erosion of these materials. The reinforced jetty feature will be the primary line of defense against shoreline erosion due to wave action. The length of the proposed expanded jetty is approximately 260 feet.

The proposed cross sectional design of the jetty was selected to optimize anticipated material and construction costs, as well as wave attenuation performance. The crest of the reinforced jetty section exceeds the Mean Higher High Water (MHHW) elevation to allow the wave breaking action during most typical tidal conditions and the increased wave heights due to potential Sea Level Rise (SLR). Another method to attenuate waves is to construct the jetty with a wider and shorter cross section. This approach was not selected due to the increased volume of required fill, and the lack of potential habitat improvements.

The jetty crest elevation was selected as the design water elevation (existing MHW; 1.8 feet NAVD88) plus the NYSDEC medium projection SLR scenario for 2050 (1.5 feet). The proposed crest elevation of 3.2 feet (NAVD88) was checked against the calculated wave run-up which incorporates the design wave height. The design wave height of 2 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 mile fetch distance and a 40 mph wind speed. The wave run-up was calculated as 2.6 feet using the NYSDEC guidance, “Protection against Wave-based Erosion”. Adding this on to the design water elevation would yield a run-up elevation of 4.4 feet (NAVD88) which would exceed the elevation of the proposed jetty crest.

- As was mentioned previously, the jetty crest elevation was selected following consideration of fill volumes and potential cost. 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. The jetty dimensions can then be optimized to meet design targets.

Riprap stone revetments will be installed on top of and adjacent to the jetty, as well as within the rock sill to attenuate wave energy and resist erosive forces on erodible materials, such as sand and sediment. For riprap stability considerations, the design water depth is typically controlled by the tide level matching the crest elevation of the structure. The jetty elevation is set to an approximate elevation of 3.2 feet (NAVD88), whereas the MHHW elevation is 2.1 feet (NAVD88). The designed jetty elevation accounts for anticipated SLR, which is elevation 3.4 feet (NAVD88).

5.4.2 Material Reuse

Existing rock from the site will be reused as much as possible to construct the proposed project elements. Larger rocks which are substantial enough to withstand wave action will be used for the jetty reinforcement or boulder cluster areas, whereas smaller stones and gravel may be used in the rock sill areas or as protection within the boat ramp or points of public water access areas. The reuse of rock and materials is encouraged to reduce material purchasing and shipping costs; however, it must satisfy the engineering criteria which will be developed during later stages of design.

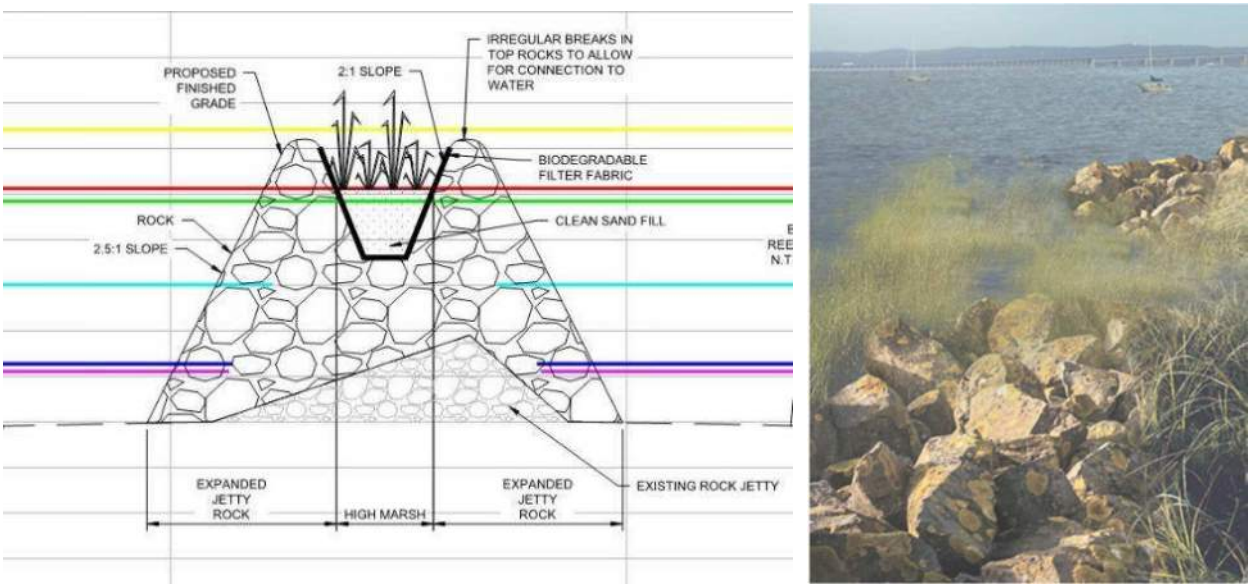

Figure 9. Proposed Expanded Jetty with High Marsh Habitat Enhancement (Left) Similar to the Jetty Image from CAD Studio Design: Evolve…Connect…Redefine (Right).

5.5 Phased Design Considerations

The proposed design present 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 living shoreline 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. Restore the existing concrete and boulder seawall along Flywheel Park by creating a gradually sloping revetment that would be planted with native vegetation and by acquiring the existing paved pathway (and potentially moving the existing gazebo to the south)
2. Implement oyster gabions or reef balls in deeper areas of the Hudson River

3. Up-gradient improvements (i.e. in community garden area, Parelli Park parking lot drainage improvements, etc.)

5.6 Quality Assurance Practices

In accordance with the QAPP Version #1, all data, including data generated from the drone survey, has been Quality Control (QC) 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. Documentation of these checks can be provided upon request.

6 Permitting Approach

The overall permitting for this project will fall under the purview of NYSDEC's Region 3 regulatory office with input from HREP. 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. During the stakeholder engagement, NYSDEC staff indicated that the project may be an unlisted action, which has an uncoordinated review, but that completion of SEQR documents (e.g., Environmental Assessment Form) will still 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. Early feedback on the project's design elements was garnered during the design workshop held in February 2020 from NYSDEC regulatory staff and was incorporated into the preliminary design. 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.

The overall design goal for this project is to improve coastal resiliency by protecting and stabilizing the existing shoreline north of the Piermont Pier and East of Parelli Park through the development of both intertidal and subtidal habitat features to attenuate wave energy and simultaneously

benefit fish, shellfish and other wildlife while creating recreational opportunities for the community. As currently proposed, the project would result in the creation and enhancement of 1.23 acres of intertidal and subtidal habitat including the creation of 0.19 acres of low marsh and 0.23 acres of high marsh (Table 3). In order to create these habitat enhancement features, the project (as currently proposed) would require approximately 8,151 cubic yards (CY) of fill (Table 3).

The overall permitting approach was discussed during a pre-application permitting meeting with NYSDEC on July 26, 2020 (Appendix D). 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).

Table 3. 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)
Rock Jetty	0.20	8,787	5	1,925
Rock Low Sill	0.19	8,145	4	1,207
Low Marsh	0.19	8,264	4	1,224
High Marsh	0.23	10,054	5	1,862
Pocket Sand Beach (microhabitat areas)	0.01	605	1	11
Sand/Low Density Boulder Terrace	0.26	11,329	4	1,678
Sand/Gravel/Boat Launch Path	0.02	934	1	35
Sand Beach	0.10	4,285	1	159
Pathway Rock	0.00	154	1	6
Reef Balls	0.03	1,225	1	45
Totals	**1.23**	**53,782**		**8,151**

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 30% 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 Inventory and Analysis and Proposed Projects sections of Piermont's LWRP (2017). 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 (up to $15 Million) to prepare or implement strategies that would support Piermont's Local Waterfront Revitalization Program. 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 25% match (15% for environmental justice communities). The following link provides more details on available New York State opportunities: http://www.dec.ny.gov/docs/remediation_hudson_pdf/financewr2019.pdf.

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. Given the Village's unique commitment to improving its coastal resiliency and desire to be a model for other communities, it is likely that the Village of Piermont would be successful in obtaining this type of state and federal funding.

Although the overall goal of the living shoreline design is to create a feature that is self-sustaining and requiring minimal upkeep, as with any public park area, some yearly maintenance is expecting to be required including debris removal from beach and access areas as well as maintenance of the upland amenities in Parelli Park.

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 $90,000 and final engineering design and permitting would be approximately $352,000. The total estimated project cost including construction and materials in 2020 ($) would be approximately $2.7 Million without contingencies.

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 10 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**

Site Name:

WORKSHEET 10: Ecological Attributes

Date:

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

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

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Appendix A

HDR Site Assessment Report (October 24, 2019)

Memo

Date:	Thursday, October 24, 2019
Project:	Climate Adaptive Design (CAD) Studio – Piermont Living Shoreline Project
Prepared By:	HDR Engineering
Subject:	Site Assessment Report
Site Visit Participants:	HDR: David S. Davis, Dave Yozzo, Steve Seymour, Kevin Verweire, Casey Stokes, James Eberhardt, Zak Lehmann with Daniel Miller (NYSDEC-HRNERR) and Nathan Mitchell (Piermont Waterfront Resiliency Commission)

PURPOSE AND INTENT

HDR conducted a site investigation of the proposed Piermont living shoreline project ("Project") area on September 23, 2019 and on October 4, 2019 [unmanned aerial system (drone) survey only]. Prior to the site assessment a qualitative review of each of the five original Climate Adaptive Design (CAD) Studio concepts and input from the stakeholder engagement process were used to identify the potential project area located in the northwest corner of the existing Piermont Pier adjacent to and centered on the water-ward side of Flywheel Park and Parelli Park in the Village of Piermont, 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 preliminary design of a living shoreline feature 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 living shoreline project design.

In addition, a reference shoreline was surveyed at the southeast end of Piermont Pier (reference site) on September 23, 2019. The objective of the reference site survey was to record the elevation of substrate and shoreline vegetation communities along transects perpendicular to the shore. The data collected from the reference site will be used during the development of the

preliminary design to design target plant communities and aid in the understanding of local tidal datums.

Site Assessment Activities

The following activities were conducted during the site assessment in accordance with the approved Quality Assurance Project Plan (QAPP), Version 1 dated August 13, 2019:

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, single-family residences, parkland, paved parking areas, walking paths, lawns, and gardens. This developed area is located upgradient of a bulkhead that runs west to east along the north shore of Piermont Pier. Vegetation in the upland is dominated by invasive species such as common reed, mugwort, Japanese knotweed, Asian bittersweet, porcelain berry, black locust, and tree-of-heaven.

The intertidal area is unvegetated; near the overlook area the substrate consists of sand, fine gravel, cobbles, cinders, and glass. Sand is predominant at the upper tidal limits and finer grained material increased from east to west along the shoreline. The intertidal community area near the overlook area is best described by the "Marine Intertidal Gravel/Sand Beach" in Edinger (2014). HDR crews found several inches of very soft organic material over the gravel and cobbles in the subtidal shallows. A concrete bulkhead ranging from 7.3 to 8 ft. in height runs along the entire east-west shore of the Project area; there is one 30" diameter metal pipe embedded in and flush with the concrete wall. The pipe is fully exposed at low water; a metal grating over the pipe is partially dislodged. The foot of the concrete wall is exposed at low tide; the intertidal area

consists of cobbles with some larger boulders along the bulkhead face. There are large, discontinuous pieces of concrete, rock, and asphalt rubble in the "elbow" of the project area; some tidally stranded logs and woody debris are also present. A photographic log of key features observed during the site assessment is included as Attachment A of this report. The intertidal area at the foot of the bulkhead is best described by Edinger as the "Estuarine Riprap/Artificial Shore".

A Village of Piermont representative (Nathan Mitchell) indicated that an existing low area immediately north of the radio/siren tower serves as a conduit for storm surge into the adjacent paved parking area. He also said there is a check valve on the stormwater drain which closes at high tide to prevent surcharging via the drain. There are nearby street signs in Piermont citing the location as a "flood prone area."

In preparation for the site survey, estimates of the tidal datums were retrieved for the Project area using the NOAA Vdatum online tool on August 14, 2019. The values are shown in Table 1 below.

Table 1. Estimated Tidal Datum Elevations computed using NOAA Vdatum Online Tool. Retrieved 8/14/19.

Location	
Lat	41.042833
Lon	-73.913702

Tidal Datum	Elevation (NAVD88, US-feet)
MLLW	-1.894
MLW	-1.73
LMSL	0.113
MTL	0.008
MHW	1.841
MHHW	2.125

Based on NOAA topobathymetry data available from 2018, intertidal areas (MHHW to MLLW) down to an elevation of -2 feet (NAVD88) generally extend from approximately 25 to 75 feet riverward along the shoreline with the greatest extents occurring adjacent to Parelli Park and near the public kayak launch (**Figure 1**). Beyond the Mean Lower Low Water (MLLW) mark, project area bathymetry generally ranged from -4 to -6 feet within the Project area. Elevations recorded along shoreline transects and in upland areas during the field survey will be used during the development of the preliminary design to confirm the general bathymetric and topographic conditions.

Ecological Assessment

HDR ecologists walked the perimeter of the proposed Project area, documenting existing habitats and general site conditions, along with surrounding land use. HDR staff were accompanied by Dan Miller (NYSDEC-HRNERR) and Nathan Mitchell (Piermont Waterfront Resiliency Commission) for a portion of the site assessment. 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. 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. Estuarine organisms noted in the tidal shallows and intertidal zone included schools of juvenile Atlantic menhaden (a.k.a. "peanut bunker"), and blue crabs (both live animals, carcasses, and carapace sheds present). Atlantic rangia clam shells were abundant along the shore and in shallow water areas. A few small ribbed mussel shells were observed, but no live mussels were present in the intertidal zone. A single American eel was observed in a tide pool under a rock in the intertidal zone. Both aquatic and terrestrial/arboreal bird species were present; consisting of great blue heron, American crow, mallard, Canada goose, double-crested cormorant, rough-winged swallow, house sparrow, goldfinch, blue jay, mourning dove, Carolina wren, European starling, and ring-billed gull. No state or federally-listed rare plant or animal species were observed during the site assessment.

HDR also examined the reference shoreline on the south side of Piermont Pier. The upper intertidal area was predominantly sand, the lower intertidal area was soft peat. There was a distinct break along the shoreline where sand deposition was occurring to the east, and erosion of the peat mat was occurring to the west. Vegetation in the peat mat area was a common reed monoculture; there were several small patches of saltmarsh cordgrass associated with coarse rip rap to the east.

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; 13 bird species were observed during the walk-over. Blue heron, mallard, Canada geese, and gulls were observed in the intertidal area or nearby offshore waters. Schools of small menhaden and blue crabs were observed in the nearshore shallows, shells of rangia clams, ribbed mussel, and American oyster (few) were also observed.

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 for the Piermont Rowing Club for kayak and canoe launching. The nearshore waters are too shallow

for any motorized craft. No evidence of fishing was observed in the Project Area. Fishing is focused in the deeper waters to the east toward the end of Piermont Pier.

Flood, Storm and Hurricane Control – the vertical concrete bulkhead deflects waves but does not absorb wave energy. The east-west shoreline does attenuate and absorb some wave energy; but sufficient energy is apparently present to preclude intertidal plant growth.

Marine Food Production – is limited by the lack of intertidal vegetation. Use of the shallows by forage fish does contribute to the food base for larger fish and fish-eating birds.

Education and Research – Knowledge gained during the current project will contribute to restoration efforts elsewhere along the tidal Hudson River. Site is in close proximity to the Piermont Marsh component of the Hudson River National Estuarine Research Reserve (HRNERR), The Beacon Institute maintains a River and Estuary Observatory Network monitoring station at the east end of the Piermont pier and the Lamont Doherty Earth Observatory (LDEO) recently established a Hudson River Field Station on the pier.

Open Space – Parelli Park and walkways provide access to the Hudson River waterfront. Benches in the park were being used during the site visit.

Aesthetic Appreciation – The Project area provides views of the Hudson River and the Governor Mario Cuomo Bridge. A community garden is present to the west, as well as wildflower plantings.

Ecosystem Cleansing – is limited due to the lack of intertidal or subtidal vegetation. There is also no functional transition area between the upland and the intertidal area, much of the tidal range is on vertical or near-vertical surfaces in the Project Area, such as the concrete bulkhead, rip-rap, and timber cribbing backfilled with coarse rock.

Sediment/Toxicant Retention – retention of organic material is limited due to tidal flushing, lack of intertidal and subtidal vegetation, and predominantly coarse sediments.

Topographic Survey

A topographic survey was completed for the area including the existing seawall along the northern shore of the pier/condominium development, Flywheel Park, the parking area to the west of the Project area, and the overlook area near the River. The study team also visited the reference shoreline site along the southern shoreline of the pier to assess intertidal vegetation communities (both invasive common reed as well as small patches of native saltmarsh cordgrass), and substrate conditions at a small cove which may provide essential bio-“benchmarking” or reference data for the design of the living shoreline habitat mosaic. Elevation data was collected using an EOS Arrow Gold high accuracy real-time kinematic (RTK) Global Navigation Satellite System (GNSS). Points were recorded across pre-selected transects spanning the topographic profile from the pier into the Hudson River. Ground surface shots (latitude, longitude, and

elevation) were collected along transects run approximately every 50 feet perpendicular to the shoreline, and transects extended to the maximum safe wading depth out into the River. In addition, opportunistic spot elevations were recorded at various natural and man-made points of interest within the park, the adjacent community garden, and the parking lot. Finally, elevations corresponding to specific vegetation communities and shoreline features (e.g., eroding peat reefs, sand deposits, wrack line, MLW, etc.) were also recorded along two survey transects at the reference shoreline located on the southern shore of the Pier (**Figure 2**). See also Attachment B for a complete listing of all of the points that were collected.

Following the site visit, estimates of the tidal datums were retrieved for the reference site using the NOAA Vdatum online tool on October 1, 2019. The values are shown in Table 2 below.

Table 2. Estimated Tidal Datum Elevations computed using NOAA Vdatum Online Tool. Retrieved 10/1/19.

Location	
Lat	41.042097
Lon	-73.90446

Tidal Datum	Elevation (NAVD88, US-feet)
MLLW	-1.92
MLW	-1.753
LMSL	0.111
MTL	0.008
MHW	1.848
MHHW	2.13

The estimated tidal datum elevations were plotted along with elevation, substrate, and vegetation data collected at two transects (PLS-REF-T1 and PLS-REF-T2) at the reference site (**Figure 3** and **Figure 4**). These figures show *Spartina alterniflora* occurring between estimated MTL and MHW elevations, with *Phragmites australis* occurring above estimated MHW elevation, as expected for these species.

Aerial Imagery (Drone) Survey

The proposed drone flights could not be completed on September 23, 2019 because of airspace restrictions in effect related to activities at the United Nations. However, all ground control points were established and surveyed during the site visit. A second site visit including the drone survey was completed on October 4, 2019. Aerial still imagery, videos, and a photogrammetry survey were completed for the Project and adjacent areas during multiple drone flights. Following the drone survey, a 2D orthometric aerial photo was created and is shown in **Figure 2**. A preliminary digital surface model and point cloud were created for the Project site, and these models will be

reviewed further along with the on-the-ground topographic survey data during development of the preliminary 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 preliminary 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 were discussed including the use of concrete "reef balls" and "oyster castles." The idea of using a variety of features installed in an aggregated, nature-like non-linear manner were discussed. Given the uncertainty of biological success and potential permitting challenges, live oysters would likely not be transplanted but habitat for recruitment by native, local oysters (via natural reefs present in the vicinity of the GMC Bridge) could be created. Habitat enhancement for other, native suspension-feeding invertebrates such as 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. Recreational access through the project area for kayaks and similar non-motorized recreational vessels should be maintained in the placement of habitat enhancement structures. The concept of using subtidal structures for the creation of aquatic habitat and enhancing recreational opportunities was considered in several of the original CAD concepts including Piermont Nexus and Piermont: The New Beginning.

Intertidal Shoreline

Opportunities for vegetated marsh plantings would likely focus on existing sandy substrate areas along the existing viewing area adjacent to Parelli Park and potentially into an area of privately owned shoreline to the north of the site. Plant species selection, substrate type and planting elevation ranges may be optimized based on bio-benchmarking data gathered from the reference shoreline site to the south of the pier and east of the Piermont Marsh reserve. The concept of using intertidal shoreline plantings to promote resiliency and habitat enhancement was considered in all of the original CAD concepts including most prominently in Re-Appearing Piermont and Piermont: The New Beginning.

Bulkheaded and Upland Areas

Educational signage describing the purpose and benefit of living shorelines could be placed along the existing viewing area in Parelli Park and potentially in Flywheel Park. Opportunities for

restoring, moving or incorporating the existing fire whistle/cell tower should be considered (note that a separate Piermont Lighthouse project is also considering this). Upland (coastal meadow) plantings and opportunities for increased water retention in Parelli Park could be considered. The existing kayak launch is being replaced within its existing same footprint and should be incorporated into the preliminary design. The concept of restoring the existing concrete and boulder bulkhead along Flywheel Park was also discussed by creating a more sloping revetment that could be planted with vegetation and by acquiring the existing paved pathway, and potentially moving the existing gazebo to the south. The concept of improving bulkheaded and upland areas to promote resiliency as well as promoting educational components was included in all of the original CAD concepts including most prominently in Evolve/Connect/Redefine, Cultural-Led Adaptation and Piermont: The New Beginning.

Restoration Constraints

Several potential design constraints were identified in the Project area. The elevation difference between the existing intertidal area and crest of the concrete bulkhead will require any change in the shoreline repose (revetment) to extend into the tidal Hudson or further to the south with a lowering of the current upland area. The current use of the adjacent upland as either a park, active roadway, or walking path may preclude any re-contouring to increase the width of the tidally affected area while maintaining the existing walkway elevation. However, the design could consider either an elevated walkway or a lower elevation walkway through the shoreline stabilization area. Preservation of the existing 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.

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 preliminary conceptual design for the living shoreline project. The overarching project goals for the project remain:

1. Protect and stabilize the existing shoreline north of the Piermont Pier and East of Parelli Park;

2. Develop intertidal and subtidal habitat features to benefit fish, shellfish and other wildlife within the project area;

3. Maintain and enhance recreational access to the river and its shoreline habitats while including educational and interpretive elements that effectively engage the public.

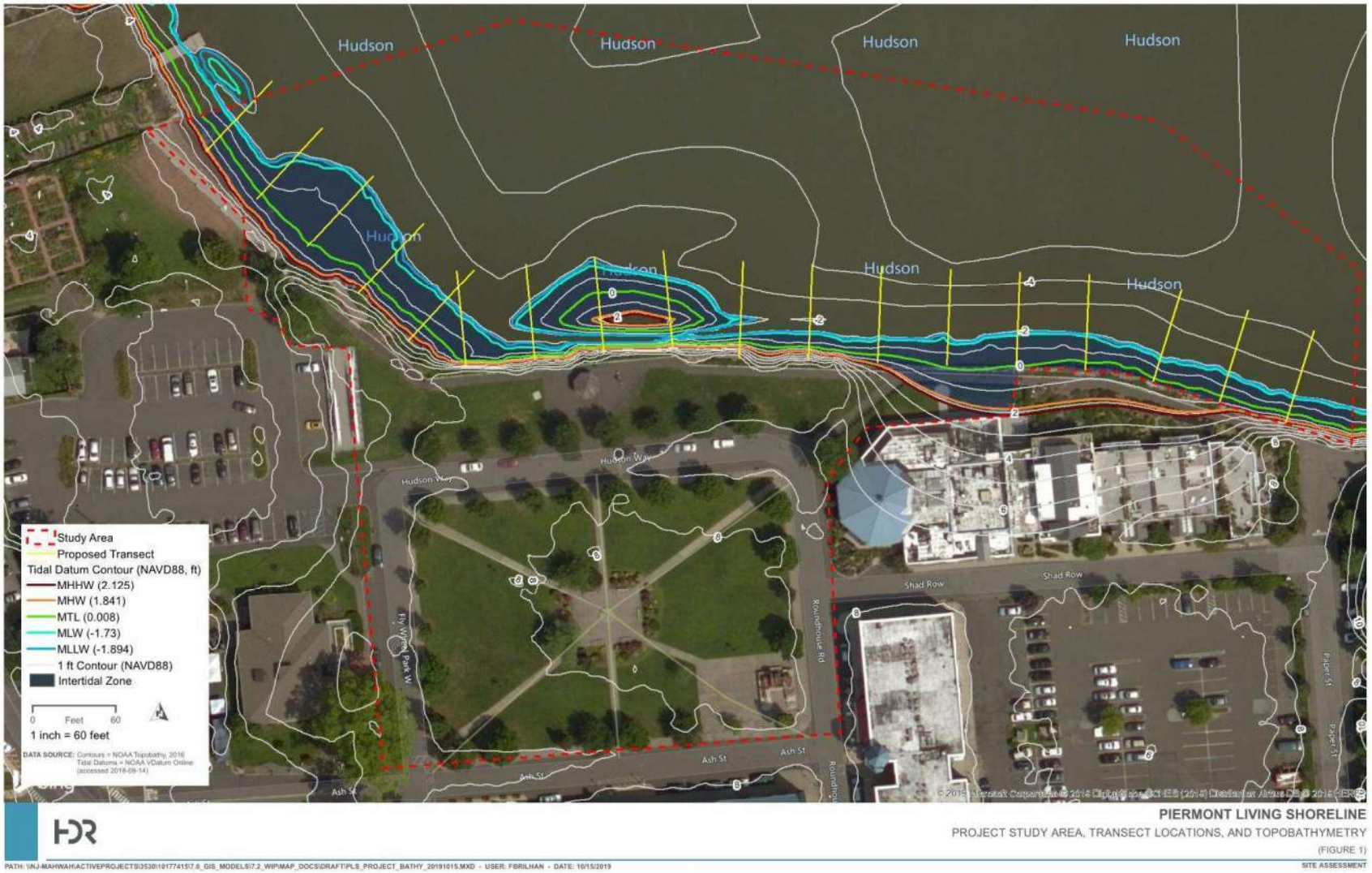


Figure 1. Project Study Area, Transect Locations, and Topobathymetry.

Figure 2. 2D Orthophoto and Topographic Elevation Mapping.

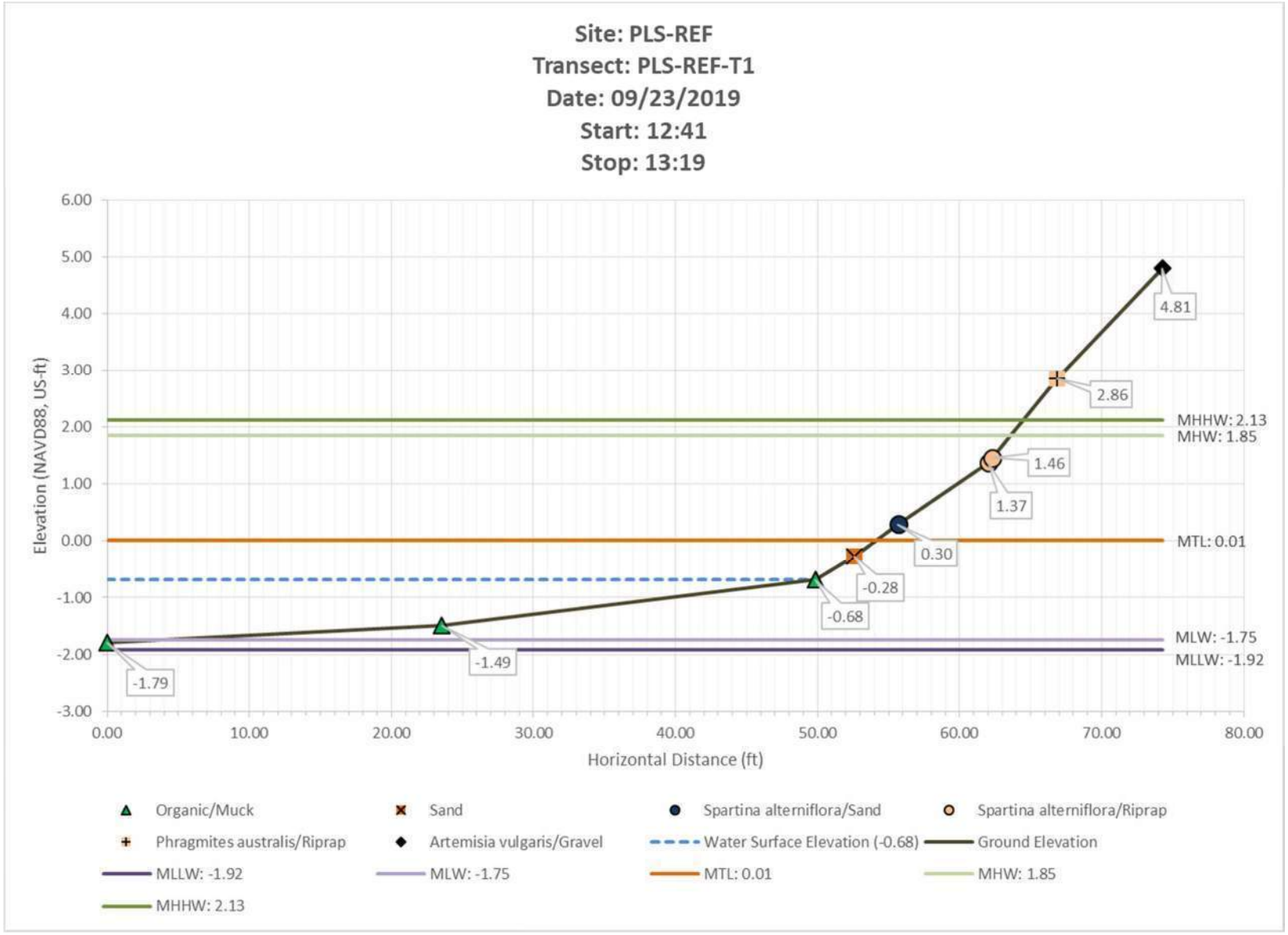


Figure 3. Survey Transect PLS-REF-T1

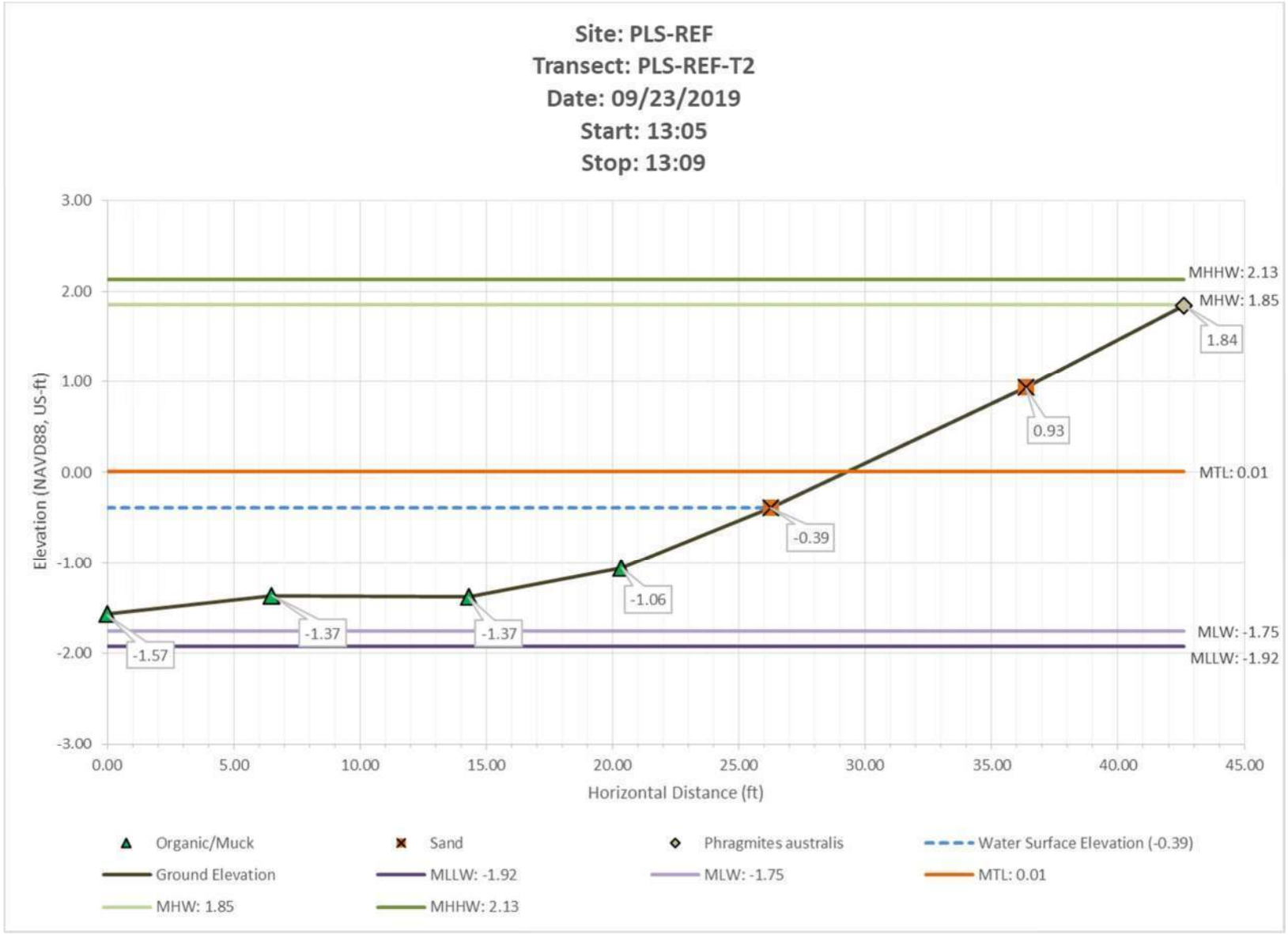


Figure 4. Survey Transect PLS-REF-T2

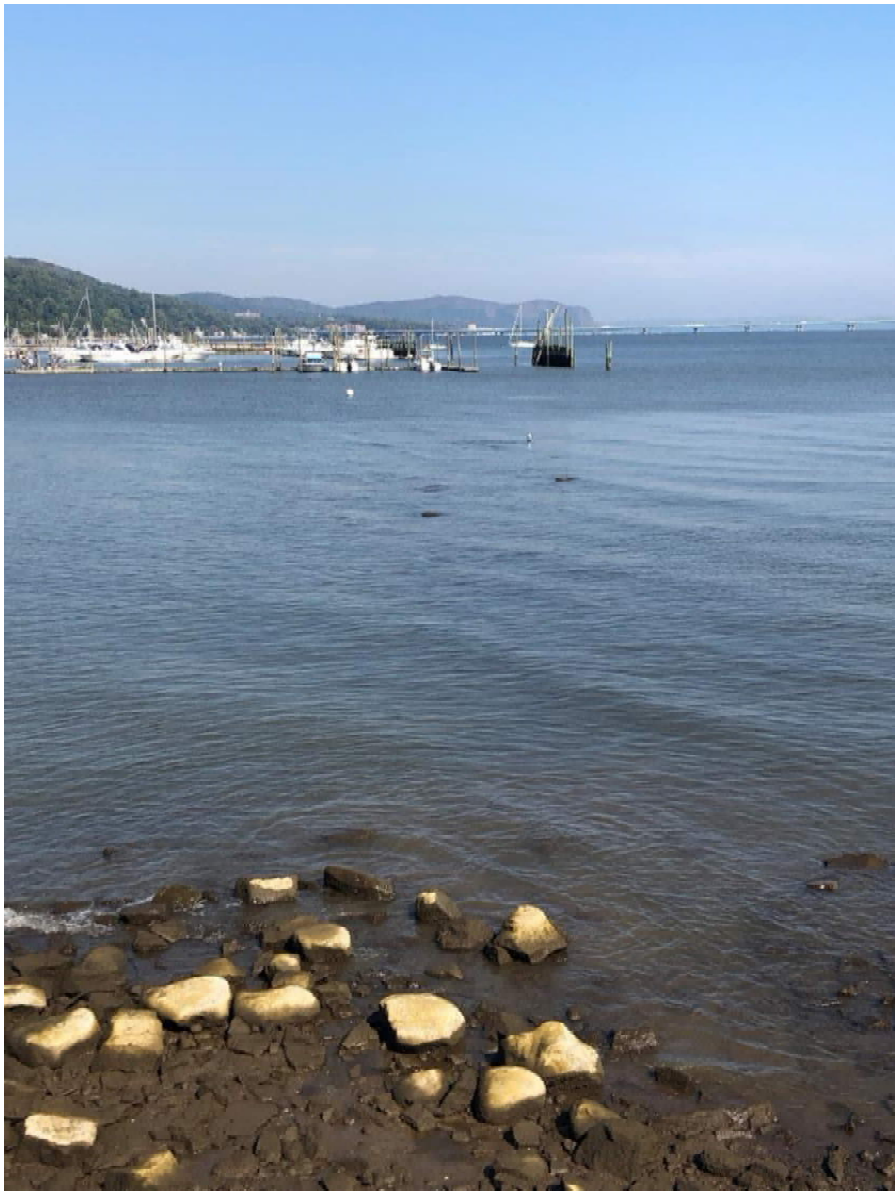
Attachment A

Site Assessment Photo Log

PIERMONT LIVING SHORELINE PROJECT

SITE ASSESSMENT 9-23-19

GENERAL SITE AND SHORELINE FEATURES




Parelli Park
Village of Piermont
No Dogs or Bicycles
Please keep gate closed
Play at your own risk
Park Closes at 9 p.m.


Village of Pierment
COMMUNITY
GARDEN
"To Nourish the Spirit"

SITE ASSESSMENT ACTIVITY

REPRESENTATIVE BIOTA

REFERENCE SITE – SOUTH SHORE OF PIER

UAS (Drone) Survey – 10-4-2019

Attachment B

Survey Datasheet

SURVEY DATASHEET

Location:	Piermont, New York			**Project Name:**	Piermont CAD-Living Shoreline
Date:	9/23/2019	**Observers:**	Verweire, Stokes, Lehmann, Eberhardt	**Project Number:**	N/A
Weather:	Partly cloudy, no rainfall in the past 3 days, high temp in the mid 80s°F, predicted low water at 11:37 a.m.			**Notes:**	See comments field
Start Time:	9:00	**Stop Time:**	15:00		

TransectID	Name	PointType	DomSubstrate	WaterDepth	Comments	POINT_X	POINT_Y	ElevNAVD88, ft	GNSS Fix DateTime (GMT)
PLS-T1	PLS-T1-1	General Ground	Sand - Medium			-73.9161514	41.0427562	1.43	2019-09-23 15:01
PLS-T1	PLS-T1-2	General Ground			transition	-73.9161343	41.0427636	0.68	2019-09-23 15:02
PLS-T1	PLS-T1-3	General Ground			transition substrate	-73.9161398	41.0427693	0.76	2019-09-23 15:02
PLS-T1	PLS-T1-4	General Ground	Gravel - Medium			-73.9161236	41.0427786	0.00	2019-09-23 15:02
PLS-T1	PLS-T1-5	General Ground	Gravel - Medium		wsel	-73.9161006	41.0427917	-1.25	2019-09-23 15:03
PLS-T1	PLS-T1-6	General Ground			transition of substrate	-73.9160947	41.0428052	-1.61	2019-09-23 15:04
PLS-T1	PLS-T1-7	General Ground	Silt/Clay			-73.9160377	41.0428494	-2.24	2019-09-23 15:05
PLS-T1	PLS-T1-8	General Ground	Silt/Clay			-73.9159990	41.0428793	-2.32	2019-09-23 15:05
PLS-T2	PLS-T2-1	General Ground			transition	-73.9160970	41.0426782	1.87	2019-09-23 15:07
PLS-T2	PLS-T2-2	General Ground			transition	-73.9160950	41.0426747	1.85	2019-09-23 15:08
PLS-T2	PLS-T2-3	General Ground	Gravel - Fine			-73.9160891	41.0426782	1.59	2019-09-23 15:08
PLS-T2	PLS-T2-4	General Ground			transition	-73.9160840	41.0426812	1.38	2019-09-23 15:09
PLS-T2	PLS-T2-5	General Ground	Gravel - Coarse			-73.9160721	41.0426910	0.83	2019-09-23 15:09
PLS-T2	PLS-T2-6	General Ground			transition	-73.9160599	41.0426995	0.22	2019-09-23 15:10
PLS-T2	PLS-T2-7	General Ground	Gravel - Fine			-73.9160527	41.0427040	-0.13	2019-09-23 15:10
PLS-T2	PLS-T2-8	General Ground			transition	-73.9160454	41.0427075	-0.45	2019-09-23 15:10
PLS-T2	PLS-T2-9	General Ground	Gravel - Coarse		wsel	-73.9160317	41.0427156	-1.26	2019-09-23 15:10
PLS-T2	PLS-T2-10	General Ground			transition	-73.9160171	41.0427334	-1.85	2019-09-23 15:11
PLS-T2	PLS-T2-11	General Ground	Silt/Clay			-73.9159608	41.0427795	-2.52	2019-09-23 15:11
PLS-T2	PLS-T2-12	General Ground	Silt/Clay			-73.9159076	41.0428242	-2.52	2019-09-23 15:12
PLS-T3	PLS-T3-1	General Ground	Sand - Medium			-73.9160083	41.0425512	3.29	2019-09-23 15:13
PLS-T3	PLS-T3-2	General Ground			transition	-73.9159842	41.0425682	1.85	2019-09-23 15:14
PLS-T3	PLS-T3-3	General Ground	Gravel - Fine			-73.9159817	41.0425693	1.73	2019-09-23 15:14
PLS-T3	PLS-T3-4	General Ground			transition	-73.9159781	41.0425726	1.56	2019-09-23 15:14
PLS-T3	PLS-T3-5	General Ground	Gravel - Coarse			-73.9159581	41.0425865	0.70	2019-09-23 15:14
PLS-T3	PLS-T3-6	General Ground			transition	-73.9159315	41.0426048	-0.84	2019-09-23 15:15
PLS-T3	PLS-T3-7	General Ground	Cobble - Small		wsel	-73.9159121	41.0426267	-1.32	2019-09-23 15:15
PLS-T3	PLS-T3-8	General Ground	Cobble - Small			-73.9158450	41.0426847	-1.85	2019-09-23 15:16
PLS-T3	PLS-T3-9	General Ground	Cobble - Small			-73.9157768	41.0427259	-2.33	2019-09-23 15:16
PLS-T4	PLS-T4-1	General Ground	Gravel - Coarse			-73.9158669	41.0424482	2.49	2019-09-23 15:18
PLS-T4	PLS-T4-2	General Ground			transition	-73.9158359	41.0424787	0.56	2019-09-23 15:18
PLS-T4	PLS-T4-3	General Ground	Cobble - Small			-73.9157808	41.0425325	-0.64	2019-09-23 15:19
PLS-T4	PLS-T4-4	General Ground	Cobble - Small		wsel	-73.9157077	41.0425815	-1.34	2019-09-23 15:20
PLS-T4	PLS-T4-5	General Ground	Cobble - Small			-73.9156487	41.0426350	-2.20	2019-09-23 15:20
PLS-T5	PLS-T5-1	General Ground	Boulder - Large/Vry Large			-73.9156982	41.0423922	3.57	2019-09-23 15:21
PLS-T5	PLS-T5-2	General Ground			transition	-73.9156793	41.0424096	0.25	2019-09-23 15:22
PLS-T5	PLS-T5-3	General Ground	Cobble - Small			-73.9156431	41.0424440	-1.03	2019-09-23 15:23
PLS-T5	PLS-T5-4	General Ground	Cobble - Small		wsel	-73.9156170	41.0424654	-1.37	2019-09-23 15:23

TransectID	Name	PointType	DomSubstrate	WaterDepth	Comments	POINT_X	POINT_Y	ElevNAVD88, ft	GNSS Fix DateTime (GMT)
PLS-T5	PLS-T5-5	General Ground			transition	-73.9155491	41.0425150	-2.19	2019-09-23 15:24
PLS-T5	PLS-T5-6	General Ground	Silt/Clay			-73.9155237	41.0425335	-2.17	2019-09-23 15:24
PLS-T6	PLS-T6-1	General Ground	Boulder - Medium			-73.9155700	41.0422862	2.46	2019-09-23 15:25
PLS-T6	PLS-T6-2	General Ground			transition	-73.9155312	41.0423267	-0.25	2019-09-23 15:26
PLS-T6	PLS-T6-3	General Ground	Cobble - Large			-73.9155137	41.0423444	-0.90	2019-09-23 15:26
PLS-T6	PLS-T6-4	General Ground	Cobble - Large		wsel	-73.9155036	41.0423605	-1.37	2019-09-23 15:26
PLS-T6	PLS-T6-5	General Ground			transition	-73.9154381	41.0424049		
PLS-T6	PLS-T6-6	General Ground			transition	-73.9154442	41.0424035	-2.21	2019-09-23 15:32
PLS-T6	PLS-T6-7	General Ground	Silt/Clay			-73.9153908	41.0424443	-2.39	2019-09-23 15:33
PLS-T7	PLS-T7-1	General Ground	Cobble - Large			-73.9154134	41.0422523	-0.19	2019-09-23 15:34
PLS-T7	PLS-T7-2	General Ground	Boulder - Small			-73.9154131	41.0422832	-0.91	2019-09-23 15:35
PLS-T7	PLS-T7-3	General Ground	Boulder - Small			-73.9154105	41.0423106	-1.56	2019-09-23 15:35
PLS-T7	PLS-T7-4	General Ground			transition	-73.9154241	41.0423894	-2.27	2019-09-23 15:36
PLS-T7	PLS-T7-5	General Ground	Silt/Clay			-73.9154397	41.0424345	-2.48	2019-09-23 15:37
PLS-T7	PLS-T7-6	General Ground	Silt/Clay			-73.9154460	41.0424510	-2.32	2019-09-23 15:37
PLS-T8	PLS-T8-1	General Ground	Silt/Clay			-73.9152321	41.0422567	-1.89	2019-09-23 15:38
PLS-T8	PLS-T8-2	General Ground			transition	-73.9152332	41.0422732	-1.66	2019-09-23 15:39
PLS-T8	PLS-T8-3	General Ground	Gravel - Coarse			-73.9152329	41.0422834	-1.47	2019-09-23 15:39
PLS-T8	PLS-T8-4	General Ground	Sand - Coarse			-73.9152422	41.0423579	-2.20	2019-09-23 15:40
PLS-T8	PLS-T8-5	General Ground			transition	-73.9152471	41.0423817	-2.62	2019-09-23 15:40
PLS-T8	PLS-T8-6	General Ground	Silt/Clay			-73.9152638	41.0424369	-2.76	2019-09-23 15:44
PLS-T8	PLS-T8-7	General Ground	Silt/Clay			-73.9152639	41.0424555	-2.68	2019-09-23 15:45
PLS-T8	PLS-T8-8	Other			storm water pipe	-73.9152287	41.0422540	-1.61	2019-09-23 15:46
PLS-T9	PLS-T9-1	General Ground	Gravel - Coarse			-73.9150596	41.0422630	-1.15	2019-09-23 17:27
PLS-T9	PLS-T9-2	General Ground	Gravel - Coarse			-73.9150630	41.0423147	-2.39	2019-09-23 17:27
PLS-T9	PLS-T9-3	General Ground			transition	-73.9150621	41.0423256	-2.78	2019-09-23 17:27
PLS-T9	PLS-T9-4	General Ground	Silt/Clay			-73.9150606	41.0423901	-2.90	2019-09-23 17:28
PLS-T9	PLS-T9-5	General Ground	Silt/Clay			-73.9150753	41.0424409	-3.06	2019-09-23 17:28
PLS-T9	PLS-T9-6	General Ground	Silt/Clay			-73.9150826	41.0424748	-2.96	2019-09-23 17:28
PLS-T10	PLS-T10-1	General Ground	Silt/Clay			-73.9148944	41.0424769	-2.82	2019-09-23 17:24
PLS-T10	PLS-T10-2	General Ground	Silt/Clay			-73.9148914	41.0423972	-2.85	2019-09-23 17:24
PLS-T10	PLS-T10-3	General Ground			transition	-73.9148930	41.0423315	-2.49	2019-09-23 17:25
PLS-T10	PLS-T10-4	General Ground	Gravel - Coarse			-73.9148751	41.0423009	-1.76	2019-09-23 17:26
PLS-T10	PLS-T10-5	General Ground	Gravel - Coarse			-73.9148747	41.0422744	-0.34	2019-09-23 17:26
PLS-T11	PLS-T11-1	General Ground	Gravel - Coarse			-73.9147117	41.0422651	0.09	2019-09-23 17:20
PLS-T11	PLS-T11-2	General Ground	Gravel - Coarse		wsel	-73.9147131	41.0422779	-0.46	2019-09-23 17:20
PLS-T11	PLS-T11-3	General Ground			transition	-73.9147132	41.0422838	-0.80	2019-09-23 17:20
PLS-T11	PLS-T11-4	General Ground	Boulder - Medium			-73.9147133	41.0423019	-1.41	2019-09-23 17:21
PLS-T11	PLS-T11-5	General Ground			transition	-73.9147073	41.0423234	-2.20	2019-09-23 17:21
PLS-T11	PLS-T11-6	General Ground	Silt/Clay			-73.9147109	41.0423717	-2.64	2019-09-23 17:22
PLS-T11	PLS-T11-7	General Ground	Silt/Clay			-73.9147048	41.0424261	-2.91	2019-09-23 17:22
PLS-T11	PLS-T11-8	General Ground	Silt/Clay			-73.9147004	41.0424607	-2.91	2019-09-23 17:23
PLS-T12	PLS-T12-1	General Ground	Silt/Clay			-73.9145083	41.0424562	-3.12	2019-09-23 16:40
PLS-T12	PLS-T12-2	General Ground	Silt/Clay			-73.9145202	41.0423923	-2.90	2019-09-23 16:40
PLS-T12	PLS-T12-3	General Ground			transition	-73.9145170	41.0423802	-2.74	2019-09-23 16:41
PLS-T12	PLS-T12-4	General Ground	Gravel - Coarse			-73.9145194	41.0423224	-1.87	2019-09-23 16:42
PLS-T12	PLS-T12-5	General Ground	Gravel - Coarse			-73.9145286	41.0422918	-1.10	2019-09-23 16:42
PLS-T12	PLS-T12-6	General Ground	Gravel - Coarse			-73.9145208	41.0422621	-0.56	2019-09-23 16:43

TransectID	Name	PointType	DomSubstrate	WaterDepth	Comments	POINT_X	POINT_Y	ElevNAVD88, ft	GNSS Fix DateTime (GMT)
PLS-T13	PLS-T13-1	General Ground	Gravel - Coarse			-73.9143375	41.0422448	-0.33	2019-09-23 16:36
PLS-T13	PLS-T13-2	General Ground	Gravel - Coarse		wsel	-73.9143396	41.0422609	-0.87	2019-09-23 16:37
PLS-T13	PLS-T13-3	General Ground			transition	-73.9143417	41.0423115	-2.50	2019-09-23 16:37
PLS-T13	PLS-T13-4	General Ground	Silt/Clay			-73.9143445	41.0423644	-2.81	2019-09-23 16:38
PLS-T13	PLS-T13-5	General Ground	Silt/Clay			-73.9143364	41.0424234	-3.09	2019-09-23 16:38
PLS-T13	PLS-T13-6	General Ground	Silt/Clay			-73.9143315	41.0424542	-3.20	2019-09-23 16:39
PLS-T14	PLS-T14-1	General Ground	Sand - Fine			-73.9141465	41.0424387	-3.31	2019-09-23 16:31
PLS-T14	PLS-T14-2	General Ground	Sand - Fine			-73.9141587	41.0423607	-2.89	2019-09-23 16:32
PLS-T14	PLS-T14-3	General Ground			transition	-73.9141643	41.0423073	-2.19	2019-09-23 16:33
PLS-T14	PLS-T14-4	General Ground	Cobble - Small		wsel	-73.9141498	41.0422587	-0.98	2019-09-23 16:34
PLS-T14	PLS-T14-5	General Ground	Cobble - Small			-73.9141509	41.0422460	-0.53	2019-09-23 16:34
PLS-T14	PLS-T14-6	General Ground	Cobble - Small			-73.9141537	41.0422374	-0.31	2019-09-23 16:35
PLS-T15	PLS-T15-1	General Ground	Boulder - Small			-73.9137962	41.0422322	0.18	2019-09-23 16:26
PLS-T15	PLS-T15-2	General Ground			transition	-73.9137932	41.0422607	-0.96	2019-09-23 16:26
PLS-T15	PLS-T15-3	General Ground	Cobble - Large			-73.9137892	41.0423198	-2.17	2019-09-23 16:27
PLS-T15	PLS-T15-4	General Ground	Cobble - Large			-73.9137787	41.0424013	-2.67	2019-09-23 16:29
PLS-T15	PLS-T15-5	General Ground	Cobble - Large			-73.9137949	41.0424344	-2.56	2019-09-23 16:29
PLS-T16	PLS-T16-1	General Ground	Sand - Fine			-73.9133645	41.0423573	-3.34	2019-09-23 16:21
PLS-T16	PLS-T16-2	General Ground	Sand - Fine			-73.9133922	41.0422735	-2.99	2019-09-23 16:22
PLS-T16	PLS-T16-3	General Ground			transition	-73.9134122	41.0422362	-2.71	2019-09-23 16:23
PLS-T16	PLS-T16-4	General Ground	Cobble - Large		wsel	-73.9134328	41.0421959	-1.04	2019-09-23 16:23
PLS-T16	PLS-T16-5	General Ground	Cobble - Large			-73.9134484	41.0421664	0.05	2019-09-23 16:24
PLS-T17	PLS-T17-1	General Ground	Silt/Clay			-73.9130075	41.0422773	-3.27	2019-09-23 14:34
PLS-T17	PLS-T17-2	General Ground	Gravel - Coarse			-73.9131099	41.0420872	0.60	2019-09-23 16:17
PLS-T17	PLS-T17-3	General Ground	Gravel - Coarse			-73.9131011	41.0420977	0.15	2019-09-23 16:17
PLS-T17	PLS-T17-4	General Ground			transition	-73.9130954	41.0421067	-0.37	2019-09-23 16:18
PLS-T17	PLS-T17-5	General Ground	Cobble - Small		wsel	-73.9130885	41.0421190	-0.89	2019-09-23 16:18
PLS-T17	PLS-T17-6	General Ground			transition	-73.9130744	41.0421583	-2.60	2019-09-23 16:19
PLS-T17	PLS-T17-7	General Ground	Silt/Clay			-73.9130416	41.0422008	-3.03	2019-09-23 16:19
PLS-T17	PLS-T17-8	General Ground	Silt/Clay			-73.9130237	41.0422716	-3.13	2019-09-23 16:20
	GCP-1	Other			GCP-1	-73.9154096	41.0415186	7.74	2019-09-23 13:23
	GCP-2	Other			GCP-2	-73.9145427	41.0415413	8.41	2019-09-23 13:25
	GCP-3	Other			GCP-3	-73.9145439	41.0421844	7.84	2019-09-23 13:29
	GCP-4	Other			GCP-4	-73.9160255	41.0425887	2.90	2019-09-23 13:32
	PLS-GS-1	General Ground			parking lot curb	-73.9166031	41.0419033	5.23	2019-09-23 13:54
	PLS-GS-2	General Ground			parking lot curb	-73.9166186	41.0421664	5.16	2019-09-23 13:55
	PLS-GS-3	General Ground			catch basin	-73.9164266	41.0421870	3.78	2019-09-23 13:56
	PLS-GS-4	General Ground			catch basin	-73.9164147	41.0423015	3.84	2019-09-23 13:57
	PLS-GS-5	General Ground			catch basin	-73.9164106	41.0423810	3.00	2019-09-23 13:57
	PLS-GS-6	General Ground			gate to community garden	-73.9164318	41.0425435	3.60	2019-09-23 13:59
	PLS-GS-7	General Ground			center of community garden	-73.9165363	41.0425173	3.85	2019-09-23 14:01
	PLS-GS-8	General Ground	Vegetation - Herbaceous			-73.9163005	41.0425973	3.73	2019-09-23 14:05
	PLS-GS-9	General Ground	Vegetation - Herbaceous		overlook decking	-73.9162421	41.0427130	5.37	2019-09-23 14:06
	PLS-GS-10	General Ground	Vegetation - Herbaceous		overlook decking	-73.9161459	41.0426389	5.31	2019-09-23 14:06
	PLS-GS-11	General Ground	Vegetation - Herbaceous			-73.9161428	41.0425183	3.83	2019-09-23 14:07
	PLS-GS-12	Other			ground at tree, ornamental beech	-73.9160712	41.0424705	4.38	2019-09-23 14:11
	PLS-GS-13	Other			ground at tree, red maple, 16"	-73.9162691	41.0424532	3.23	2019-09-23 14:13
	PLS-GS-14	Other			ground at tree, crab apple	-73.9163707	41.0424721	3.50	2019-09-23 14:13

TransectID	Name	PointType	DomSubstrate	WaterDepth	Comments	POINT_X	POINT_Y	ElevNAVD88, ft	GNSS Fix DateTime (GMT)
	PLS-GS-15	Other			ground at tree, crab apple	-73.9164119	41.0425756	3.98	2019-09-23 14:14
	PLS-GS-16	General Ground			curb	-73.9161771	41.0423578	3.39	2019-09-23 14:16
	PLS-GS-17	General Ground			catch basin	-73.9160936	41.0422423	1.98	2019-09-23 14:16
	PLS-GS-18	General Ground			catch basin	-73.9160740	41.0420654	2.18	2019-09-23 14:17
	PLS-GS-19	General Ground			curb	-73.9160349	41.0418918	3.39	2019-09-23 14:17
	PLS-GS-20	General Ground			catch basin	-73.9158857	41.0419223	3.09	2019-09-23 14:19
	PLS-GS-21	General Ground			lot corner curb	-73.9157576	41.0419098	4.87	2019-09-23 14:19
	PLS-GS-22	General Ground			curb	-73.9157918	41.0420285	4.56	2019-09-23 14:20
	PLS-GS-23	General Ground	Gravel - Medium			-73.9158134	41.0421604	3.73	2019-09-23 14:20
	PLS-GS-24	General Ground			top wall	-73.9157777	41.0421654	6.89	2019-09-23 14:21
	PLS-GS-25	General Ground			top wall	-73.9157656	41.0420636	6.76	2019-09-23 14:21
	PLS-GS-26	General Ground			top end wall	-73.9158627	41.0422820	6.94	2019-09-23 14:22
	PLS-GS-27	General Ground			top corner wall	-73.9157919	41.0422861	6.98	2019-09-23 14:22
	PLS-GS-28	General Ground			top end wall	-73.9157662	41.0420638	6.79	2019-09-23 14:24
	PLS-GS-29	Other			tree, mulberry	-73.9158476	41.0423384	8.71	2019-09-23 14:25
	PLS-GS-30	General Ground			paved walkway	-73.9158261	41.0423951	6.66	2019-09-23 14:27
	PLS-GS-31	General Ground			top wall	-73.9158257	41.0423979	8.17	2019-09-23 14:27
	PLS-GS-32	General Ground	Boulder - Medium	0		-73.9138034	41.0427628	-1.14	2019-09-23 14:28
	PLS-GS-33	General Ground			top wall at gate	-73.9157112	41.0423291	8.41	2019-09-23 14:28
	PLS-GS-34	General Ground				-73.9156203	41.0421539	6.35	2019-09-23 14:29
	PLS-GS-35	General Ground			catch basin	-73.9155797	41.0420862	6.73	2019-09-23 14:30
	PLS-GS-36	General Ground	Boulder - Medium	0		-73.9137915	41.0426118	-1.10	2019-09-23 14:30
	PLS-GS-37	General Ground			catch basin	-73.9156368	41.0420366	6.35	2019-09-23 14:30
	PLS-GS-38	General Ground			top curb	-73.9156285	41.0420402	6.84	2019-09-23 14:31
	PLS-GS-39	General Ground			corner curb	-73.9155772	41.0419555	6.98	2019-09-23 14:31
	PLS-GS-40	General Ground			catch basin	-73.9155868	41.0419222	6.87	2019-09-23 14:31
	PLS-GS-41	General Ground			catch basin	-73.9156660	41.0419164	6.41	2019-09-23 14:32
	PLS-GS-42	General Ground			top curb	-73.9155599	41.0417262	7.48	2019-09-23 14:32
	PLS-GS-43	General Ground	Vegetation - Herbaceous			-73.9153618	41.0417327	7.98	2019-09-23 14:33
	PLS-GS-44	General Ground	Vegetation - Herbaceous			-73.9151800	41.0415637	8.00	2019-09-23 14:33
	PLS-GS-45	General Ground			top curb	-73.9152161	41.0414648	7.63	2019-09-23 14:34
	PLS-GS-46	General Ground			flag pole	-73.9150502	41.0417432	9.77	2019-09-23 14:35
	PLS-GS-47	General Ground			top curb	-73.9150821	41.0420084	8.45	2019-09-23 14:35
	PLS-GS-48	General Ground			top curb	-73.9150920	41.0420745	8.09	2019-09-23 14:36
	PLS-GS-49	General Ground	Silt/Clay			-73.9130328	41.0425773	-3.91	2019-09-23 14:36
	PLS-GS-50	General Ground			south center of gazebo	-73.9151004	41.0421755	7.87	2019-09-23 14:36
	PLS-GS-51	General Ground			north center of gazebo	-73.9151053	41.0422289	7.63	2019-09-23 14:37
	PLS-GS-52	General Ground			top wall	-73.9151084	41.0422424	8.52	2019-09-23 14:37
	PLS-GS-53	General Ground	Sand - Very Fine			-73.9134676	41.0429866	-4.21	2019-09-23 14:37
	PLS-GS-54	General Ground			top outer wall	-73.9151139	41.0422539	7.02	2019-09-23 14:38
	PLS-GS-55	General Ground			ground wall	-73.9151118	41.0422452	6.98	2019-09-23 14:38
	PLS-GS-56	General Ground			paved ground wall	-73.9151102	41.0422422	7.44	2019-09-23 14:38
	PLS-GS-57	General Ground	Sand - Very Fine			-73.9141927	41.0432655	-4.29	2019-09-23 14:39
	PLS-GS-58	General Ground			maintenance point access to storm drain	-73.9152323	41.0421822	7.62	2019-09-23 14:39
	PLS-GS-59	General Ground	Silt/Clay			-73.9150350	41.0432844	-3.31	2019-09-23 14:41
	PLS-GS-60	General Ground			top outer wall	-73.9154363	41.0422325	7.15	2019-09-23 14:41
	PLS-GS-61	General Ground			ground at wall	-73.9154337	41.0422243	6.62	2019-09-23 14:42
	PLS-GS-62	General Ground			top wall	-73.9154339	41.0422228	8.41	2019-09-23 14:42

TransectID	Name	PointType	DomSubstrate	WaterDepth	Comments	POINT_X	POINT_Y	ElevNAVD88, ft	GNSS Fix DateTime (GMT)
	PLS-GS-63	General Ground			pavement at wall	-73.9154340	41.0422207	7.29	2019-09-23 14:42
	PLS-GS-64	General Ground			top wall	-73.9155242	41.0422150	8.56	2019-09-23 14:43
	PLS-GS-65	General Ground			pavement at wall	-73.9155238	41.0422142	7.35	2019-09-23 14:43
	PLS-GS-66	General Ground			top wall	-73.9148666	41.0422578	8.47	2019-09-23 14:44
	PLS-GS-67	General Ground			ground at wall	-73.9148675	41.0422609	6.62	2019-09-23 14:44
	PLS-GS-68	General Ground			top outer wall	-73.9148662	41.0422680	7.23	2019-09-23 14:44
	PLS-GS-69	General Ground			pavement at wall	-73.9148684	41.0422569	7.33	2019-09-23 14:45
	PLS-GS-70	General Ground			pavement at wall	-73.9148356	41.0422401	7.48	2019-09-23 14:46
	PLS-GS-71	General Ground			top wall	-73.9148360	41.0422406	8.56	2019-09-23 14:46
	PLS-GS-72	General Ground			top curb	-73.9148422	41.0420909	7.55	2019-09-23 14:48
	PLS-GS-73	General Ground			top curb	-73.9148321	41.0420238	7.41	2019-09-23 14:48
	PLS-GS-74	General Ground			center walkway	-73.9148247	41.0418824	8.32	2019-09-23 14:48
	PLS-GS-75	General Ground	Vegetation - Herbaceous			-73.9147499	41.0417858	8.57	2019-09-23 14:49
	PLS-GS-76	General Ground			sidewalk	-73.9147352	41.0416024	8.59	2019-09-23 14:49
	PLS-GS-77	General Ground			top curb	-73.9146918	41.0414988	8.33	2019-09-23 14:50
	PLS-GS-78	General Ground			corner of flywheel monument	-73.9146624	41.0415430	8.47	2019-09-23 14:50
	PLS-GS-79	General Ground			corner of flywheel monument	-73.9145479	41.0415527	8.45	2019-09-23 14:51
	PLS-GS-80	General Ground			corner of flywheel monument	-73.9145576	41.0416502	8.28	2019-09-23 14:51
	PLS-GS-81	General Ground			corner of flywheel monument	-73.9146737	41.0416419	8.72	2019-09-23 14:51
	PLS-GS-82	General Ground			top curb	-73.9145457	41.0417599	8.01	2019-09-23 14:53
	PLS-GS-83	General Ground			catch basin	-73.9146604	41.0420376	6.50	2019-09-23 14:54
	PLS-GS-84	General Ground			top curb	-73.9146155	41.0420359	7.47	2019-09-23 14:54
	PLS-GS-85	General Ground			catch basin	-73.9146653	41.0420997	6.32	2019-09-23 14:54
	PLS-GS-86	General Ground			top curb	-73.9145709	41.0420959	7.30	2019-09-23 14:54
	PLS-GS-87	General Ground			sewer manhole cover	-73.9145109	41.0421119	7.68	2019-09-23 14:55
	PLS-GS-88	General Ground	Vegetation - Herbaceous			-73.9145801	41.0421767	7.57	2019-09-23 14:56
	PLS-GS-89	General Ground			manhole cover	-73.9145301	41.0422192	7.71	2019-09-23 14:56
	PLS-GS-90	General Ground			hydrant	-73.9144625	41.0420905	7.89	2019-09-23 14:57
	PLS-GS-91	General Ground			sidewalk	-73.9143932	41.0421487	7.35	2019-09-23 14:58
	PLS-GS-92	General Ground			sidewalk in front of gate to the View	-73.9141735	41.0422124	7.61	2019-09-23 14:58
	PLS-GS-93	General Ground	Boulder - Small		top outer wall, transition point to boulder wall	-73.9148322	41.0422523	6.92	2019-09-23 15:01
	PLS-GS-94	General Ground			top wall	-73.9137406	41.0422072	8.68	2019-09-23 15:04
	PLS-GS-95	General Ground			ground at wall	-73.9137410	41.0422057	7.64	2019-09-23 15:04
	PLS-GS-96	General Ground			ground at wall	-73.9137388	41.0422093	7.84	2019-09-23 15:04
	PLS-GS-97	General Ground			top outer wall, concrete on top of small boulders	-73.9137361	41.0422184	7.93	2019-09-23 15:05
	PLS-GS-98	General Ground	Sand - Medium			-73.9161475	41.0426590	3.76	2019-09-23 15:06
	PLS-GS-99	General Ground			pavement at wall	-73.9131210	41.0420611	7.95	2019-09-23 15:06
	PLS-GS-100	General Ground			top wall	-73.9131214	41.0420639	8.74	2019-09-23 15:07
	PLS-GS-101	General Ground			ground at wall	-73.9131223	41.0420645	8.20	2019-09-23 15:09
	PLS-GS-102	General Ground	Boulder - Small		top outer wall, rip rap	-73.9131208	41.0420741	7.68	2019-09-23 15:09
	PLS-GS-103	General Ground			catch basin	-73.9131347	41.0419974	7.56	2019-09-23 15:11
	PLS-GS-104	General Ground			hydrant	-73.9131247	41.0419820	8.19	2019-09-23 15:11
	PLS-GS-105	General Ground			top curb	-73.9130674	41.0420182	8.74	2019-09-23 15:12
	PLS-GS-106	General Ground			water main access, V91 marker	-73.9131024	41.0420368	7.96	2019-09-23 15:12
	PLS-GS-107	General Ground			water main access, V92 marker	-73.9131432	41.0420304	7.60	2019-09-23 15:13
	PLS-GS-108	General Ground			water main access	-73.9131507	41.0419869	7.65	2019-09-23 15:13
	PLS-GS-109	General Ground			top curb	-73.9132400	41.0420677	8.24	2019-09-23 15:14
	PLS-GS-110	General Ground			catch basin	-73.9132440	41.0420529	7.69	2019-09-23 15:14

TransectID	Name	PointType	DomSubstrate	WaterDepth	Comments	POINT_X	POINT_Y	ElevNAVD88, ft	GNSS Fix DateTime (GMT)
	PLS-GS-111	Photo				-73.9132031	41.0420522	9.29	2019-09-23 15:16
	PLS-GS-112	Photo				-73.9138596	41.0422088	7.51	2019-09-23 15:17
	PLS-GS-113	Photo				-73.9142740	41.0422127	8.88	2019-09-23 15:18
	PLS-GS-114	Photo				-73.9146827	41.0419954	9.16	2019-09-23 15:19
	PLS-GS-115	Photo				-73.9153466	41.0422148	7.62	2019-09-23 15:21
	PLS-GS-116	Photo				-73.9156899	41.0419422	8.39	2019-09-23 15:23
	PLS-GS-117	General Ground			east corner of overlook decking	-73.9158960	41.0424633	5.59	2019-09-23 15:34
	PLS-GS-118	General Ground			southeast corner of overlook decking	-73.9159129	41.0424507	5.51	2019-09-23 15:34
	PLS-GS-119	General Ground			edge of overlook decking at stairs	-73.9160715	41.0425963	5.60	2019-09-23 15:35
	PLS-GS-120	General Ground			south edge of overlook decking at stairs	-73.9160868	41.0425827	5.54	2019-09-23 15:36
	PLS-GS-121	General Ground			northwest corner of overlook decking	-73.9162319	41.0427161	5.43	2019-09-23 15:37
	PLS-GS-122	General Ground			west corner of overlook decking	-73.9162524	41.0427071	5.38	2019-09-23 15:37
	PLS-GS-123	General Ground			wooden ramp northeast corner	-73.9157594	41.0424274	2.23	2019-09-23 15:42
	PLS-GS-124	General Ground			wooden ramp northwest corner	-73.9157803	41.0424169	2.34	2019-09-23 15:43
	PLS-GS-125	General Ground			wooden ramp southwest corner at gate	-73.9156958	41.0423235	7.81	2019-09-23 15:43
	PLS-GS-126	General Ground			wooden ramp northeast corner at gate	-73.9156762	41.0423425	7.89	2019-09-23 15:44
	PLS-GS-127	General Ground			wooden ramp corner at gate	-73.9156982	41.0423547	7.75	2019-09-23 15:44
	PLS-GS-128	General Ground			wooden ramp corner at gate	-73.9157149	41.0423375	7.75	2019-09-23 15:44
	PLS-GS-129	General Ground			top end wall	-73.9158681	41.0424237	7.86	2019-09-23 15:45
	PLS-GS-130	General Ground			ground end wall	-73.9158677	41.0424226	5.99	2019-09-23 15:46
	PLS-GS-131	General Ground	Sand - Medium		ground at edge stairs	-73.9160558	41.0425985	2.96	2019-09-23 15:48
	PLS-GS-132	General Ground	Sand - Medium		ground at edge stairs	-73.9160701	41.0426092	3.09	2019-09-23 15:48
	PLS-GS-133	General Ground			top bulkhead	-73.9163088	41.0429645	4.13	2019-09-23 15:50
	PLS-GS-134	General Ground	Cobble - Small		ground at bulkhead	-73.9163056	41.0429668	0.47	2019-09-23 15:51
	PLS-GS-135	General Ground	Gravel - Medium			-73.9162662	41.0429793	-1.26	2019-09-23 15:52
	PLS-GS-136	General Ground			top cribbing	-73.9162099	41.0428208	4.38	2019-09-23 15:54
	PLS-GS-137	General Ground	Sand - Fine		ground at cribbing wall	-73.9162083	41.0428214	1.48	2019-09-23 15:55
	PLS-GS-138	General Ground	Gravel - Medium			-73.9161719	41.0428327	-0.03	2019-09-23 15:56
	PLS-GS-139	Water Surface	Gravel - Medium			-73.9161468	41.0428470	-1.21	2019-09-23 15:59
	PLS-GS-140	General Ground	Sand - Medium		corner if crib wall	-73.9161412	41.0427421	1.46	2019-09-23 15:59
	PLS-GS-141	General Ground	Sand - Medium		top corner if crib wall	-73.9161430	41.0427409	4.78	2019-09-23 16:00
	PLS-GS-142	Other			base of cell tower	-73.9158779	41.0424406	3.41	2019-09-23 16:02
	PLS-GS-143	Benchmark				-73.9160259	41.0425886	2.91	2019-09-23 16:10
	PLS-GS-144	Photo				-73.9158956	41.0424792	2.31	2019-09-23 16:18
	PLS-GS-145	Other	(blank)	(blank)	pipe	-73.9151400	41.0422570	-1.00	2019-09-23 16:12
	PLS-GS-146	Other	(blank)	(blank)	(blank)	-73.9145300	41.0422600	-0.60	2019-09-23 16:14
	PLS-GS-147	Other	(blank)	(blank)	pipe	-73.9137610	41.0422360	-0.22	2019-09-23 16:25
	PLS-REF-P1	General Ground	Gravel - Very Fine			-73.9048137	41.0419057	0.38	2019-09-23 17:10
	PLS-REF-P2	General Ground	Other		organic mat	-73.9048175	41.0419031	0.94	2019-09-23 17:11
	PLS-REF-P3	Wrack			wrack line	-73.9048181	41.0419797	2.87	2019-09-23 17:13
	PLS-REF-SA-1	General Ground			s. alt low elev, muck on rip rap	-73.9042939	41.0421400	-0.13	2019-09-23 16:57
	PLS-REF-SA-2	General Ground	Other		s. alterniflora low end, muck on rip rap	-73.9042413	41.0421371	-0.66	2019-09-23 16:59
	PLS-REF-SA-3	General Ground	Other		s. alterniflora high, muck on rip rap	-73.9042524	41.0421453	0.09	2019-09-23 17:00
PLS-REF-T1	PLS-REF-T1-1	General Ground	Other	1.1	organics/muck	-73.9042789	41.0419923	-1.79	2019-09-23 16:40
PLS-REF-T1	PLS-REF-T1-2	General Ground	Other	0.7	organics/muck	-73.9043140	41.0420513	-1.49	2019-09-23 16:41
PLS-REF-T1	PLS-REF-T1-3	General Ground	Other	edge water	organics/muck	-73.9043563	41.0421159	-0.68	2019-09-23 16:42
PLS-REF-T1	PLS-REF-T1-4	General Ground	Sand - Coarse		some riprap, gravel	-73.9043658	41.0421208	-0.28	2019-09-23 16:45
PLS-REF-T1	PLS-REF-T1-5	General Ground	Sand - Coarse		s. alterniflora start	-73.9043635	41.0421311	0.30	2019-09-23 16:46

TransectID	Name	PointType	DomSubstrate	WaterDepth	Comments	POINT_X	POINT_Y	ElevNAVD88, ft	GNSS Fix DateTime (GMT)
PLS-REF-T1	PLS-REF-T1-6	General Ground	Other		s. alterniflora upper, muck on rip rap	-73.9043780	41.0421451	1.37	2019-09-23 16:47
PLS-REF-T1	PLS-REF-T1-7	General Ground	Other		s. alt end, start rip rap, muck on riprap	-73.9043803	41.0421452	1.46	2019-09-23 16:50
PLS-REF-T1	PLS-REF-T1-8	General Ground	Cobble - Large		stop rip rap, start phrag.	-73.9043796	41.0421593	2.86	2019-09-23 16:51
PLS-REF-T1	PLS-REF-T1-9	General Ground	Gravel - Medium		mug wort, road edge	-73.9043943	41.0421765	4.81	2019-09-23 17:18
PLS-REF-T2	PLS-REF-T2-1	General Ground	Other	1.0	muck	-73.9045807	41.0419343	-1.57	2019-09-23 17:09
PLS-REF-T2	PLS-REF-T2-2	General Ground	Other	1.0	muck	-73.9045932	41.0419494	-1.37	2019-09-23 17:08
PLS-REF-T2	PLS-REF-T2-3	General Ground	Other	0.90	muck	-73.9046091	41.0419671	-1.37	2019-09-23 17:08
PLS-REF-T2	PLS-REF-T2-4	General Ground	Other	0.65	muck	-73.9046220	41.0419805	-1.06	2019-09-23 17:07
PLS-REF-T2	PLS-REF-T2-5	General Ground	Sand - Medium	edge water	muck	-73.9046385	41.0419915	-0.39	2019-09-23 17:06
PLS-REF-T2	PLS-REF-T2-6	General Ground	Sand - Medium		start organic deposit	-73.9046589	41.0420146	0.93	2019-09-23 17:05
PLS-REF-T2	PLS-REF-T2-7	General Ground	Sand - Fine		edge phrag	-73.9046729	41.0420281	1.84	2019-09-23 17:05

Appendix B

Stakeholder Kickoff Meeting (August 22, 2019)

Climate Adaptive Design (CAD) Studio

Piermont Living Shoreline Project

Kickoff Meeting
Piermont Village Hall
August 22, 2019

NEIWPCC
New England Interstate Water Pollution Control Commission

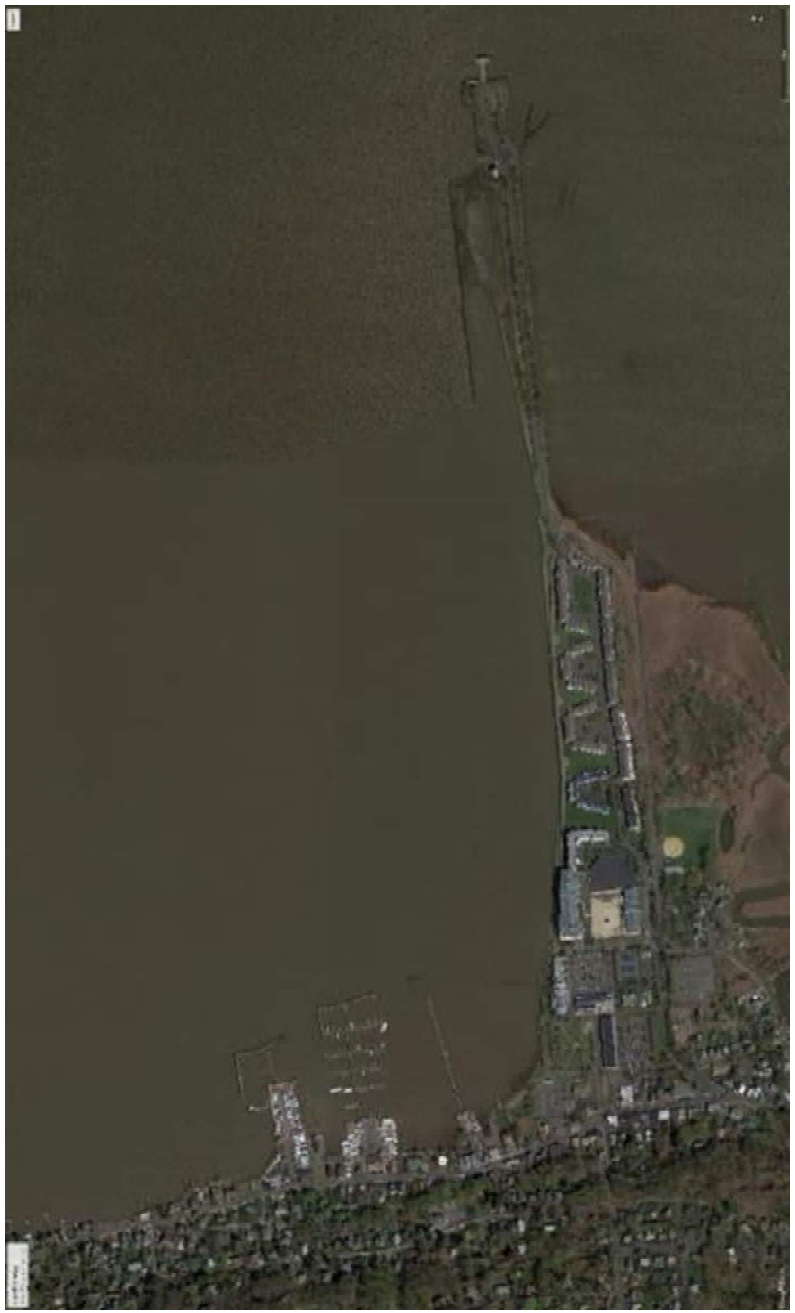
NEW YORK STATE OF OPPORTUNITY | Hudson River Estuary Program
A Program of the New York State Department of Environmental Conservation

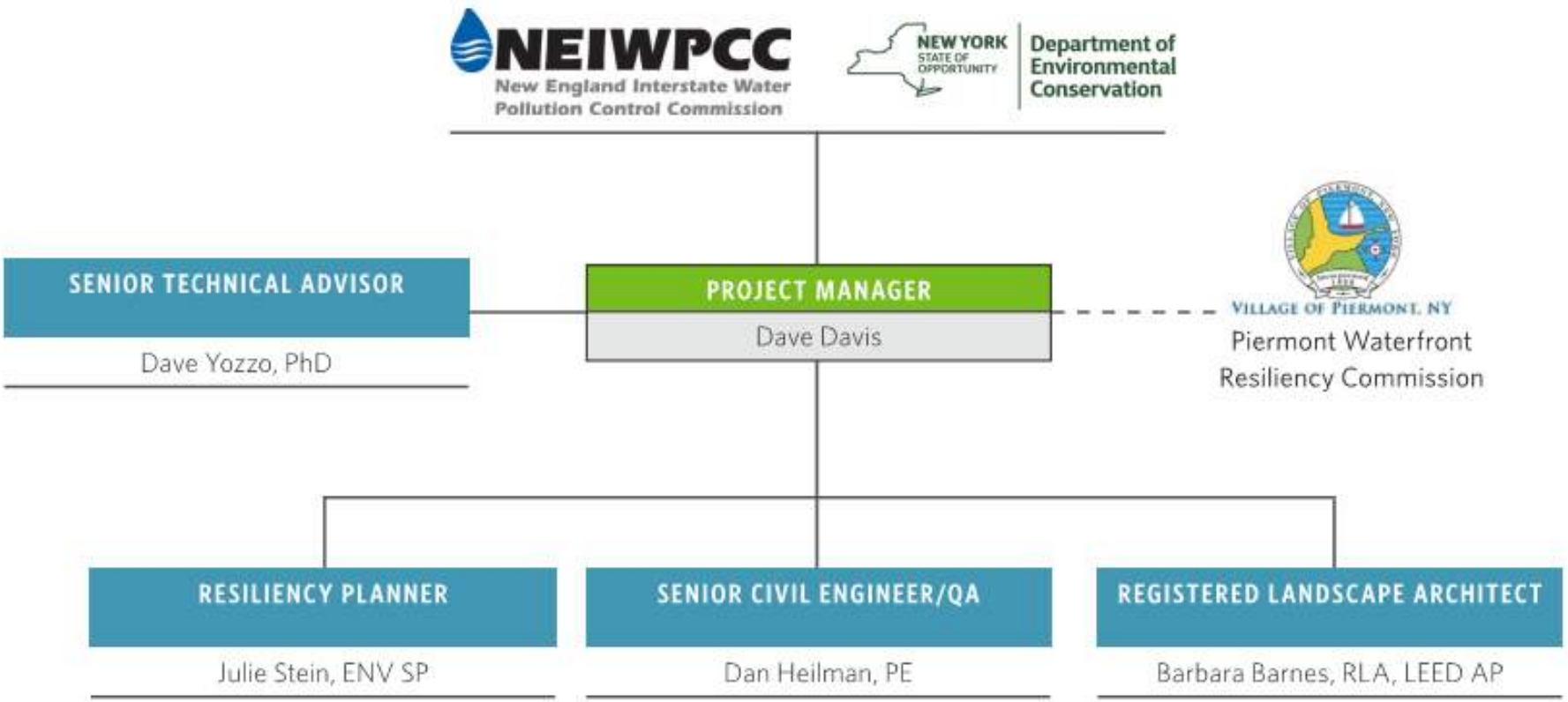
VILLAGE OF PIERMONT, NY

HDR

Agenda

- Introduce HDR team & Project Partners (Roles & Responsibilities)
- Project Background & Shared Vision
- CAD Concepts & Overall Design Objectives (Expected Outputs & Outcomes)
- QAPP & Site Investigation
- Stakeholder Engagement & Coordination
- Overall Permitting Strategy
- Project Schedule
- Site Visit





ADDITIONAL RESOURCES

SITE ASSESSMENT LEAD
Kevin Verweire

ENVIRONMENTAL SCIENTISTS
David Brizzolara
Jaclyn Chapman
Darren Sinnott

WATER RESOURCE ENGINEER
Kim Lukas, PE

WETLAND SCIENTIST
Steve Seymour, PWS

FIELD/LAB COORDINATOR
Ehren Deppert

DATA AQUISITION MANAGER/QC
Jaak Van den Sype

DRONE PILOT-IN-COMMAND
Casey Stokes

GIS ANALYST
Marc Korpus

Roles & Responsibilities

Organization	Name	Role	Responsibility
HDR	Julie Stein	HDR Principle in Charge (PiC)	• Overall contract management for HDR
HDR	David S. Davis	Project Manager	• Establish and maintain project schedule and budget • Stakeholder strategy and engagement • Oversight and final review of all project deliverables • QAPP implementation
HDR	David J. Yozzo	Senior Technical Advisor/QA	• Technical oversight of data collections and review of deliverables • QAPP implementation
HDR	Barbara Barnes	Registered Landscape Architect/QC	• QC Review and oversight of landscape design and deliverables
HDR	Kim Lukas	Water Resource Engineer	• Review CAD concepts • Prepare engineering design report
HDR	Kevin VerWeire	Site Assessment Lead	• Site assessment lead and living shoreline design
NYSDEC	Daniel Miller	NEIWPCC Project Manager	• Review and oversight of technical work progress and deliverables • Coordinate NYSDEC and HREP stakeholder engagement
NEIWPCC	Peter Zaykoski	Quality Assurance Program Manager	• Contract management • Review QAPP and subsequent revisions for conformance to NEIWPCC guidelines
NYSDEC/ Cornell Cooperative Extension	Libby Zemaitis	HREP Climate Outreach Specialist	• Project implementation and reviews
Village of Piermont	Nathan Mitchell	Piermont Waterfront Resiliency Commission Chair	• Project implementation and oversight • Local stakeholder engagement

Project Background

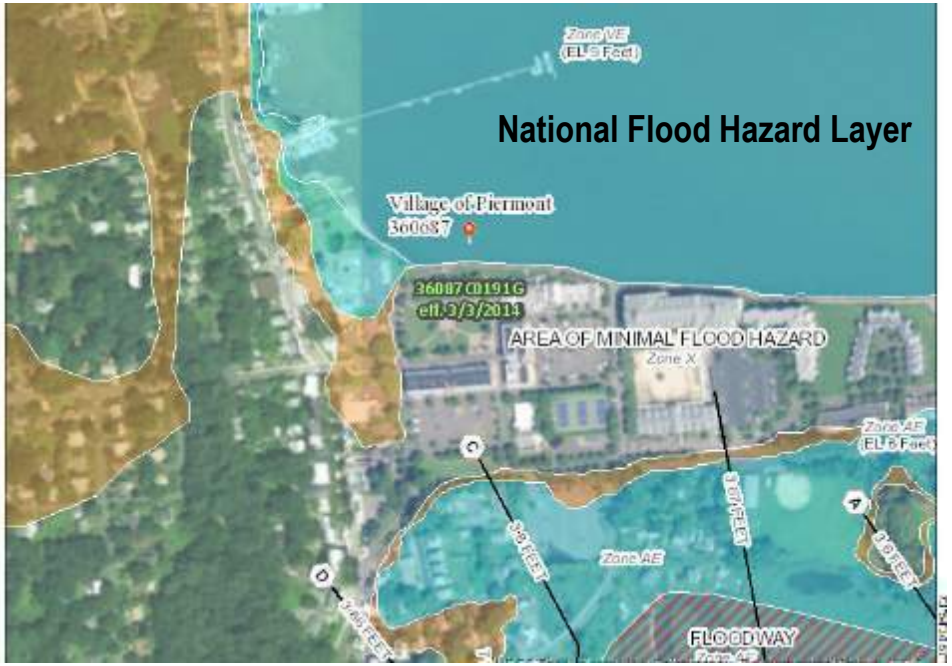
- Piermont's location is a great asset and offers a unique opportunity for coastal resiliency planning.
- The challenges of climate change and sea level rise will be significant:
  - ✓ 0.75 to 2.5 feet rise by 2050 and 1.25 to 9.5 feet by 2100 in lower HR estuary (NYSDEC)
  - ✓ 52.5% of Piermont at risk from 1% flood event (Rockland County Hazard Mitigation Plan)
- Through collective planning, engaged citizens and a shared stakeholder vision, Piermont is uniquely positioned to face the challenge.

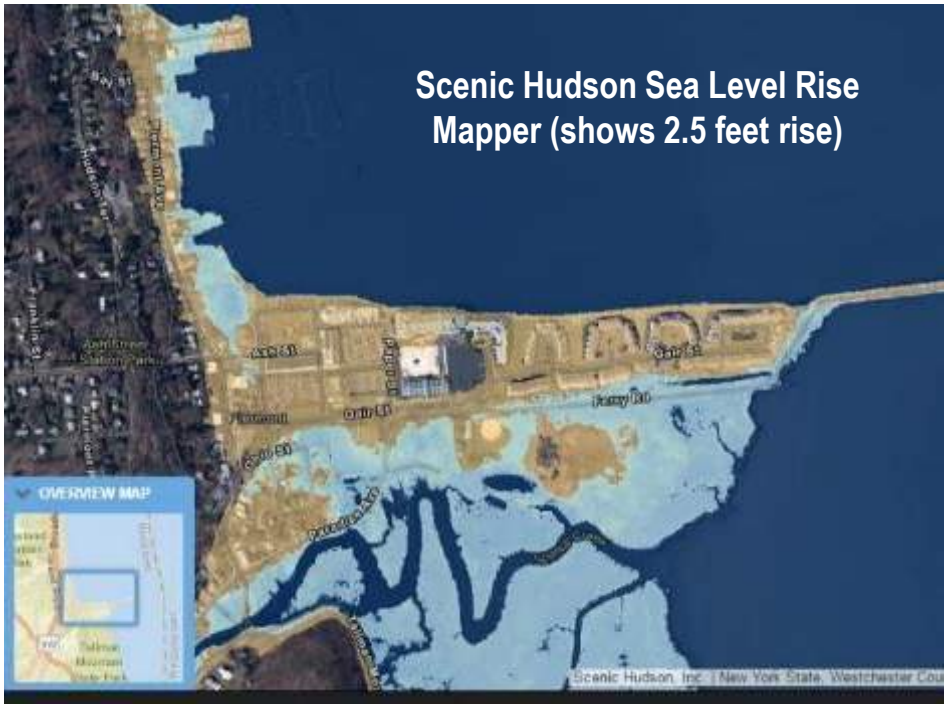
From Piermont Waterfront Resiliency Commission 2018

From Piermont Marsh Reserve Management Plan 2017 (NYSDEC)

Shared Vision for a Resilient Piermont

- Report of the Piermont Waterfront Resilience Task Force (2014)
- Desired outcomes from the community, a resilient Piermont will…
  - ✓ adapt gradually to avoid and minimize risks
  - ✓ be a model for others
  - ✓ help its residents and businesses to recover quickly from floods and storms
  - ✓ maintain the Village's relationship with the Hudson River
  - ✓ maintain a vibrant business district and local economy
  - ✓ foster and build community
  - ✓ be environmentally responsible





Climate Adaptive Design (CAD) Studio

- Cornell University's CAD Studio began design process in Fall 2017.
- Students developed 5 independent designs that envisioned future waterfront reinforcement, adaptation and relocation in Piermont.
- Each of the CAD Studio designs offers well thought out, innovative ideas for improving Piermont's coastal resiliency.

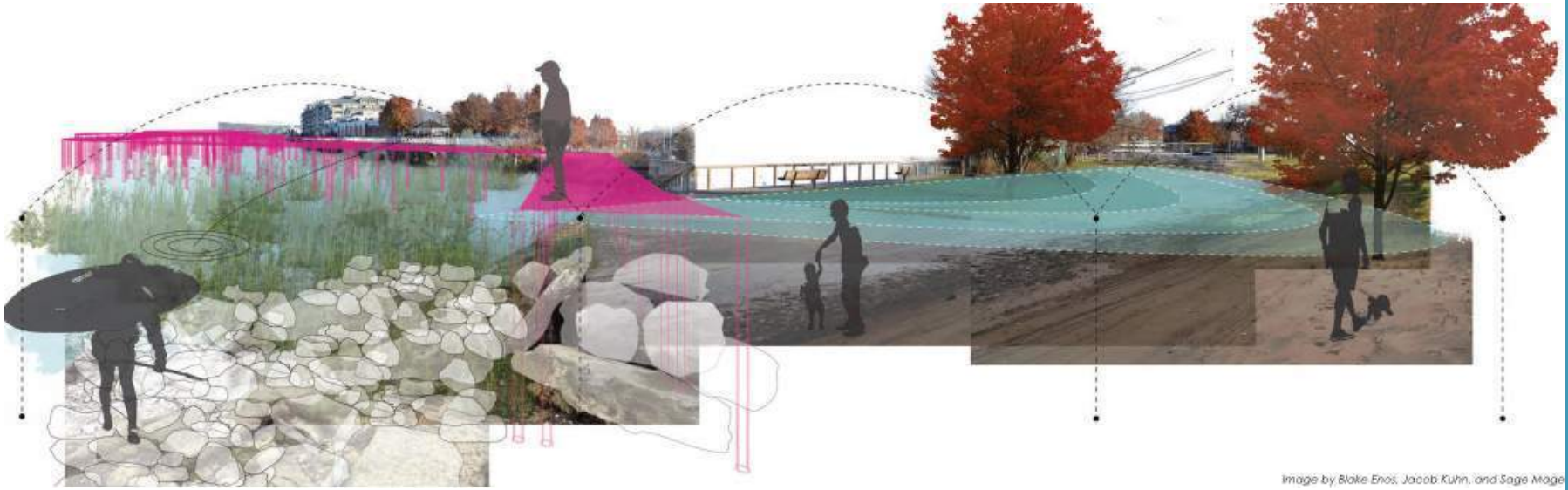
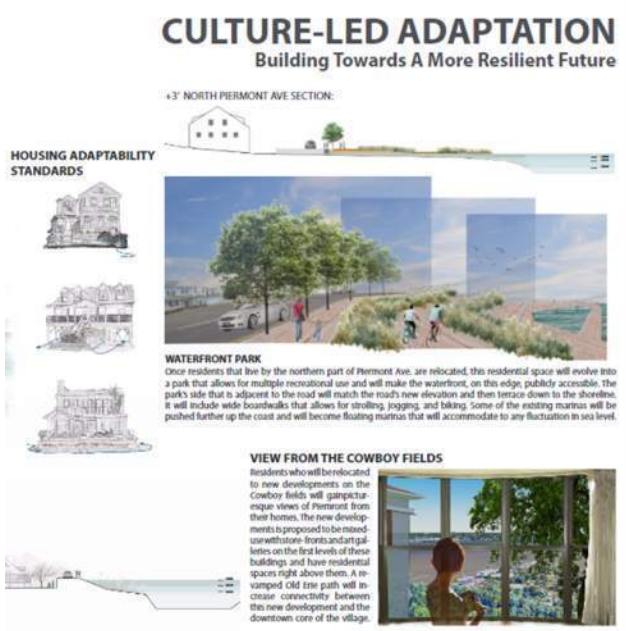
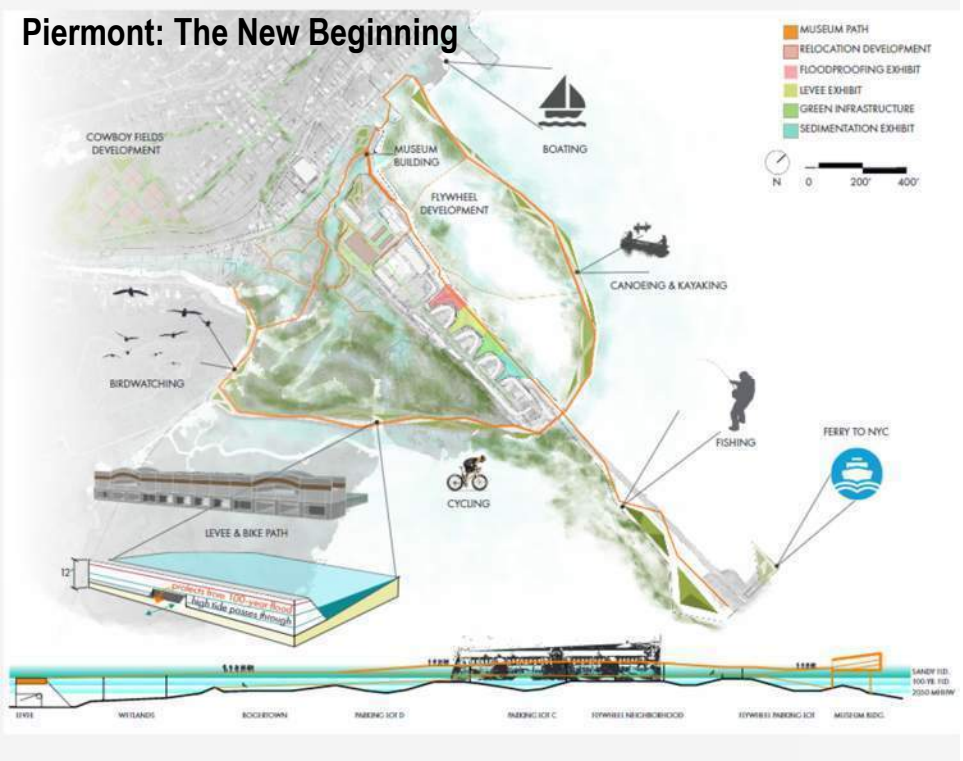


Image by Blake Enos, Jacob Kuhn, and Sage Mage

Design Objective

- Review CAD Studio concepts and use common elements to develop a cohesive and implementable design for a coastal resiliency project.
- Must achieve five overarching criteria:
  - ✓ Be cost-effective and able to attain state and local agency support and permits
  - ✓ Align with Piermont's existing Waterfront Resiliency Program and Local Waterfront Revitalization Plan (LWRP)
  - ✓ Align with the goals of the Hudson River Estuary Program and nearby Piermont Marsh reserve.
  - ✓ Be in keeping with the village's scenic and waterfront character
  - ✓ Include educational or interpretive elements





Site Identification

- During the RFP stage, HDR met with the Village and identified a potential project area north of the existing pier.
- Public open space area that could offer an opportunity to restore ecological diversity and protect a mix of land uses and infrastructure offset from the waterfront.
- An ecological and general site condition assessment will be conducted during a one-day site investigation planned for mid to late September.

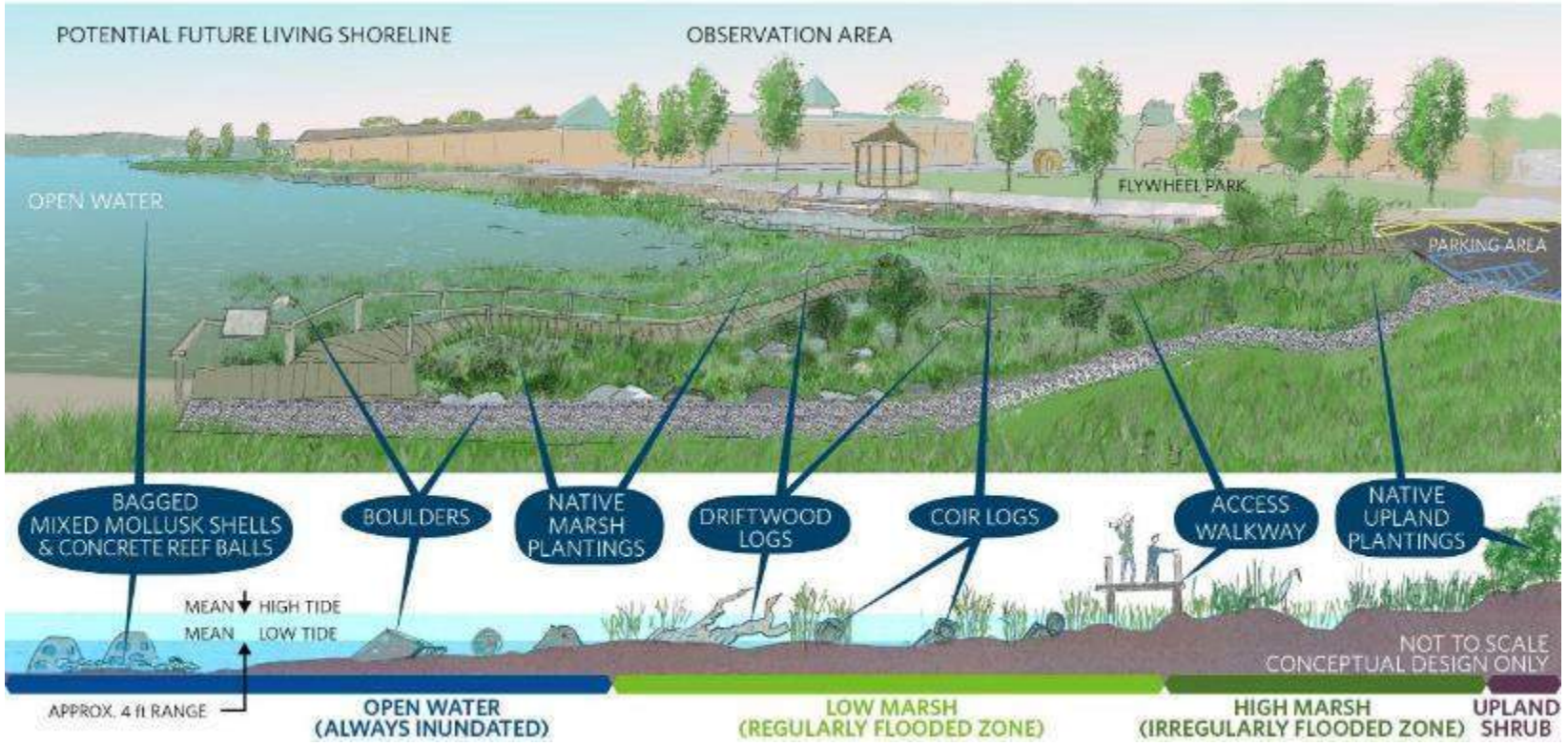
Design Methodology

- Preliminary design will follow the guidance outlined by NYSDEC for Marine and Coastal District Waters including the Hudson River south of the Tappan Zee Bridge.
- Living shorelines use vegetation and other natural elements, such as oysters or mussel beds, often in combination with harder shoreline structures to stabilize and protect coastlines in an estuarine system.
- Added benefits:
  - ✓ Improving water quality by filtering nutrients and pollutants,
  - ✓ Creating habitat for fish, birds and other living resources,
  - ✓ Promoting recreation and adaptive uses.

Preliminary Design (to be investigated)

- Incorporate additional structured protection as appropriate to stabilize the slope and protect against erosive forces such as boat wakes, ice scour and storm surge.

- Low profile sills made of broken rock, bagged mixed mollusk shells, modular oyster “castles”, or concrete reef balls to protect marsh plantings and provide additional habitat for aquatic organisms.



First Steps

- ✓ Finalize Quality Assurance Project Plan (QAPP)
- ✓ Project Kickoff Meeting (August 22, 2019)
- Review CAD Concepts and Develop Checklist of Key Elements
- Conduct Site Assessment (September 2019)

Northern pier ecological buffer and pedestrian walkway to protect Piermont against wave action and reduce sediment deposition

Site Assessment (Topo)

- Review existing data (see NOAA Digital Coast Topobathymetry Base Map with elevation contours).
- Aerial drone survey will collect aerial imagery, videography, and photogrammetry as well as high-accuracy topography.
- Water elevations collected at low tide every 50 feet along the shoreline as well as locations of both natural and man-made features to a wadeable depth using RTK GPS.

Site Assessment (Ecological and General Site Condition)

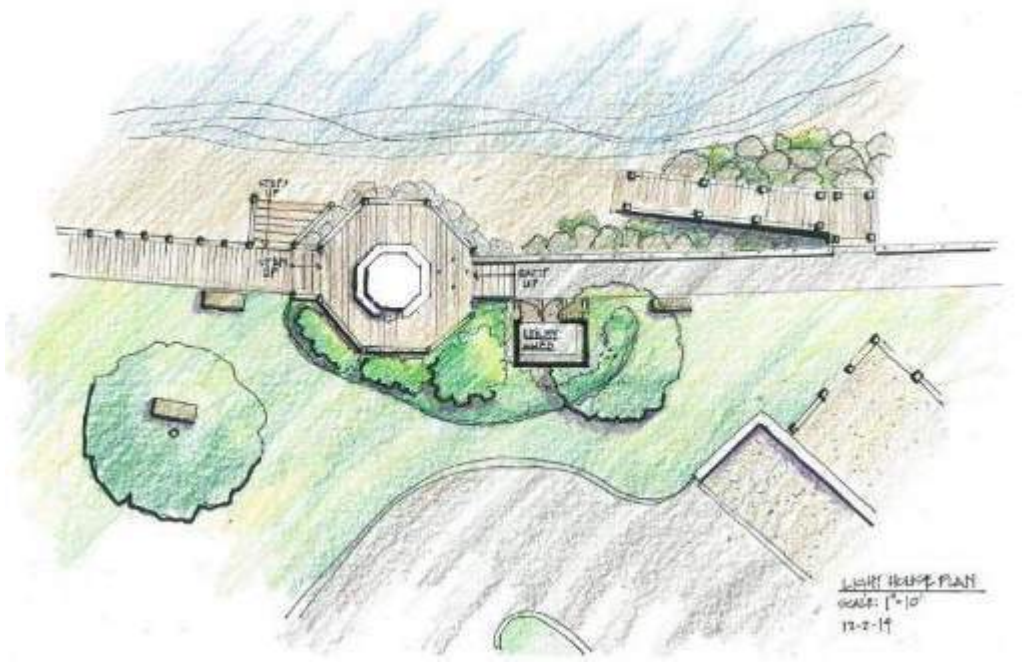
- Describe existing ecological communities based on Edinger *et al.* 2014
- Record:
  - ✓ Dominant plant species
  - ✓ Invasive species present
  - ✓ Rare plants or animals observed
  - ✓ Dominant substrate types
  - ✓ Visual assessment of bank and shoreline stability
  - ✓ Observed site constraints and ecological opportunities

Stakeholder Engagement

- Stakeholder engagement will guide the selection of design features and refine preliminary concept design.
- Key stakeholders include:
  - ✓ NYSDEC Hudson River Estuary Program (HREP)
  - ✓ NYSDEC Division of Fish & Wildlife (Regulatory)
  - ✓ Hudson River National Estuarine Research Reserve (HRNERR)
  - ✓ Hudson River Sustainable Shorelines Project
  - ✓ New England Interstate Water Pollution Control Commission (NEIWPCC)
  - ✓ U.S. Army Corps of Engineers – New York District
  - ✓ NOAA National Marine Fisheries Service (NMFS)
  - ✓ Village of Piermont
  - ✓ Piermont Waterfront Resiliency Commission
  - ✓ Cornell University
  - ✓ Scenic Hudson

Local Stakeholders

- Village staff will assist planning and stakeholder engagement including coordination with property/landowners at the community level.
- Concurrent Projects Near Parelli Park:
  - ✓ Rebuild of Public Boat Ramp Damaged during Superstorm Sandy
  - ✓ Memorial Lighthouse Project



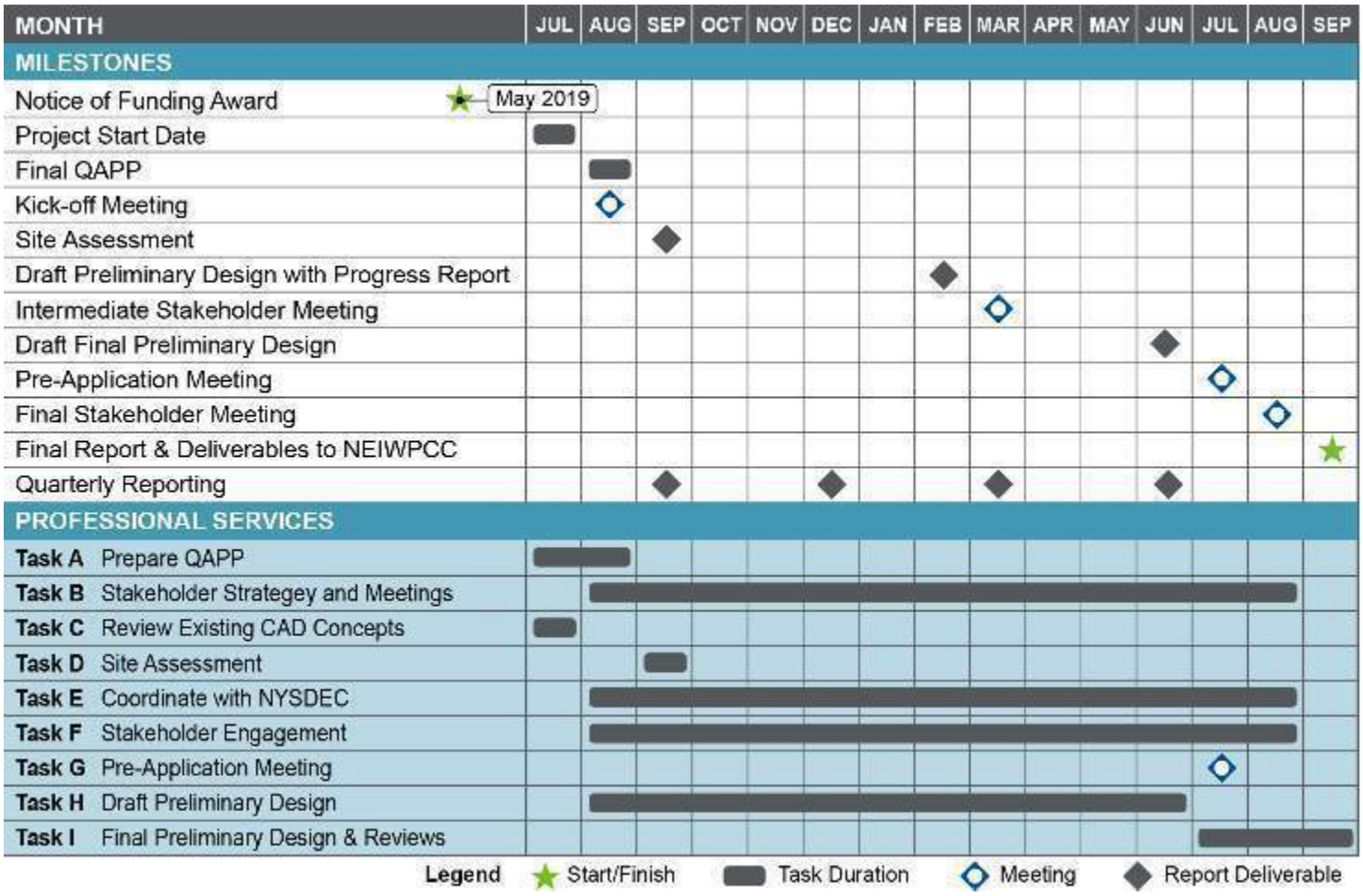
Permitting Strategy

- As part of the Preliminary Design Report, HDR will outline an overall permitting strategy for the proposed project.
- HDR will prepare materials and attend a pre-application meeting with relevant state and federal regulatory staff to review the draft preliminary design.
- No permit applications will be filed under this contract.

Preliminary Concept Design Deliverables

- Engineering Report and Drawings (Draft & Final)
- Summary of CAD Studio Design Review and Project Justification
- Stakeholder Engagement Summary
- Site Assessment Summary
- Permitting Strategy and Compiled Application Materials
- Implementation Strategy that estimates:
  - ✓ Future construction and maintenance costs
  - ✓ Permitting and construction timelines
  - ✓ Recommended project specifications with construction, maintenance and monitoring considerations
  - ✓ Potential funding source(s)
  - ✓ General implementation recommendations

Project Schedule with Key Milestones & Deliverables



Discussion

- Questions for the project team?
- Action Items
- HDR will prepare a meeting summary for review and inclusion in the Preliminary Design Report
- Site Visit

Appendix C

Preliminary Design Drawings

SITE AERIAL
SCALE: N.T.S.

Contract Drawings For

Climate Adaptive Design (CAD) Studio Piermont Living Shoreline Project

Final 30% Conceptual Design

Civil/Environmental

Project No.
000000010177415

Piermont, New York
July 2020

INDEX OF DRAWINGS

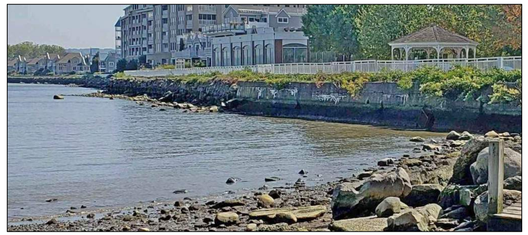
THIS DOCUMENT WAS PREPARED FOR THE HUDSON RIVER ESTUARY PROGRAM, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, WITH SUPPORT FROM THE NEW YORK STATE ENVIRONMENTAL PROTECTION FUND, IN COOPERATION WITH NEIWPCC. THE VIEWPOINTS EXPRESSED HERE DO NOT NECESSARILY REPRESENT THOSE OF NEIWPCC OR NYS 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.

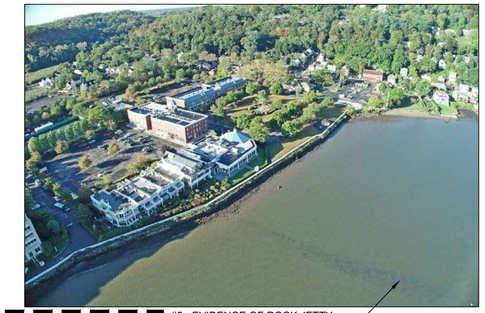
#1 - PARELLI PARK

#2 - EXISTING BOARDWALK OVERLOOK AND BEACH ACCESS

#3 - EXISTING BOARDWALK RAMP ACCESS TO BEACH

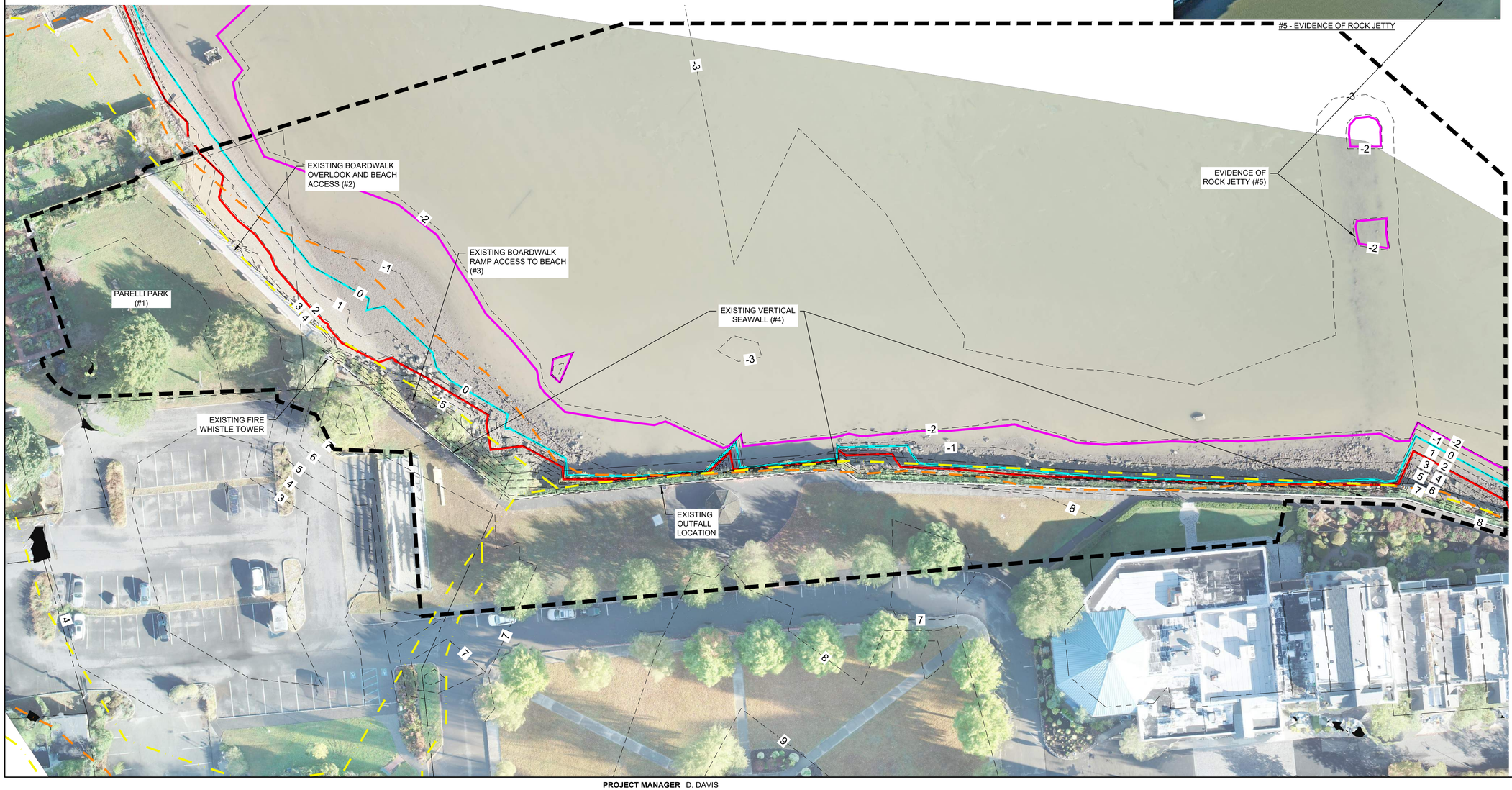


#4 - EXISTING VERTICAL SEAWALL



#5 - EVIDENCE OF ROCK JETTY

N



LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- FEMA HAZARD AREA
- TIDAL WETLAND REGULATORY LINE
- PUBLIC PARCEL
- STUDY AREA
- MEAN HIGH HIGH WATER LINE (MHHW)
- MEAN TIDE LEVEL (MTL)
- MEAN LOW LOW WATER LINE (MLLW)

NOTES:

1. EXISTING CONTOURS DERIVED FROM HDR SITE ASSESSMENT COMPLETED ON 9/23/19, WITH ELEVATIONS RELATIVE TO NAVD88.
2. AERIAL IMAGERY DERIVED FROM HDR UAV SURVEY COMPLETED ON 10/4/19.
3. TIDAL DATUM ELEVATIONS (NAVD88) ESTIMATED BY HDR USING NOAA VDATUM TOOL ON 8/14/19.

ISSUE	DATE	DESCRIPTION
2	07-13-20	FINAL 30% CONCEPTUAL DESIGN
1	05-15-20	DRAFT FINAL FOR PERMITTING REVIEW
0	02-14-20	PRELIMINARY DRAFT FOR CLIENT REVIEW

PROJECT MANAGER	D. DAVIS
DESIGNER	K. VERWEIRE
DRAFTER	J. WYNOHRADNYK
REVIEWER	D. HEILMAN
PROJECT NUMBER	000000010177415

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

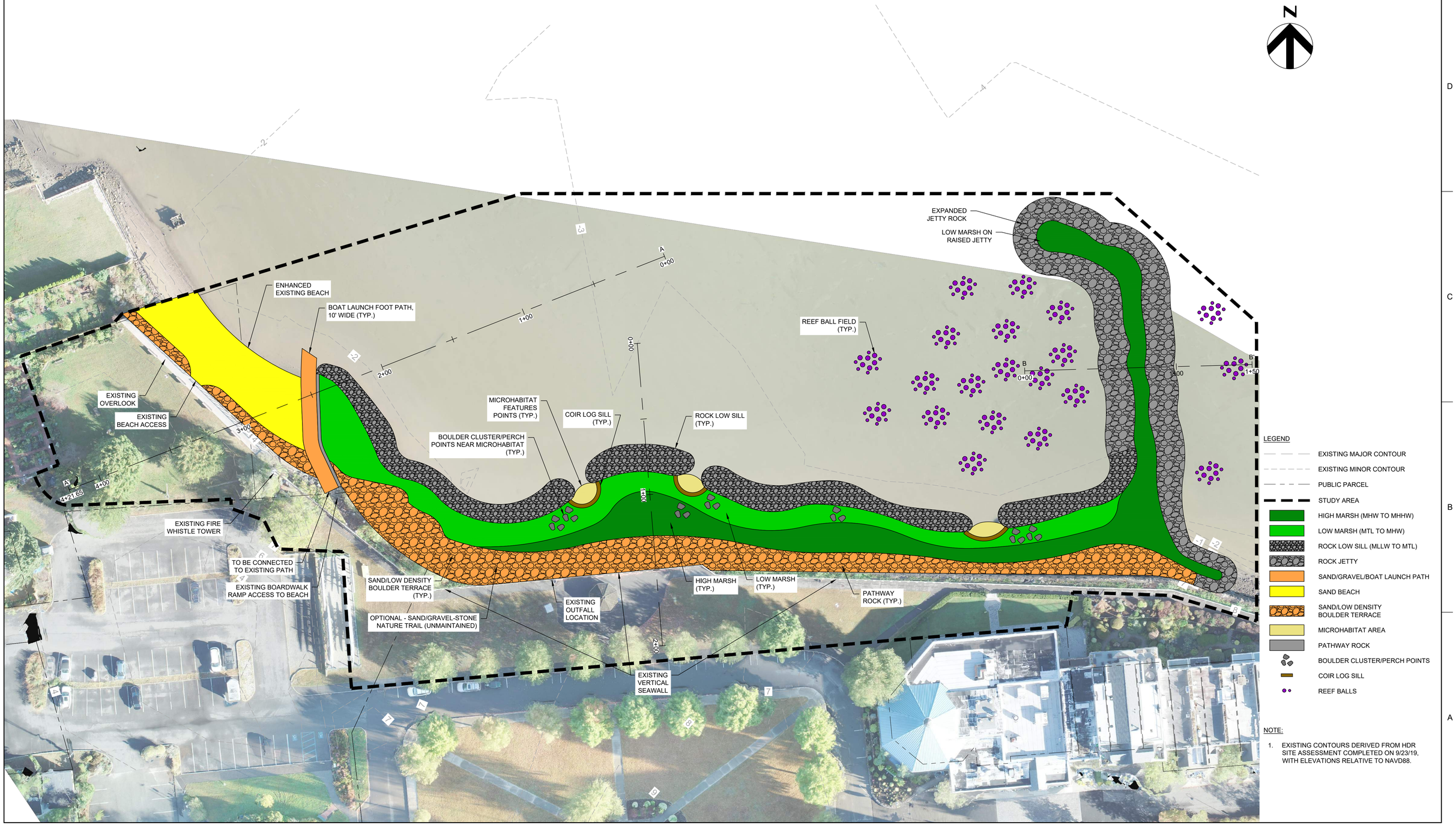
CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

EXISTING CONDITIONS PLAN

0 30' 60'

FILENAME -
SCALE 1" = 30'

SHEET
V-101



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CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

PROPOSED SITE PLAN

0 30' 60'

FILENAME -

SCALE 1" = 30'

SHEET C-101

Amelanchier ssp.
Serviceberry

Cercis canadensis
Eastern Redbud

Diervilla lonicera
Bush Honeysuckle

Vaccinium ssp.
Blueberry

Cornus sericea
Red and Yellow Twig Dogwood

Juniperus ssp.
Juniper

Physocarpus opulifolius
Eastern Ninebark

Rudbeckia hirta
Blackeye Susan

Asclepias incarnata
Swamp Milkweed

Viburnum dentatum
Arrowwood Viburnum

Symphyotrichum novae-angliea
New England Aster

Panicum virgatum
Switchgrass

Monarda ssp.
Bee Balm

Carex pensylvanica
Pennsylvania Sedge

Echinacea ssp.
Cone Flower

Rhus aromatica 'Gro-Low'
Gro-Low Fragrant Sumac

Aronia arbutifolia
Chokeberry

Solidago rugosa
Goldenrod

N

LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- STUDY AREA
- HIGH MARSH (MHW TO MHHW)
- LOW MARSH (MTL TO MHW)
- ROCK LOW SILL (MLLW TO MTL)
- ROCK JETTY
- SAND/GRAVEL/BOAT LAUNCH PATH
- SAND BEACH
- SAND/LOW DENSITY BOULDER TERRACE
- MICROHABITAT AREA
- PATHWAY ROCK
- BOULDER CLUSTER/PERCH POINTS
- COIR LOG SILL
- REEF BALLS
- SHADE TREE
- ORNAMENTAL TREE
- RESIDENTIAL PLANTING GARDEN
- PICNIC TABLE

NOTE:

1. EXISTING CONTOURS DERIVED FROM HDR SITE ASSESSMENT COMPLETED ON 9/23/19, WITH ELEVATIONS RELATIVE TO NAVD88.

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CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

PROPOSED LANDSCAPE PLAN

0 30' 60'

FILENAME -
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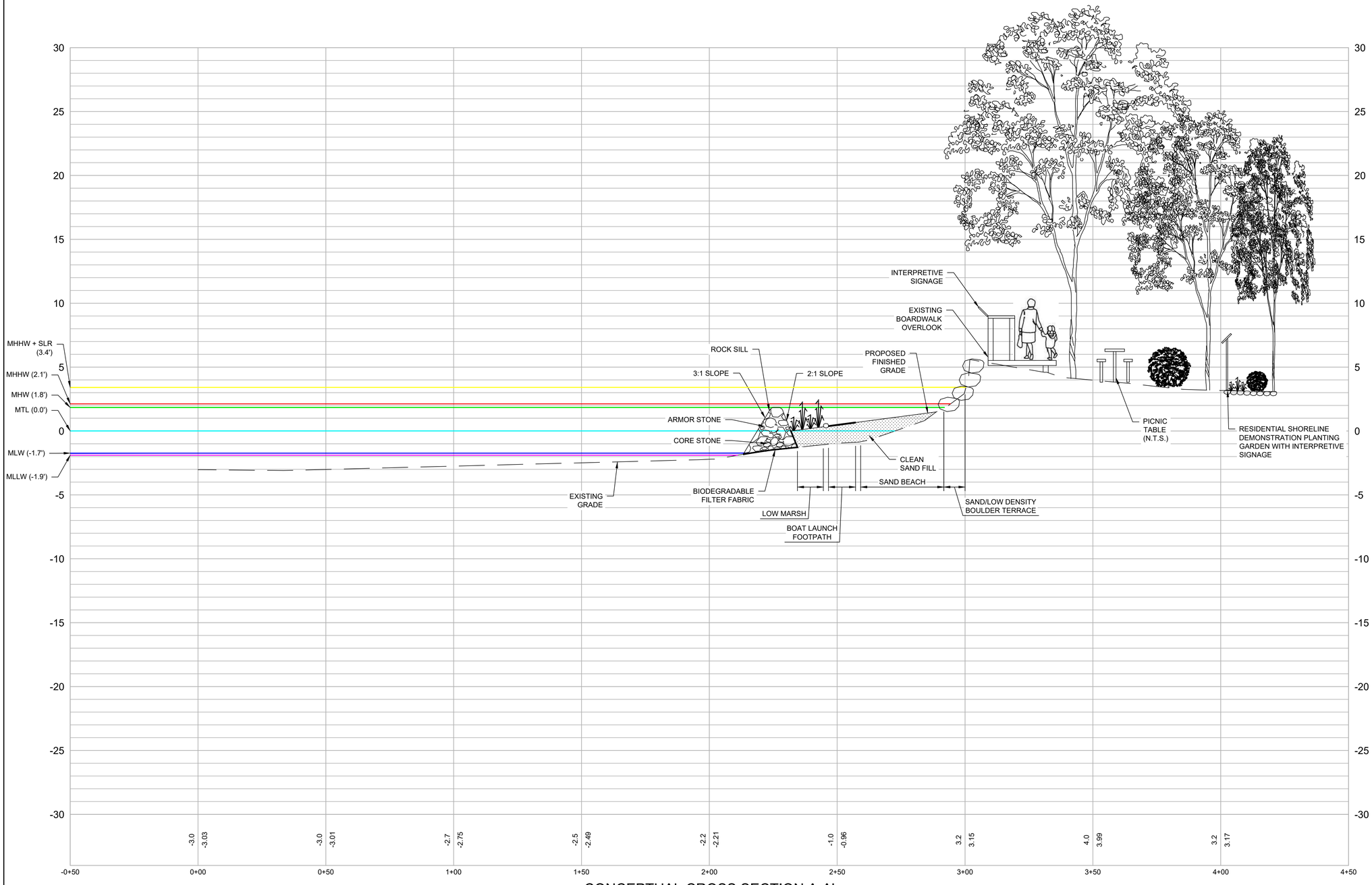
SHEET
L-101



CONCEPTUAL CROSS SECTION A-A'

NOTES:

1. EXISTING GROUND SURFACE DERIVED FROM HDR SITE ASSESSMENT COMPLETED ON 9/23/19, WITH ELEVATIONS RELATIVE TO NAVD88.
2. TIDAL DATUM ELEVATIONS (NAVD88) ESTIMATED BY HDR USING NOAA VDATUM TOOL ON 8/14/19.
3. MHHW + SLR TIDAL DATUM BASED ON NYSDEC 2050 MEDIUM PROJECTION (16") SEA LEVEL RISE (SLR) FOR THE LOWER HUDSON REGION.

0 20' 40'
HORIZONTAL SCALE

0 4' 8'
VERTICAL SCALE

ISSUE	DATE	DESCRIPTION
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CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

SECTIONS

FILENAME -
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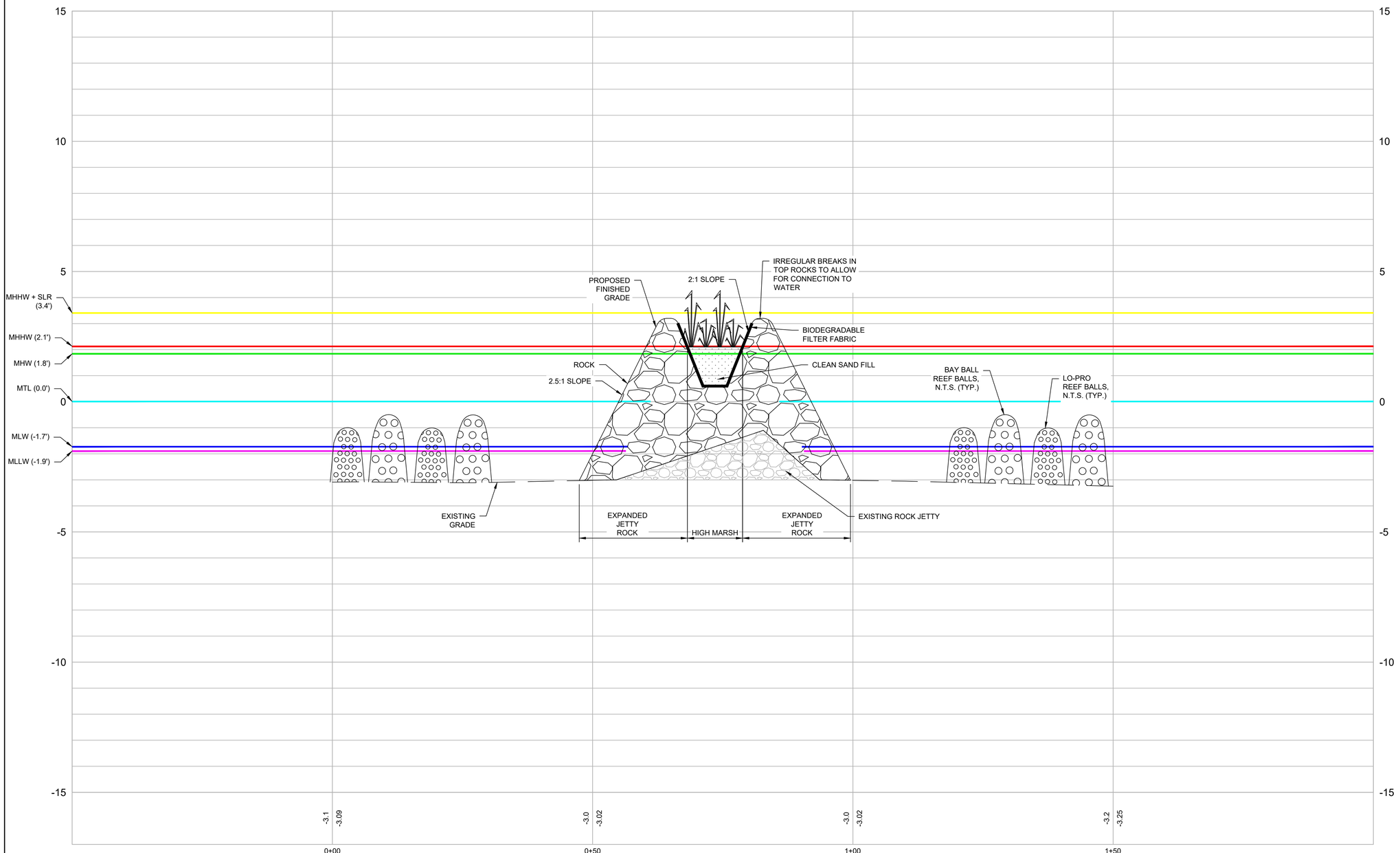
SHEET
C-301



CONCEPTUAL CROSS SECTION B-B'

NOTES:

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0 10' 20'
HORIZONTAL SCALE

0 2' 4'
VERTICAL SCALE

ISSUE	DATE	DESCRIPTION
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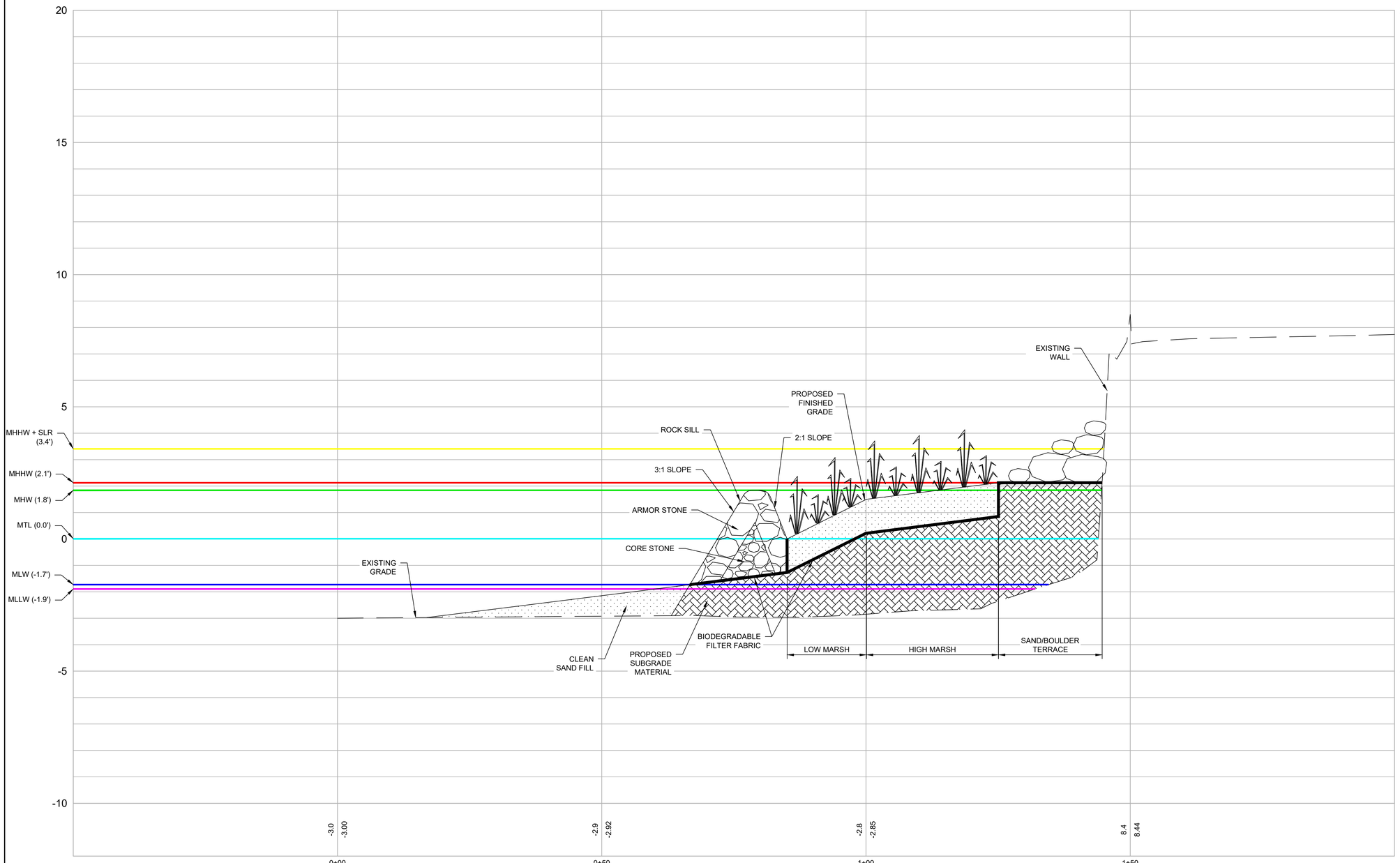
CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

SECTIONS

FILENAME -
SCALE 1" = 10'

SHEET
C-302



CONCEPTUAL CROSS SECTION C-C'

NOTES:

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0 10' 20'
HORIZONTAL SCALE

0 2' 4'
VERTICAL SCALE

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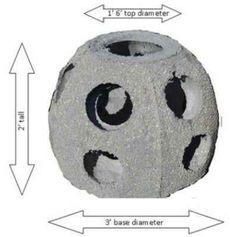
CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

SECTIONS

FILENAME -
SCALE 1" = 10'

SHEET
C-303

Bay Ball Module

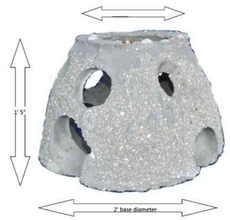


- 2' tall
- 3' feet base diameter
- surface area 40 sq ft
- average number of holes 14
- wavy bottom
- interconnecting holes
- aggregated exposed outside surface texture
- Weight 500 lbs
- Easy to deploy
- Great for shallow water
- Works well with docks

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

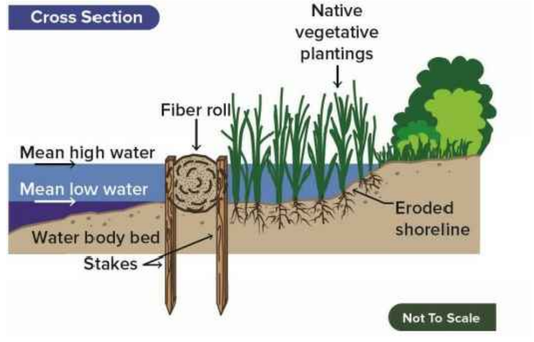
2 - LO-PRO REEF BALL
N.T.S.

Source: NYSDEC. 2017. Tidal Wetlands Guidance Document. Living Shoreline Techniques in the Marine District of NYS.

3 - ROCK SILL, MICROHABITAT FEATURE, AND LOW MARSH
N.T.S.

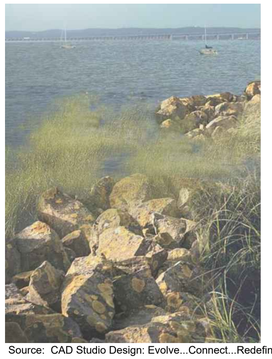
Source: HDR site assessment photo, 9/23/19

4 - PERCH BOULDER
N.T.S.



Source: NYSDEC. 2017. Tidal Wetlands Guidance Document. Living Shoreline Techniques in the Marine District of NYS.

5 - COIR LOG
N.T.S.

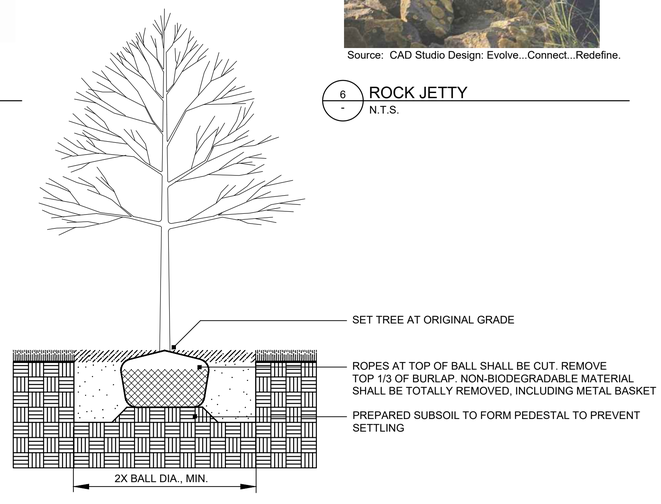


Source: CAD Studio Design: Evolve...Connect...Redefine.

6 - ROCK JETTY
N.T.S.

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

7 - LOW MARSH
N.T.S.



8 - TREE PLANTING DETAIL
N.T.S.

ISSUE	DATE	DESCRIPTION
2	07-13-20	FINAL 30% CONCEPTUAL DESIGN
1	05-15-20	DRAFT FINAL FOR PERMITTING REVIEW
0	02-14-20	PRELIMINARY DRAFT FOR CLIENT REVIEW

PROJECT MANAGER	D. DAVIS
DESIGNER	K. VERWEIRE
DRAFTER	J. WYNOHRADNYK
REVIEWER	D. HEILMAN
PROJECT NUMBER	000000010177415

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

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

DETAILS

FILENAME -
SCALE -
SHEET C-501

Appendix D

NYSDEC Pre-Application Meeting (June 26, 2020)

Climate Adaptive Design (CAD) Studio

Piermont (Hudson River) Living Shoreline Preliminary Design Project

NYSDEC Pre-Application Meeting
June 26, 2020

NEIWPCC
New England Interstate Water Pollution Control Commission

NEW YORK STATE OF OPPORTUNITY | Hudson River Estuary Program
A Program of the New York State Department of Environmental Conservation

VILLAGE OF PIERMONT, NY

HDR

Meeting Agenda

- Introductions
- Overview of the Cornell Climate Adaptive Design (CAD) Studio program
- Design goals for the Piermont Living Shoreline
- Review the project's preliminary/30% design plans
- Permitting discussion
- Next steps/Action Items

Project Background

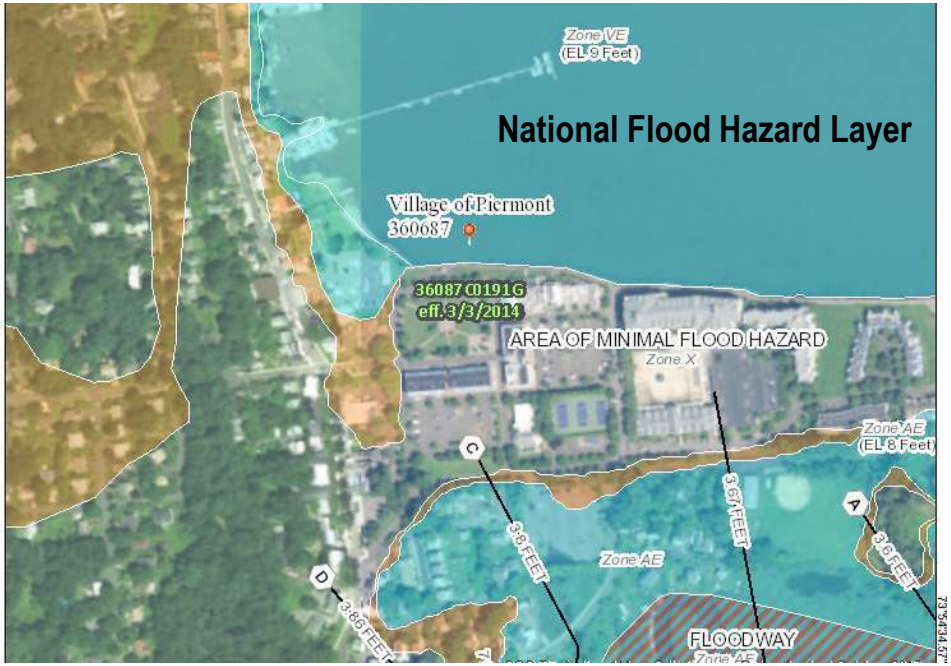
- Piermont's location is a great asset and offers a unique opportunity for coastal resiliency planning.
- The challenges of climate change and sea level rise will be significant:
  - ✓ 0.75 to 2.5 feet rise by 2050 and 1.25 to 9.5 feet by 2100 in lower HR estuary (NYSDEC)
  - ✓ 52.5% of Piermont at risk from 1% flood event (Rockland County Hazard Mitigation Plan)
- Through collective planning, engaged citizens and a shared stakeholder vision, Piermont is uniquely positioned to face the challenge.

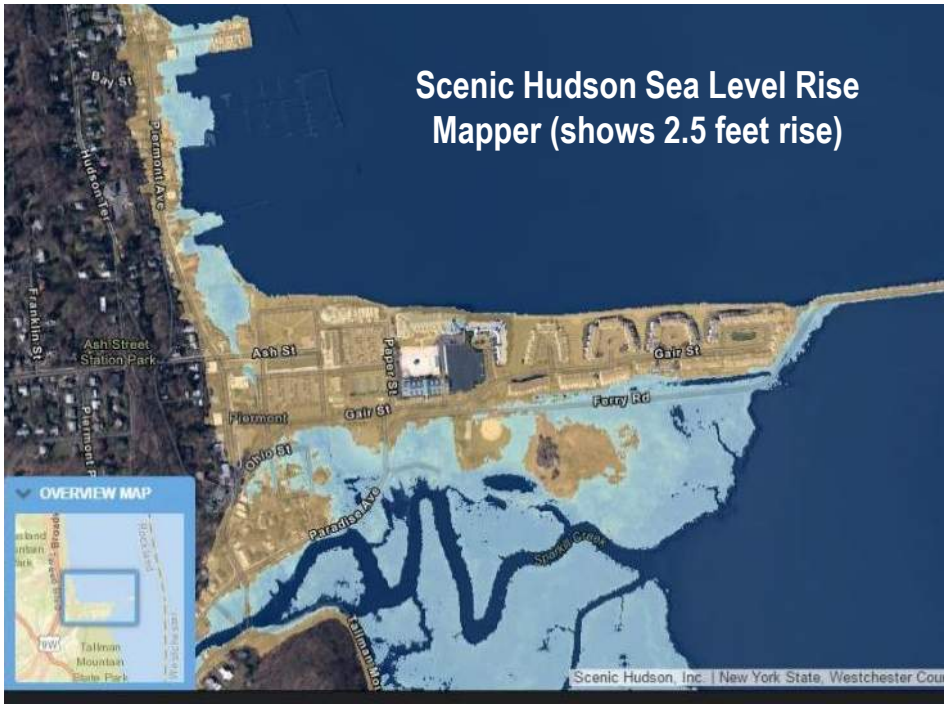
From Piermont Waterfront Resiliency Commission 2018

From Piermont Marsh Reserve Management Plan 2017 (NYSDEC)

Shared Vision for a Resilient Piermont

- Report of the Piermont Waterfront Resilience Task Force (2014)
- Desired outcomes from the community, a resilient Piermont will…
  - ✓ adapt gradually to avoid and minimize risks
  - ✓ be a model for others
  - ✓ help its residents and businesses to recover quickly from floods and storms
  - ✓ maintain the Village's relationship with the Hudson River
  - ✓ maintain a vibrant business district and local economy
  - ✓ foster and build community
  - ✓ be environmentally responsible





Climate Adaptive Design (CAD) Studio

- Cornell University's CAD Studio began design process in Fall 2017.
- Students developed 5 independent designs that envisioned future waterfront reinforcement, adaptation and relocation in Piermont.
- Each of the CAD Studio designs offers well thought out, innovative ideas for improving Piermont's coastal resiliency.

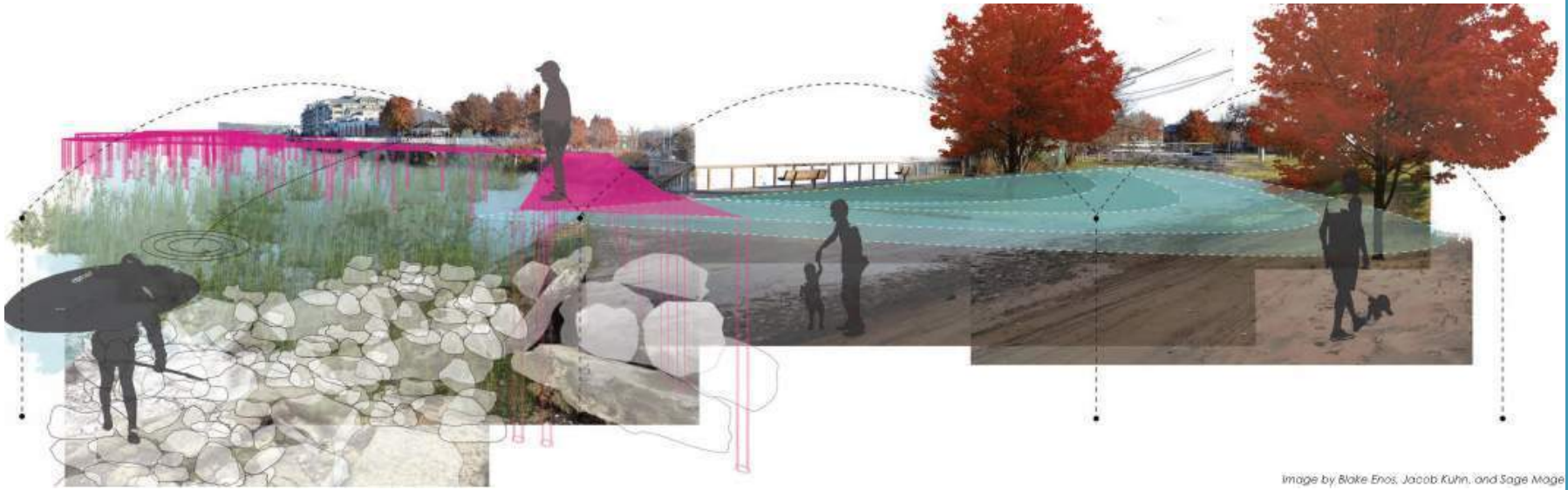
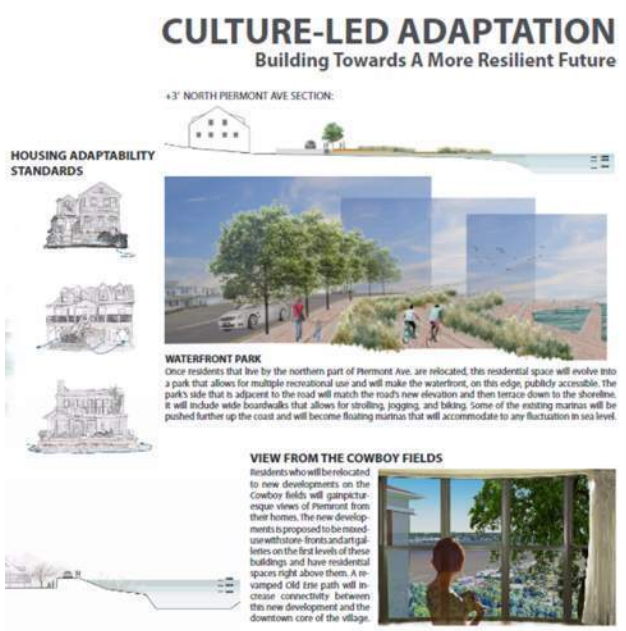
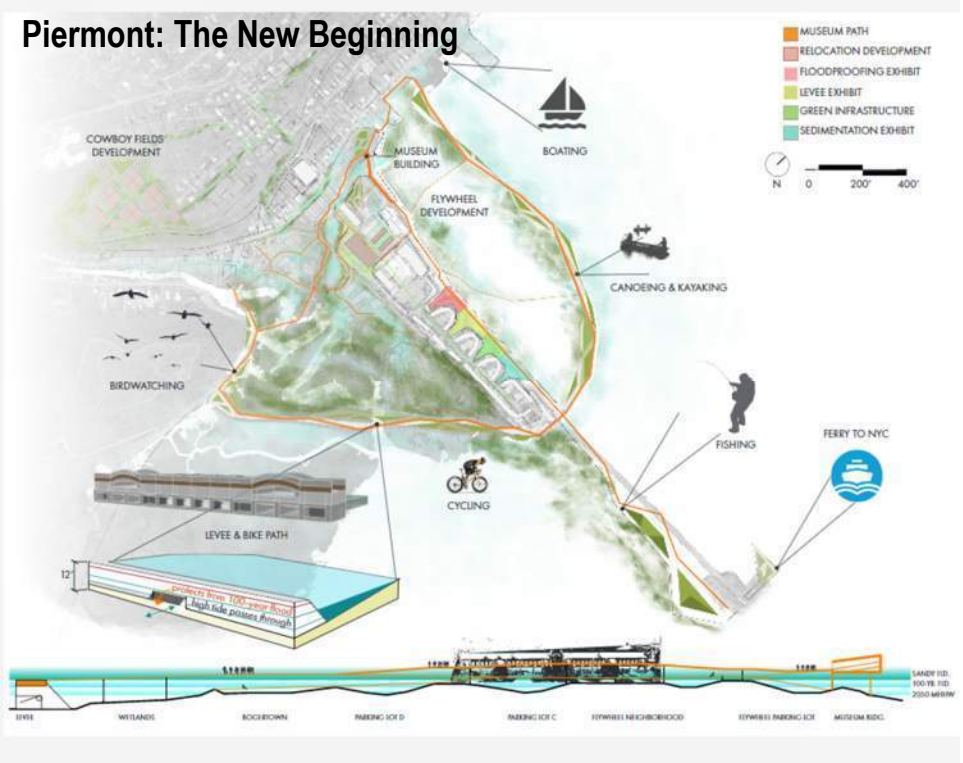


Image by Blake Enos, Jacob Kuhn, and Sage Mage

Design Objective

- Review CAD Studio concepts and use common elements to develop a cohesive and implementable design for a coastal resiliency project.
- Must achieve five overarching criteria:
  - ✓ Be cost-effective and able to attain state and local agency support and permits
  - ✓ Align with Piermont's existing Waterfront Resiliency Program and Local Waterfront Revitalization Plan (LWRP)
  - ✓ Align with the goals of the Hudson River Estuary Program and nearby Piermont Marsh reserve.
  - ✓ Be in keeping with the village's scenic and waterfront character
  - ✓ Include educational or interpretive elements





Site Identification

- During the RFP stage, HDR met with the Village and identified a potential project area north of the existing pier.
- Public open space area that could offer an opportunity to restore ecological diversity and protect a mix of land uses and infrastructure offset from the waterfront.
- An ecological and general site condition assessment was conducted in September 2019.

Site Assessment (Topo)

- Review existing data (see NOAA Digital Coast Topobathymetry Base Map with elevation contours).
- Aerial drone survey will collect aerial imagery, videography, and photogrammetry as well as high-accuracy topography.
- Water elevations collected at low tide every 50 feet along the shoreline as well as locations of both natural and man-made features to a wadeable depth using RTK GPS.

Site Assessment (Ecological and General Site Condition)

- Describe existing ecological communities based on Edinger *et al.* 2014
- Record:
  - ✓ Dominant plant species
  - ✓ Invasive species present
  - ✓ Rare plants or animals observed
  - ✓ Dominant substrate types
  - ✓ Visual assessment of bank and shoreline stability
  - ✓ Observed site constraints and ecological opportunities

Design Methodology

- Preliminary design follows the guidance outlined by NYSDEC for Marine and Coastal District Waters including the Hudson River south of the Tappan Zee Bridge.
- Improve coastal resiliency by protecting and stabilizing the existing shoreline through the development of both intertidal and subtidal habitat features to attenuate wave energy.
- Added benefits:
  - ✓ Improving water quality by filtering nutrients and pollutants,
  - ✓ Creating habitat for fish, birds and other living resources,
  - ✓ Promoting recreation and adaptive uses.

Preliminary Design - Proposed Site Plan

HDR

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1	05-15-20	DRAFT FINAL FOR PERMITTING REVIEW
0	02-14-20	PRELIMINARY DRAFT FOR CLIENT REVIEW

PROJECT MANAGER	D. DAVIS
DESIGNER	K. VERWEIRE
DRAFTER	J. WYNCHRADYK
REVIEWER	D. HEILMAN
PROJECT NUMBER	10000010177415

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

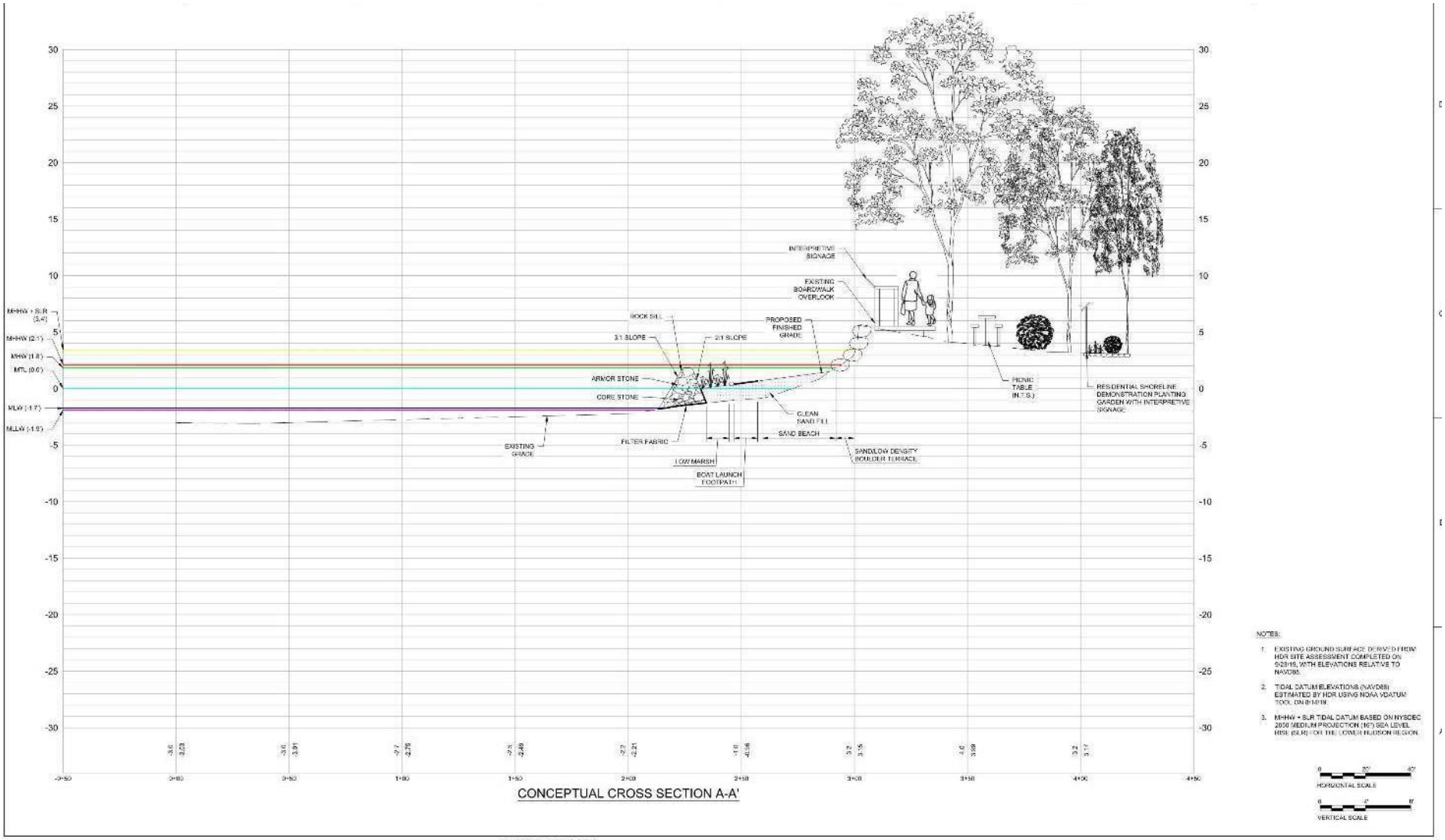
PROPOSED SITE PLAN

FILENAME

SCALE 1" = 30'

SHEET C-101

Preliminary Design – Cross Section



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DRAFTER	J. WYNOHRADNYK
REVIEWER	D. HELLMAN
PROJECT NUMBER	10030010177415

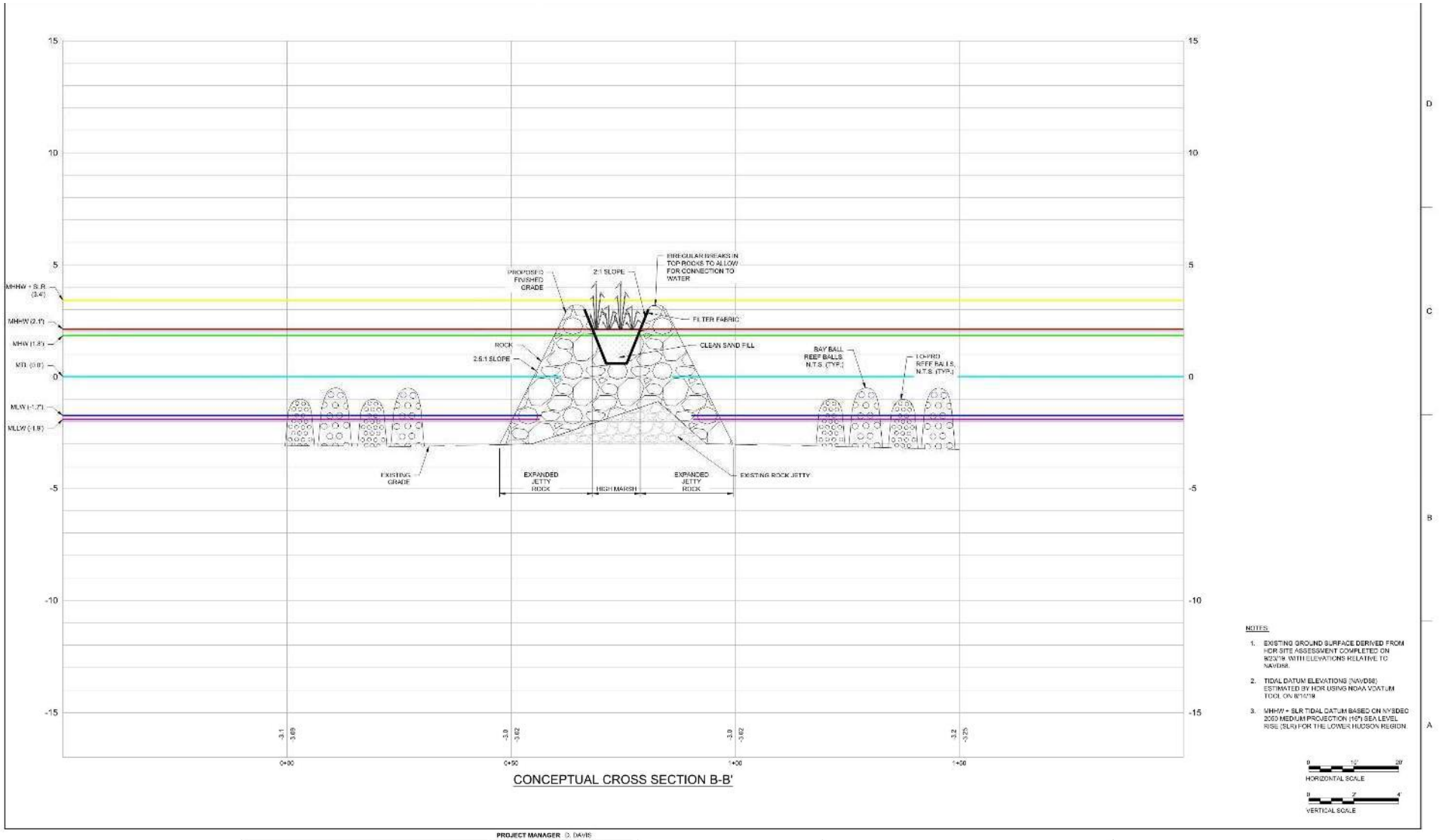
CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

SECTIONS

FILENAME -
SCALE 1" = 20'

SHEET
C-301

Preliminary Design – Rock Jetty Cross Section



CONCEPTUAL CROSS SECTION B-B'

NOTES:

1. EXISTING GROUND SURFACE DERIVED FROM HDR SITE ASSESSMENT COMPLETED ON 8/23/19, WITH ELEVATIONS RELATIVE TO NAVD88.
2. TIDAL DATUM ELEVATIONS (NAVD88) ESTIMATED BY HDR USING NOAA VDATUM TOOL ON 8/16/19.
3. MHHW + SLR TIDAL DATUM BASED ON NYSDEC 2050 MEDIUM PROJECTION (16") SEA LEVEL RISE (SLR) FOR THE LOWER HUDSON REGION.

HORIZONTAL SCALE

VERTICAL SCALE

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0	02-14-20	PRELIMINARY DRAFT FOR CLIENT REVIEW

PROJECT MANAGER	D. DAVIS
DESIGNER	K. VERWEIRE
DRAFTER	J. WYNOHRADNYK
REVIEWER	D. HEILMAN
PROJECT NUMBER	10090010177415

CLIMATE ADAPTIVE DESIGN (CAD) STUDIO
PIERMONT LIVING SHORELINE PROJECT
PIERMONT, NEW YORK

SECTIONS

FILENAME

SCALE 1" = 10'

SHEET C-302

Permitting Discussion

- Early engagement of regulatory staff.
- Document the type of project information required by regulatory staff for future permit approvals.
- Opportunity to provide initial feedback and perspective to be used in future design development.
- Actual permit applications will be submitted during the next phase of the project.

Habitat Zone	Habitat Area (Acre)	Habitat Area (ft^^{2})	Estimated Fill Depth (ft)	Estimated Fill Volume (CY)
Rock Jetty	0.20	8,787	5	1,925
Rock Low Sill	0.19	8,145	4	1,207
Low Marsh	0.19	8,264	4	1,224
High Marsh	0.23	10,054	5	1,862
Pocket Sand Beach (microhabitat areas)	0.01	605	1	11
Sand/Low Density Boulder Terrace	0.26	11,329	4	1,678
Sand/Gravel/Boat Launch Path	0.02	934	1	35
Sand Beach	0.10	4,285	1	159
Pathway Rock	0.00	154	1	6
Reef Balls	0.03	1,225	1	45
Totals	**1.23**	**53,782**		**8,151**

Project would result in the creation and enhancement of 1.23 acres of intertidal and subtidal habitat.

Next Steps/Action Items

Appendix E

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

Piermont Climate Adaptive Design

Class V Reasonable Order of Magnitude - Opinion of Probable Construction Costs - May 2020

Category	Item No.	Task	Quantity	UOM	Unit Cost (2020$s)	Total Cost (2020$s)	Assumptions & Notes
Soft Costs							
Site Assessment / Investigation	**1**	Delineation of Wetlands and Waters/Functional Assessment	1	EA	$ 10,000	$ 10,000	Delineation for approx. 1 acre acre site
	2	Section 106	1	EA	$ 10,000	$ 10,000	Includes Phase 1A/B archeological survey and coordination with SHPO.
	3	Threatened and Endangered Species Consultation	1	EA	$ 5,000	$ 5,000	Basic habitat assessment, coordination with USFWS and NY
	4	Phase 1 Environmental Site Assessment	1	EA	$ 10,000	$ 10,000	
	5	Sediment / Geotechnical Sampling	1	EA	$ 40,000	$ 40,000	Sediment sampling to confirm material classification and required management during construction and geotech samples for evaluating stability of existing jetty
	6	Site survey (property lines, utilities, topography)	1	EA	$ 15,000	$ 15,000	For approx. 1 acre site
		Subtotal				$ 90,000	
Permitting & Engineering Design Development	**7**	65% Design Plans	6	EA	$ 15,000	$ 90,000	65% Design
	8	95% Design Plans	6	EA	$ 10,000	$ 60,000	95% Design
	9	Final Contract Drawings - 100% Design	6	EA	$ 7,500	$ 45,000	Construction bid documents
	10	Response to contractor RFIs during bidding		POC	$ 0	$ 10,375	Assume 5% of overall design cost
	11	Estimate Quantities/Engineer's Cost Estimate	1	EA	$ 5,000	$ 5,000	
	12	Specifications	1	EA	$ 7,500	$ 7,500	
	13	U.S. Army Corps of Engineers Permitting	1	EA	$ 50,000	$ 50,000	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
	14	NYSDEC Stormwater Permit preparation	1	EA	$ 25,000	$ 25,000	Preparation of SWPPP, NOI, MS4 Acceptance Form, and NOT for SPDES General Permit for Construction
	15	Local Permits and/or Site Plan Review	1	EA	$ 20,000	$ 20,000	
	16	Stakeholder Engagement During Design	1	EA	$ 40,000	$ 40,000	
		Subtotal				$ 352,875	
Construction Costs							
Construction Materials	**17**	Rock Jetty Improvements	1039.5	TON	$ 743	$ 771,964	Tonnage of boulders installed
	18	Rock Low Sill	1207	CYD	$ 39	$ 47,379	
	19	Low and High Marsh Construction	3086	CYD	$ 48	$ 147,327	Comprised of Clean Sand Fill
	20	Pocket Sand & Sand Beach	170	CYD	$ 48	$ 8,116	
	21	Geotextile Filter Fabric	905	SYD	$ 11	$ 10,186	Beneath Rock Sill areas
	22	Sand / Low Density Boulder Terrace	1678	CYD	$ 39	$ 65,867	
	23	Sand / Gravel Boat Launch Path	35	SYD	$ 68	$ 2,376	
	24	Educational Signage	2	EA	$ 15,000	$ 30,000	
	25	Reef Balls - Low Pro	120	EA	$ 96	$ 11,480	
	26	Reef Balls - Bay Ball	120	EA	$ 163	$ 19,584	
	27	Permanent Vegetation - Spartina	2035	SYD	$ 3	$ 6,046	Plantings for low and high marsh areas
	28	Sediment Excavation & Relocation on Site	6079.5	CYD	$ 13	$ 78,274	Assume 75% of excavated sediment volume can be reused on site
	29	Removal & Disposal of Unusable Sediment / Materials	2229	TON	$ 113	$ 250,893	Assume 25% of excavated sediment volume will be disposed of offsite
	30	Existing Stormwater Outfall Modification	1	EA	$ 3,000	$ 3,000	
	31	Tree Plantings - Shade / Ornamental	6	EA	$ 1,600	$ 9,600	
	32	Picnic table	3	EA	$ 6,600	$ 19,800	
	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				$ 1,492,891	
General Reqts & Contractor Costs	**35**	Contractor Management		POC	6%	$ 116,146	Assumed percentage of overall construction cost
	36	Mobilization & Demobilization		POC	5%	$ 96,788	Assumed percentage of overall construction cost
	37	Soil Erosion and Sediment Control During Construction		POC	0.5%	$ 9,679	Assumed percentage of overall construction cost
	38	Contractor Bonds & Insurance		POC	2.0%	$ 38,715	Assumed percentage of overall construction cost
	39	Contractor Profit		POC	8.0%	$ 154,861	Assumed percentage of overall construction cost
	40	Contractor Direct Expense		POC	20%	$ 387,153	Assumed percentage of overall construction cost
		Subtotal				$ 803,343	
		Total Estimated 2020 Project Cost (without Contingency)				**$ 2,739,109**	