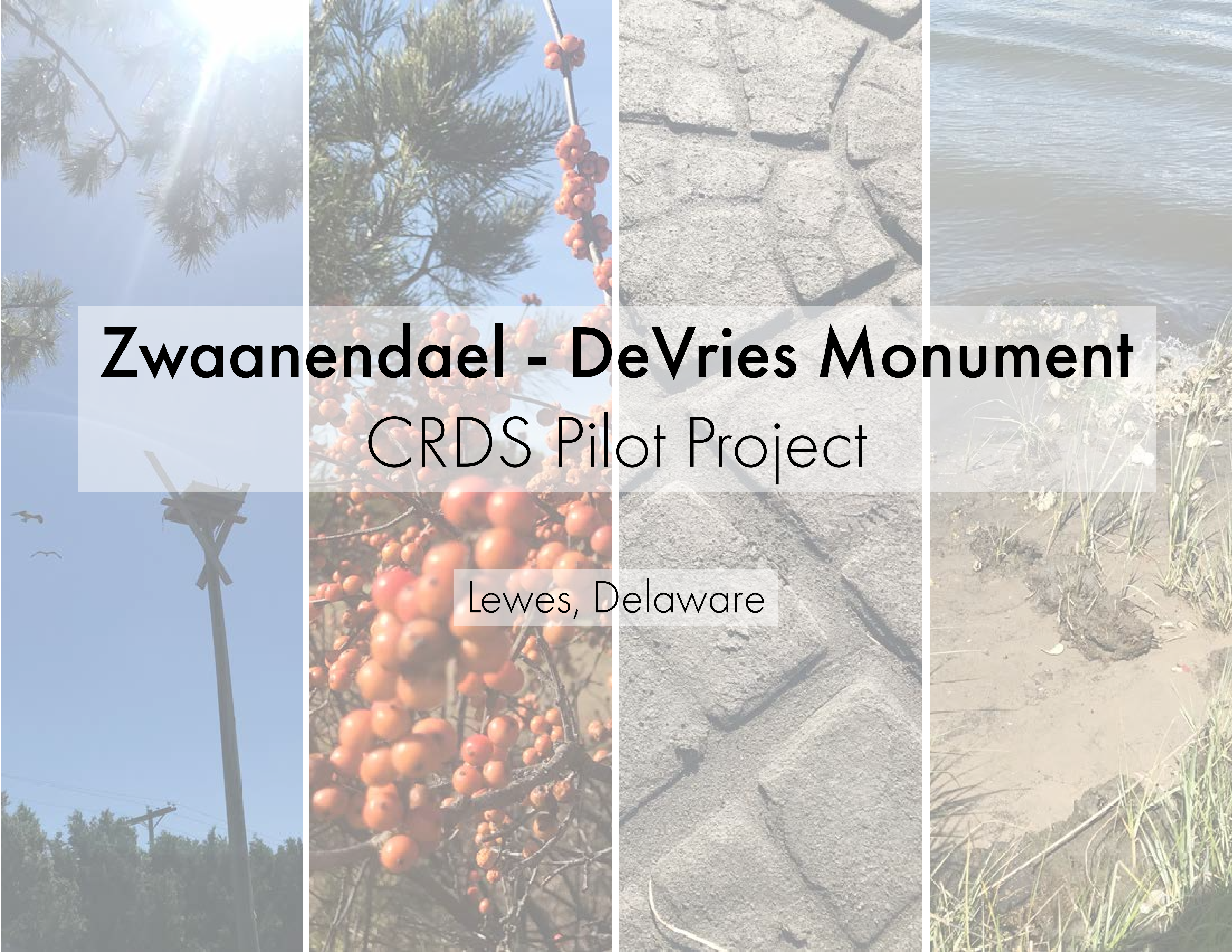


Zwaanendael - DeVries Monument

CRDS Pilot Project

Lewes, Delaware

CONTENTS

INTRODUCTION

The Coastal Resilience Design Studio (CRDS) is an interdisciplinary team of University of Delaware students focused on designing for the current and future impacts associated with sea level rise in Delaware's coastal environments. The Zwaanendael-de Vries Monument is the CRDS pilot project.

The CRDS team involved in this project include:

Dr. Jules Bruck, Principal & Founder

Ed Lewandowski, Principal

Figure 1. The CRDS team.

Emma Ruggiero, Designer

Joshua Gainey, Designer

Mark Switliski, Designer

Shannon Brown, Designer

Janelle Skaden, Designer

OBJECTIVES

The objective of this pilot project to create a recreational space surrounding an existing monument that adapts to changes in the environment, including sea level rise and increased erosion, while preserving the historical value of the property. Additionally, CRDS aims to promote accessibility from downtown Lewes to the space, thereby encouraging a greater connection between historic downtown, the monument and the nearby University of Delaware College of Earth, Ocean, and Environment Hugh R. Sharp Campus. In order to ensure valid outcomes for this project, student designers from the CRDS conducted a thorough analysis before drafting design recommendations for the Zwaanendael-de Vries Monument site.

COASTAL RESILIENCE
DESIGN STUDIO

The Zwaanendael-de Vries Monument is located in the City of Lewes in Sussex County, the southernmost county in Delaware. Lewes is a coastal town adjacent to the mouth of the Delaware Bay near the Atlantic Ocean. The property is situated between Pilottown Road and the Lewes-Rehoboth Canal, near the Roosevelt Inlet. Lewes is a medium-sized town, with a full-time population of 3,083 (2017) and approximately 2% annual growth (Lewes DE Population, 2019); however, it is a popular summer destination and the population swells to 6,000-8,000 during summer months (Lewes Chamber of Commerce, n.d.). Lewes is nearby to other popular beach towns in Delaware, including Rehoboth Beach, Bethany Beach, and Fenwick. The Cape May-Lewes Ferry connects Delaware to New Jersey in an 85-minute ferry trip. Lewes is referred to as "The First Town in The First State," because it is home to the first European settlement by the Dutch in the 1600s. The Zwaanendael-de Vries Monument marks the place of that first landing on June 3, 1631.

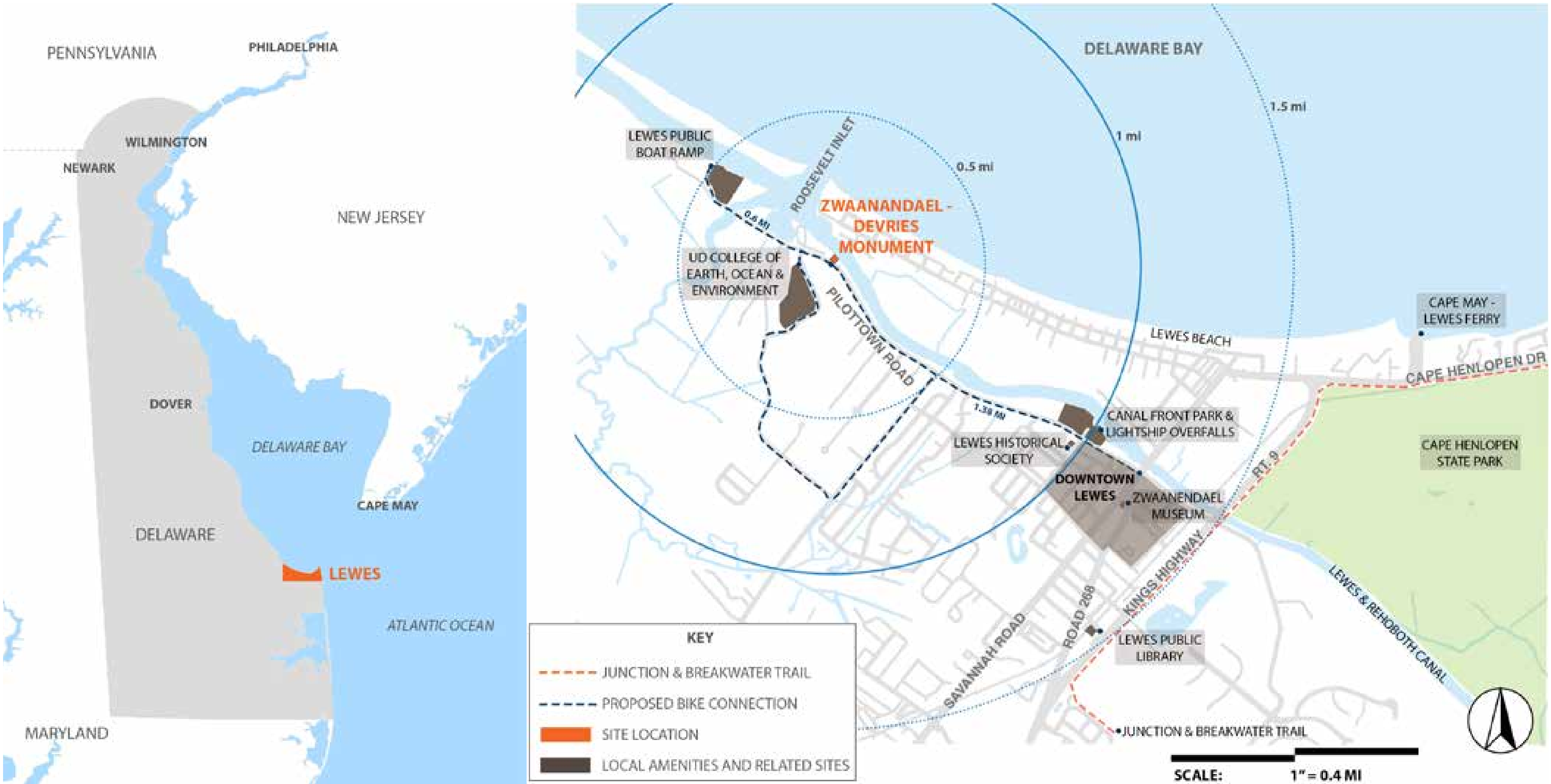


Figure 2: The Zwaanandael-de Vries Monument is located in Lewes, Delaware, and is tied closely to Lewes' historic roots.

NATIVE & COLONIAL HISTORY

The Cinconicin tribe, a local tribe of Lenni Lenape Indians, were the original indigenous inhabitants of the Lewes area prior to the arrival of Dutch settlers. Though the main Cinconicin village was located in present day Lewes, the tribe extended into other areas of southern Delaware as well (Delaware - History and Cultural Relations, n.d.). The Cinconicin tribe is part of a larger group of indigenous tribes called the Algonquian group (Division of Historical and Cultural Affairs, n.d.), referring to the Algonquin language spoken by these groups. The Cinconicin used the abundant natural resources of the region, hunting and gathering in the forests, streams, and along the coast, to thrive in this region.

The English first explored the Delaware Bay area in August of 1609. Henry Hudson passed by the area while trying to find a passage to Asia, but never settled. In 1631, David Pieterszoon de Vries, a Dutch explorer, sailed from Hoorn, Holland with a crew of 28 men and landed near Lewes, Delaware. They established a colony and called it Zwaanendael, meaning Swan's Valley (Lewes Historical Society). The Dutch colonists sought to establish a whaling station and chose this location after noting the nearby bay and ocean resources - namely the whales to use for blubber and oil. After establishing the colony, de Vries returned to the Netherlands.

When de Vries returned to the site a year later on December 5, 1632, he found none of the settlers and the original location of the colony burned (Division of Historical and Cultural Affairs, n.d.). A cultural disagreement between the settlers and the indigenous tribe prompted an attack by the indigenous people. The dispute that initiated the massacre of the Dutch settlers arose over the mounting of the Dutch coat of arms on the settlement (Lewes Historical Society).

Figure 3: "Landing of the DeVries Colony at Swaanendael, Lewes, Delaware 1631" by Stanley M. Arthurs, via University of Delaware permanent collection.

The de Vries monument was built to remember the Zwaanendael settlement that was located at the site in 1631; it was dedicated on September 22, 1909 and was officially added to the National Register of Historic Places on February 23, 1972 (Visit Delaware). This colonial establishment is a significant component in Lewes and Delaware history, and more information can be found at the Zwaanendael Museum in Lewes, DE. The Zwaanendael Museum was designed after the Hoorn City Hall in the Netherlands (Visit Delaware).

RECENT HISTORY

On November 5, 1913, the U.S. Army Corps of Engineers led the effort in constructing the Lewes-Rehoboth Canal, which was finished three years later in 1916 (Lewes Historical Society). Originally envisioned as an import passageway for cargo ships, the use was lost soon after the canal was complete. The canal is now used mostly for pleasure and for some fishing.

The de Vries monument site is owned by the City of Lewes but is surrounded by land that belongs to the University of Delaware. UD faculty who are part of the College of Earth, Ocean and the Environment use the space immediately adjacent to the site as small boat storage. Recently, the City of Lewes became interested in improving the monument site to make it more of a tourist destination. They hired Bernardon Associates to complete a conceptual design of an upgraded terrace. Danielle Swallow of UD proposed the town work with the newly established CRDS of the UD Landscape Architecture program to further develop the entire site as a demonstration of environmental resilience projects. In 2019, the CRDS entered into a cooperation agreement with the City of Lewes to complete the demonstration project as a CRDS pilot (initial) project.

There are several unique environmental features to the site making it a suitable location for the CRDS pilot project. There is an active osprey nest platform adjacent to the site and the activity of this nest can say much about the environmental conditions of the area surrounding it as osprey must have an ample food supply to survive.

There is noticeable erosion and undercut banks along the canal shoreline of the site. Tree and shrub roots protrude from the surface and sediment has traveled away from the site. This problem is observable further downstream along the canal as well.

At the shoreline, the views of the canal and surrounding area are stunning during both low and high tide. There is about a four-foot change in tide onsite (NOAA). During high tide, the water level approaches the site and flows to an existing grassy area. During low tide the water retreats offshore into the canal. Another indicator of environmental health, mussels and oysters are present in the water offshore during low tide.

Before starting work on the de Vries pilot project, designers looked at several similar precedent projects to gather ideas and learn about the types of solutions in practice.

Figure 4: The Lewes-Rehoboth Canal was completed in 1926.

Figure 5: The Zwaanendael-DeVries Monument in Lewes, DE.

Figure 6: Marsh planting behind rock toe sill at DNREC field office; see Roosevelt inlet in the background.

DNREC LIVING SHORELINE

The DNREC Living Shoreline is a local project in Lewes, about 0.5 miles away from the de Vries Monument, to the opposite side of the Roosevelt Inlet at the DNREC field office. This site experiences moderately high wave energy and therefore the design required an implementation of both hard and soft structure techniques including Spartina species, oyster castles and rock toe sills.

Repurposed sand fill was used to raise the level of substrate for optimal marsh planting elevation. A flushing port was added to allow for inflow and outflow of water to the plants behind the rock sill as the tides change.

Takeaways: use of oyster castles to break up wave action before it hits the shoreline; raising the level of substrate to allow plants to establish easier.

Figure 7: Use of coir logs and oyster bags by DNREC living shoreline site, via DNREC Living Shoreline Committee.

LEWES BALLFIELD LIVING SHORELINE

The Lewes Ballfield Living Shoreline is an installment of bio-based shoreline protection techniques along the Lewes Rehoboth Canal, about 1 mile from the de Vries Monument site. The project was implemented by the Delaware Department of Natural Resources and Environmental Control (DNREC) in response to erosion, as well as to act as an educational and demonstration site. DNREC tracked the extent of marsh over the course of four years, and concluded that within that time, a 122.11 m^2 area of salt marsh was created as compared to an adjacent control site which lost 49.10m^2. This site was deemed low energy with its placement a mile from the nearest inlet, though it does experience wake from a boat ramp across the canal. The installment includes two levels of terraced coir logs with a coir mat in between to allow for a transition in gradient from low to high marsh. The coir logs allow for plant establishment as well as erosion prevention. This design worked around existing populations of mussels and oysters and used salvaged Spartina species found floating in the canal for the planting. Monitoring the shoreline showed ice damage affected the design, and oyster bags were used to amend the protection in the first two years. The total cost of this specific project totaled $4,137.71 (Delaware Living Shoreline Committee).

Takeaways: terracing of coir logs to build topography; working around existing wildlife; using salvaged plants.

Figure 8: Rendering of coastal infrastructure, via Mathews Nielsen Landscape Architects.

PIER 42

Designed in collaboration between Mathews Nielsen Landscape Architects and NYC Parks and Recreation, Pier 42 created access to the water on Lower Manhattan's East River Shoreline and transformed a formerly industrial maritime pier into a waterfront park (Nielsen). After Superstorm Sandy in 2012, it was evident the area needed to address resilience. Pier 42 was designed to make the community resilient to sea level rise and increased storm inundation. The first phase of the project involved removal of toxic soil and asbestos from the site (Paths to Pier 42). The master plan included bulkhead removal and replacement with a soft edge comprised of restored marsh. The marsh helps to dissipate wave energy while additional bulkhead will be replaced with protective rip-rap. All removed granite bulkhead was repurposed as stone landscape features.

Park planners included a series of buffers and bioswales to protect the park from roadway runoff. In order to increase the park's resistance to sea level rise, all buildings and mechanical devices are placed behind the 100-year flood line and rely on solar power energy (Lower Manhattan Development Corporation). The aesthetics of this site are inspired from the history. The designer chose to incorporate steel framing from the former building into the final design. Finally, accessibility and connectivity to the community were also considered to create a destination and provide unity with the surrounding area (MNLA, 2014).

Takeaways: green infrastructure may increase marsh; place built features above the 100-year flood line; consider solar power for any lighting needs; incorporate items from history; connect with the surrounding community.

Figure 9: Pilings and salt marsh, via Julienne Schaer.

BROOKLYN BRIDGE PARK PIER 1

Brooklyn Bridge Park Pier 1 is a part of the larger Brooklyn Bridge Park project. The pier opened in 2010 and contains 9.5 acres of lawns, gardens and open space for use by the public. The project strove to connect the inner city with the natural world (Michael Van Valkenburgh, n.d.). Before construction, this site housed old warehouses which impacted the views of the river and city. Pier 1 was designed by Michael Van Valkenburgh Associates Inc. The designers incorporated part of the site's history by incorporating existing wooden piles, repurposing granite for seating, and using the wood from one of the warehouses to build benches (Michael Van Valkenburgh, n.d.). A unique aspect of Pier 1 is the safe and accessible approach to the river via a kayak launch (Michael Van Valkenburgh, n.d.). The project included many different stormwater management practices and green infrastructure. Stormwater is collected throughout the site through water absorbing lawns and is directed to rain gardens which use, store, and clean it. This process prevents stormwater from entering the stormwater sewer system or river. The rain gardens also provide habitat for many different species of birds, insects, butterflies, and turtles, adding to the diversity on the site and within the urban environment (Brooklyn Bridge Park, n.d.). This park contains multiple walking and bike paths and open lawn space used for various events throughout the year. A salt marsh complete with cordgrass provides habitat for ducks, other waterfowl, and crustaceans.

Takeaways: incorporate historic elements found on site during construction into the space; consider a kayak launch; increase biodiversity onsite by planting a range of native plants.

GREEN INFRASTRUCTURE

The CRDS team researched green infrastructure (GI) to compile a list of plausible natural design solutions that would mimic, protect, and enhance the natural systems that manage stormwater. Below are descriptions and benefits of various GI installments considered for this site:

RAIN GARDENS

Recommended for stormwater runoff, a rain garden is a bioretention basin that intercepts runoff and filters pollutants through mulch, soil, and root systems. Plants best suited for rain gardens are native moisture-loving plants that are able to also tolerate periods of drought. There are many benefits of including a rain garden onsite including filtering pollutants, providing habitat and pollination services, and replenishing the water table. While maintenance is considered low, there is monthly care required during the growing season to prevent weeds and invasive plants from taking hold, and seasonal pruning is also recommended (Groundwater Foundation).

Rain gardens are most effective when slopes range from 1 to 10 percent and are located in the pathway of surface runoff. Avoid placing a rain garden where the seasonally high water table is less than 2 feet below the surface (DNREC).

Image: University of Delaware Lewes Campus parking lot rain garden via DNREC.

Image: Sidewalk constructed with permeable pavement via DNREC.

PERMEABLE PAVEMENT

Permeable pavement includes a variety of surface treatments such as asphalt, concrete and brick pavers, with the capacity to allow stormwater to infiltrate to the ground before moving to stormwater sewers, lakes, or rivers. By allowing stormwater to flow through the pavement to soils below, many pollutants are filtered before entering the environment. This treatment is particularly beneficial for rainwater that would otherwise run off traditional pavements into rivers, lakes, or the ocean, because after flowing through a rain garden the water entering these systems is cleaner (EPA, n.d.).

If desired, rain water infiltrating through permeable pavement can be directed to a stormwater sewer through underground piping systems below the pavement. These treatments are best for low traffic roads, parking lots, and sidewalks. Permeable pavement does not require as much salt during the winter months as regular pavement because water seeps through the pavement instead of flowing across or sitting on top of the pavement (USGS, n.d.). Porous pavements are similar to permeable pavements but are not as highly recommended because they are prone to issues with sedimentation and clogging. Permeable pavements experience less issues with clogging, and are therefore often a better option (Scholz & Grabowiecki, 2007).

RIPARIAN BUFFERS

Riparian buffers are effective for improving the quality of stormwater runoff, thereby improving water quality in streams, lakes, and other bodies of water. These buffers include native vegetation planted near waterways. Buffers provide habitat for many edge species, help mitigate erosion by trapping sediments and increase flood protection. Riparian buffers require periodic monitoring to ensure there are no diseases or infiltrating invasive plants and should be monitored for damage after major storms and extremely high tides (DNREC, n.d.). Sturdy upland vegetation capable of slowing water flow will help minimize erosion, while lowland vegetation will increase flood resistance (Brandywine Conservancy, 2016).

Image: Riparian buffer on agricultural land in Iowa via USDA.

Image: Rendering of a green street via Vermont Urban & Community Forestry.

GREEN STREETS & ALLEYS

Green streets incorporate design techniques aimed at many environmental and community benefits. Environmentally, green streets are able to reduce stormwater runoff, improve water quality, and improve air quality by incorporating other various green infrastructure elements such as permeable pavement, bioswales, and planter boxes (EPA, n.d.). By allowing rainwater to infiltrate where it falls, unlike traditional streets where stormwater is directed to a stormwater sewer or to rivers and lakes nearby, green streets filter, clean, and slow stormwater runoff from roads and sidewalks. Green streets have been successful in reducing flooding during storms.

Community benefits come from environmental features, such as improved air quality from street trees, and improved circulation for pedestrians and cyclists. Green streets employ designs that are typically pedestrian-friendly. Green streets that are focused primarily on pedestrian, cyclist, and public transportation are called complete green streets. Pedestrian- focused streets have been found to motivate people to go outside and walk or bike places they would normally drive to, providing additional exercise opportunities they may otherwise not have access to (EPA, n.d.).

GREEN PARKING

Green parking uses a combination of GI applications such as permeable pavements, rain gardens, and bioswales to provide ecosystem services. Green parking also incorporates energy efficient lighting, consideration of pedestrian safety, and shading of pavement to minimize urban heat island effect. Heat island effect is when solar radiation warms dark surfaces and energy is released in the form of heat to surrounding areas on hot sunny days causing it to feel hotter (Montgomery County Planning Commission, n.d.).

Green parking lots are able to effectively remove pollutants from stormwater runoff and improve the water quality of nearby bodies of water. A study in Wilmington, MA found a significant decrease in the pollution of the beaches on Silver Lake after installing a green parking lot project. Before the project the beaches on the lake were constantly closed due to pollution and after installation there have been only a small number of closures due to pollutants in the water (Massachusetts Government, n.d.).

Image: Green parking lot project in Wilmington, MA with permeable pavers, porous asphalt, and biotrention via Mass.gov.

Image: Stormwater planter at Columbus Square in Philadelphia, used in part of making Reed St. a green street, via Philadelphia Water Department.

PLANTER BOXES

Stormwater planters or planter boxes are similar to rain gardens in that they are a form of bioretention. The main difference between a rain garden and a stormwater planter is that stormwater planters use structural sides surrounding them to form a box. This form of GI is typically found on sidewalks, parking lots or streets and is easily incorporated into green streets (EPA, n.d.). Similar to other forms of GI, planter boxes have the ability to improve water quality, air quality, and reduce stormwater runoff.

Choose plants for a stormwater box based on their ability to remove pollutants from stormwater and their preferred growing conditions. The planter box should sit lower than the surrounding pavement or land so runoff is directed to the planter. Stormwater planters consist of a bottom layer of permeable fabric that allows excess water to be released to the soil below, a gravel and/or stone layer where water can sit before permeating below, and then a top layer consisting of soil and plants (Philadelphia Water Dept, n.d.).

LIVING SHORELINE

Living shorelines use living plants in combination with natural structures constructed from materials including oyster and mussel shells, coir logs, or wooden logs to stabilize and protect a coastline. The benefits of a living shoreline include reducing erosion, filtering surface runoff from upland areas, increasing biodiversity, and allowing for adaptation to climate change and sea level rise. Oysters and mussels used in protective structures have an immense capacity to filter water.

A living shoreline is most suitable where wave energy is low. Once installed, living shorelines are low maintenance, but may require monitoring. For example, fiber logs are biodegradable; and therefore, require monitoring (DNREC, 2016).

Image (left): Lewes Ballfield living shoreline via Delaware Living Shorelines Committee.

BIOSWALES & GRASSED CHANNELS

Vegetated channels, such as bioswales and grassed channels, are linear swale systems that contain vegetation and convey water during storm events. They filter and attenuate volume as water travels through plant material, reducing pollutant and runoff loads to nearby water systems and storm drains. They are a green alternative to piped or "curb and gutter" stormwater conveyance systems, and can act as a pre-treatment for other GI installations, such as a rain garden.

Bioswales are effective for road runoff, small parking lots, and other applications where there is available land for a linear stretch. Soil permeability, development density, topography and the existing water table all may affect the placement and performance of a grassed channel. Compost amendments added to the bottom of the channel may improve the ability to intake water (DNREC, 2016). Maintenance for these systems is relatively low. The bioswale plants may require trimming and removal of weedy or invasive species, and should contain plants that withstand both flood and drought (Soil Science Society of America, 2019).

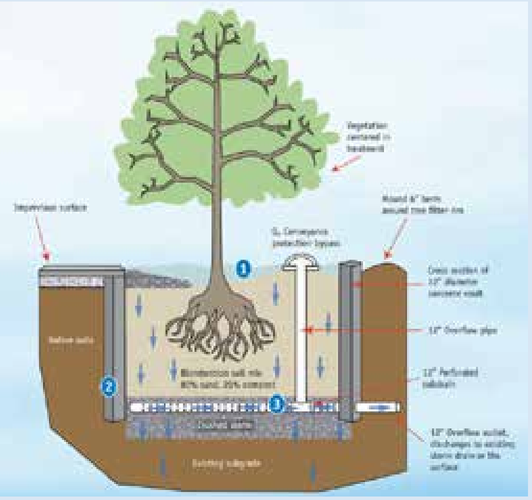
Image: Planted bioswale in Greendale, WI along a roadside, via Soil Science Society of America.

URBAN TREES

Planting trees in urban settings is an effective way to create a healthier environment. By planting trees, communities experience a multitude of benefits including: reduced stormwater runoff, shade, improved water and air quality, decreased energy requirements from increased shaded area, decreased erosion, and added beauty (FAO). Regular tree maintenance is required such as watering during establishment, applying mulch to the bed, pruning, and controlling invasive species.

Bed size and the soil depth available are important when selecting a tree for a site. Both characteristics will limit the size of tree that will thrive. Similarly, tree location has important implications. Planting trees on the south or southwest of a building can provide natural cooling abilities and reduce the energy requirement in the summer. Trees that block buildings from a continuous wind will help reduce heating needs in the winter (DNREC, 2016).

Image (left): Urban trees in Wilmington, DE via The Delaware Center for Horticulture.



TREE BOXES & TREE TRENCHES

Tree boxes and tree trenches are bioretention systems that help manage stormwater runoff for small magnitude storms in places with limited space, such as an urban setting. By collecting and filtering stormwater, they trap pollutants which degrade in place (Rector, 2013).

A tree box is a pre-cast concrete container filled with a media suited for quick infiltration such as 80% sand and 20% compost and installed underground. A tree trench connects multiple trees to an underground system that directs stormwater runoff flows into the trench through surface grates or curb drains. The runoff water supplies water to the trees before infiltrating through holes in the bottom of the trench. These treatments filter pollutants, reduce stormwater runoff, and increase tree canopy to beautify a community. They require weeding, debris and invasive plant removal especially during tree establishment, and regular pruning (DNREC, 2016).

Image (left): Illustration of a tree box retention system via Massachusetts Clean Water Toolkit.

RAIN BARRELS & CISTERNS

Image: Three rain barrels with hose for water reuse via City of Cambridge.

Rain barrels, cisterns, and downspout disconnections are all a part of rainwater harvesting. Each reduces stormwater runoff, water pollution, and potentially water bills by allowing for reuse of water. Rain barrels are one of the least expensive forms of GI that can be implemented onsite. Rain barrels and cisterns are similar in that they are both tanks that hold water after a rain event; the main difference is that cisterns are considerably larger in volume capacity than rain barrels (DNREC, n.d.) and are often buried underground. Cisterns and rain barrels must be emptied between storms to prevent overflow and use of a protective cover on top is necessary to prevent bugs and animals from entering (DNREC, n.d.). Cisterns and rain barrels are only recommended when there is a use for reused stormwater, such as a lawn or garden.

Disconnecting downspouts redirects water from the roof of a building to a specific location, such as a cistern or rain garden. These downspouts are another form of rainwater harvesting useful if there is a place for the stormwater to be redirected.

GREEN ROOFS

ILLUSTRATION: Jeffery Mathison

Image: Illustration of green roof layers, via Jeffery Mathison/ DNREC.

A green roof is a building roof designed to be covered, partially or fully, in living plants, soil, or other live medium. A green roof reduces stormwater runoff through rainwater infiltration and may reduce temperatures on the surface of the roof. A green roof is either extensive or intensive. Extensive green roofs have thinner soil beds and use plants with shallow roots; they require minimal maintenance and are adaptable to roof size and configuration. Intensive green roofs support larger plants that require deep planting beds and are often more of an amenity to the public (DNREC, 2016). A green roof insulates the roofing and increases heating and cooling efficiency, decreases stormwater runoff, and increases water quality. The green roof also provides habitat for wildlife and improves air quality around the building. Requirements for a well-designed green roof are a relatively flat roof (of 40% slope or less, so rainwater can effectively infiltrate the soil), plants resilient to heat, cold, wind, and drought, and a structure that can support the additional weight.To maintain a green roof, the establishment period is crucial. For the first two years, regular irrigation and weeding are required. The maintenance of a green roof varies depending on the nature of the roof. After establishment, an extensive green roof is self-sustaining with monitoring and an intensive green roof, due to larger plant size, requires weeding, pruning, and watering as well as removal of dead plants and control of invasive species (DNREC, 2016).

CONNECTIVITY

The Zwaanendael-de Vries Monument is within reasonable distance of many local historical, cultural, and natural amenities. Historical amenities include the Zwaanendael Museum, St. Peter's Church cemetery, Lightship Overfalls, the Harbor of Refuge and Delaware Breakwater East End Lighthouses, and the Lewes Historical Society. Recreational natural amenities include the Lewes-Rehoboth Canal, Junction & Breakwater Trail, Canalfront Park, and Cape Henlopen State Park. Cultural amenities include the Lewes Public Library, Lewes Public Boat Ramp, the Cape May-Lewes Ferry, and the UD College of Earth, Ocean and Environment downstate campus. Downtown Lewes' businesses, shops, hotels and restaurants are in close proximity to the site.

The Junction & Breakwater Trail is a designated pedestrian - cyclist route near the downtown area, bordering the western edge of Cape Henlopen State Park. It connects Lewes to Rehoboth. It was built atop an old railroad bed (Lewes Historical Society, n.d.).

Between 2003 to 2012, Delaware reported 194 deaths from accidents between pedestrians and vehicles representing 12.3% of national fatalities (Smart Growth America, n.d.). At 17.6 deaths, Sussex County has the highest rate of motor vehicle deaths in Delaware (Data USA, n.d.). Lewes specifically has received a walkability grade of 63 out of 100 from walkscore.com. Community members, including the owners of a local bike shop, have expressed concern about safety specifically along Pilottown Road. With the median age of 66 in Lewes, it is important to create accessible walking routes (Data USA, n.d.).

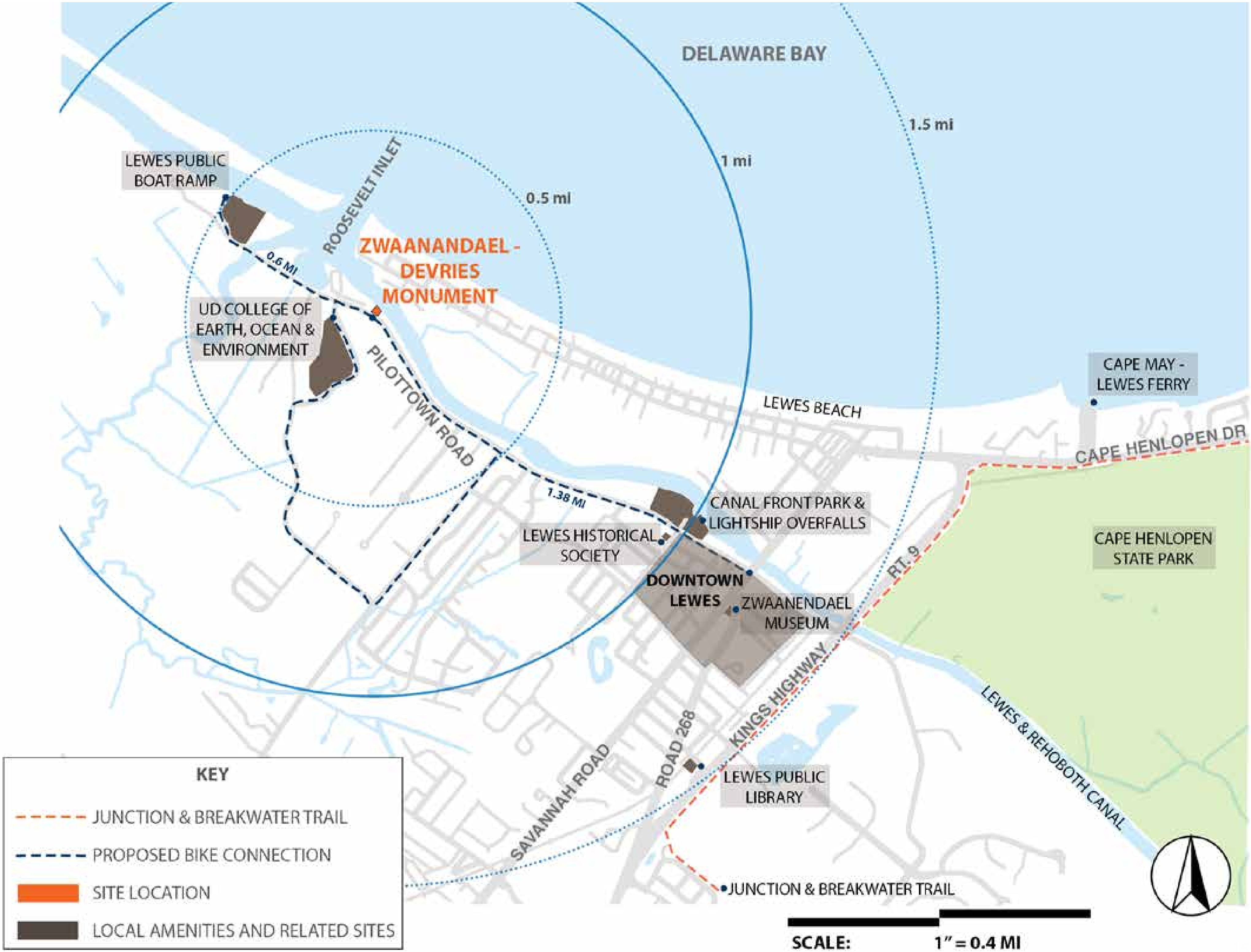
Pilottown Road runs parallel to the Lewes-Rehoboth Canal. The road connects the heart of Lewes to the UD Lewes Campus. With proper accessible routes focused on connectivity and safety, Pilottown Road can become a main artery for active community members to experience amenities along the canal.

Figure 10 (opposite page): Context of the monument within the greater Lewes area.

PARCEL BOUNDARY

The de Vries monument site is a square 88' x 88' parcel owned by the City of Lewes. It is situated on the Lewes-Rehoboth Canal and Pilottown Road. The site is fully surrounded by adjacent UD properties and a private cemetery. To the north is the Lewes-Rehoboth Canal. To the east is the UD boatlot and to the west and southwest is open space owned by UD. The adjacent cemetery to the south across Pilottown Road is owned by St. Peter's Church and has close historical ties to the monument property. The working site is defined as the area from Pilottown Road to the Canal along with 75' of UD property to the west of the current monument parcel.

Figure 11 (right): The surrounding property ownership includes parcels owned by the University of Delaware and a parcel owned by St. Peter's Church.


DELAWARE BAY
1.5 mi
1 mi
0.5 mi
LEWES PUBLIC BOAT RAMP
ROOSEVELT INLET
ZWAANANDAEL - DEVRIES MONUMENT
0.6 MI
UD COLLEGE OF EARTH, OCEAN & ENVIRONMENT
PILOTTOWN ROAD
CAPE MAY - LEWES FERRY
LEWES BEACH
CAPE HENLOPEN DR
1.38 MI
CANAL FRONT PARK & LIGHTSHIP OVERFALLS
LEWES HISTORICAL SOCIETY
CAPE HENLOPEN STATE PARK
RT. 9
DOWNTOWN LEWES
ZWAANENDAEL MUSEUM
KINGS HIGHWAY
LEWES & REHOBOTH CANAL
ROAD 268
SAVANNAH ROAD
LEWES PUBLIC LIBRARY
JUNCTION & BREAKWATER TRAIL
KEY
JUNCTION & BREAKWATER TRAIL
PROPOSED BIKE CONNECTION
SITE LOCATION
LOCAL AMENITIES AND RELATED SITES
SCALE: 1" = 0.4 MI

HYDROLOGY

The site is located along the Lewes-Rehoboth Canal within the Broadkill River watershed, and its hydrology is affected by both its topography and tidal fluctuation. A majority of the site is located within the 100-year flood zone, where tidal fluctuations are common, while the other portion of the site is considerably uphill (FEMA, 2015). The base flood elevation is 8 feet. The tidal fluctuation between mean high water (MHW) and mean low water (MLW) is 4.07 feet (NOAA, n.d.).

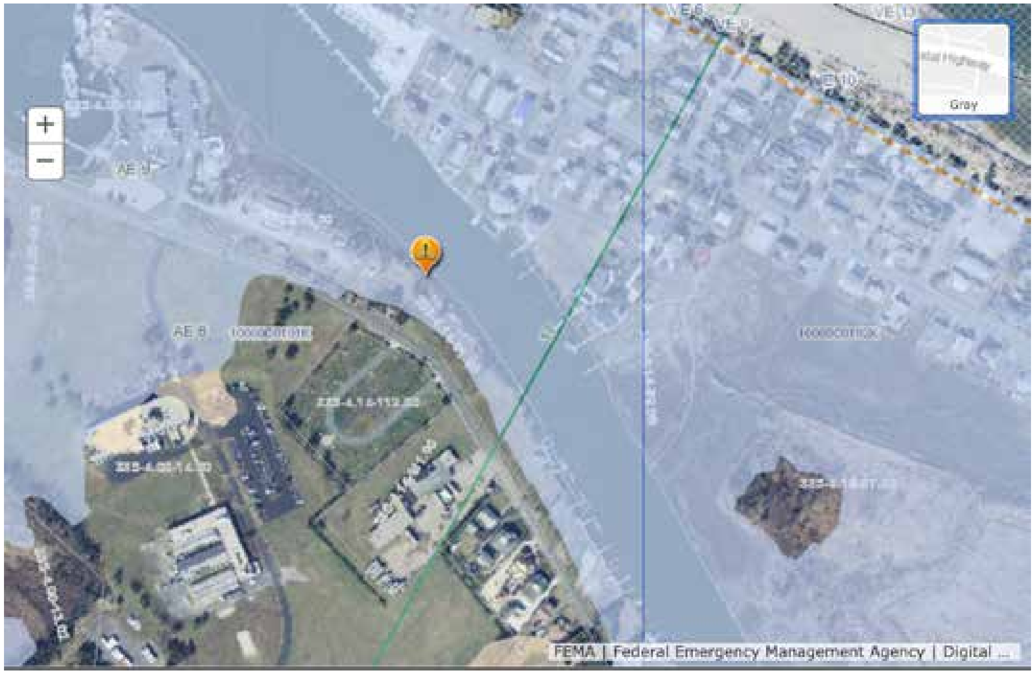


Figure 12: FEMA map showing the 100 year flood zone AE or 1% chance annual flood, which follows the 8-foot contour and bisects the de Vries property.

Figure 13: Steepness of site topography.

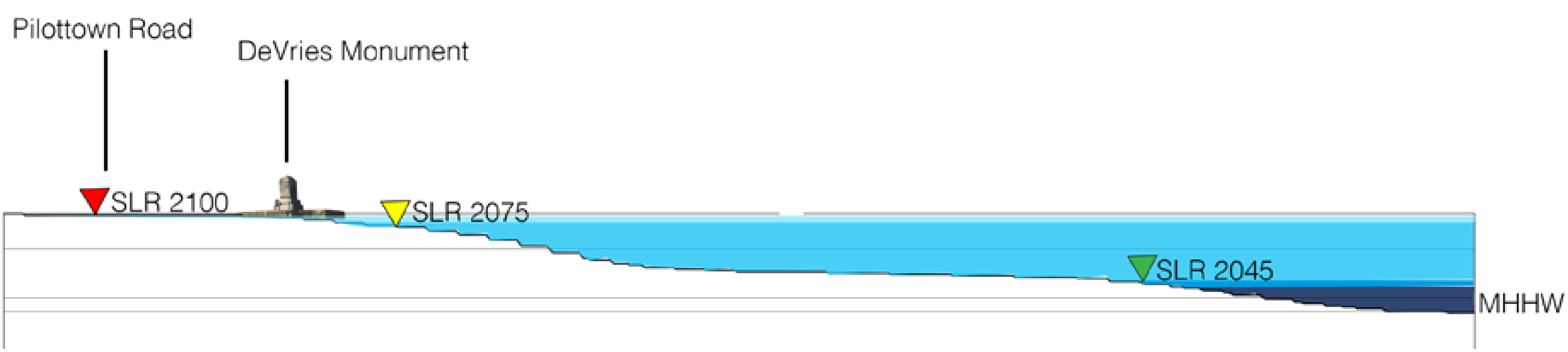


Figure 14: Site topogrqphy in the context of climate projections for sea level rise (SLR) in Delaware for years 2045, 2075, and 2100.

Before the Clean Water Act in 1972, the Lewes-Rehoboth Canal water quality was poor and contained many dead zones which are defined as areas that contain low oxygen levels, creating an uninhabitable environment for living organisms. In a dead zone, all living things leave if they are mobile or die off. The oxygen concentration determines the environment's ability to support life. Historically, sewage was disposed of by dumping it into the Delaware River, in turn contaminating the Canal. After the Clean Water Act was passed, the water quality in the Canal and the Delaware River improved dramatically. The dissolved oxygen concentration has increased since 1972, creating a better environment for living things. However, improvement is still required particularly in areas downstream of the Canal. Bald Eagle Creek and Pepper Creek are both considered dead zones (VIMS, n.d.). Figure 22 illustrates the locations of these creeks in relation to the Canal. Since the Canal is a tributary to the Rehoboth Bay, it is important to always work to improve the water quality of the Canal.

Figure 15: Red flags represent local reported dead zones as determined by the Virginia Institute of Marine Sciences.

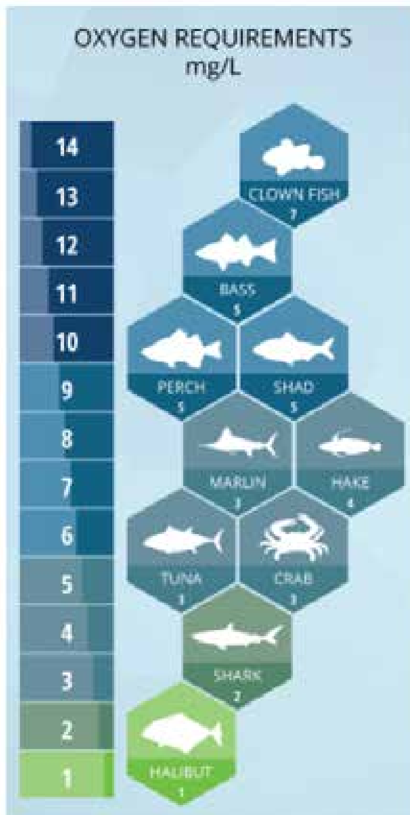


Figure 16: A display of oxygen requirements for various marine organisms, via Fondriest.

To that end, UD and DNREC monitor water quality in the Canal. In the four summer water quality reports of 2018, dissolved oxygen remained low, indicating a reduction in the ability to support aquatic life. In the beginning of the summer, harmful algal blooms (HABs) were present, but decreased by the second period. Total Enterococcus (TE) bacteria had opposite trends. Present at low levels in the first period of the summer, TE increased in the later three (Citizen Monitoring UD). Although the Canal water quality surpassed swimming standards set by DNREC, the City of Lewes would like to reduce nitrogen, phosphorous, and nonpoint bacteria loads by 40%, reduce marine nonpoint bacteria by 23%, and have a maximum on point source bacteria at 35 CFU enterococcus/100 mL (Delaware Watersheds).

Additionally, it is important to consider how rising temperature impacts water. As temperature increases, saturation levels decrease. As stated earlier, a decrease in dissolved oxygen levels creates a less suitable environment for fish and other living organisms. Additionally, salinity increases with rising temperatures. Saltwater holds 20% less dissolved oxygen than freshwater (Fondriest). This is especially important due to the Canal's proximity and connection to the Atlantic Ocean. Dissolved oxygen is a crucial aspect in sustaining aquatic life. Figure 23 below shows the requirements of different levels of aquatic life and the dissolved oxygen they require to thrive. It is important to increase current dissolved oxygen now to help as temperature of the Canal increases.

SOIL COMPOSITION

Two soils types were identified prior to a site visit via the USDA Web Soil Survey. They include an urban complex and a sandy loam:

BuA Brockatonorton-Urban land complex, 0 to 2 percent slopes
Landform: Back-barrier beaches
Moderately well-drained
Not prime farmland
Runoff class: very low
Frequency of flooding: Occasional
Available water storage: 5cm
Min. water table depth: 76cm (2.5 ft < 6 ft, high water table)

This is an urban soil with characteristics that would benefit from amendments in places of planting. The soil is sandy and dry, although it retains more moisture approaching the canal.

DodB Downer sandy loam, 2 to 5 percent slopes, Northern Tidewater Area
Landform: Broad interfluve, hill, ridge
Well-drained
All areas are prime farmland
Northern Atlantic Coastal Plain
Frequency of flooding: None
Available water storage: 10.64 cm

This soil is typically used for growing field crops, vegetables, flowers, and some fruit trees; therefore, it is well suited to planting. The dominant native vegetation for this soil type includes white oak, red oak, scarlet oak, black oak, Virginia pine, pitch pine, hickory, sassafras, dogwood, greenbriar, and American holly. Loblolly pine occurs in the southern part of Downer soils distribution. The understory is dominantly lowbush blueberry and mountain laurel. This soil ranges from extremely acid to strongly acid throughout the profile in pH. Researchers will ensure the plants selected for this site are tolerant of acidic soils.

Figure 17: Soil composition map from USGS Web Soil Survey.

During a site visit, researchers recorded general characteristics of the soil structure and texture. The soil quality was analyzed in three different locations on the site to ensure comprehensive knowledge was obtained. An auger was used to obtain soil cores on average of about 5 inch increments. No clear layers were defined. Closer to the water's edge, the soil was sandier and had higher water content. Overall, soils on site can be described as sandy and dry.

Trees
- *Juniperus virginiana*, Eastern redcedar
- *Ilex opaca*, American holly
- *Pinus strobus*, white pine

Shrubs
- *Myrica pensylvanica*, northern bayberry
- *Rhus hirta, glabra, or copallinum*, smooth/winged sumac

Grasses, Perennials
- *Opuntia humifusa*, eastern prickly pear
- *Panicum virgatum*, switchgrass
- *Spartina patens*, salt meadow cordgrass

Invasives
- *Phragmites australis*, invasive phragmites

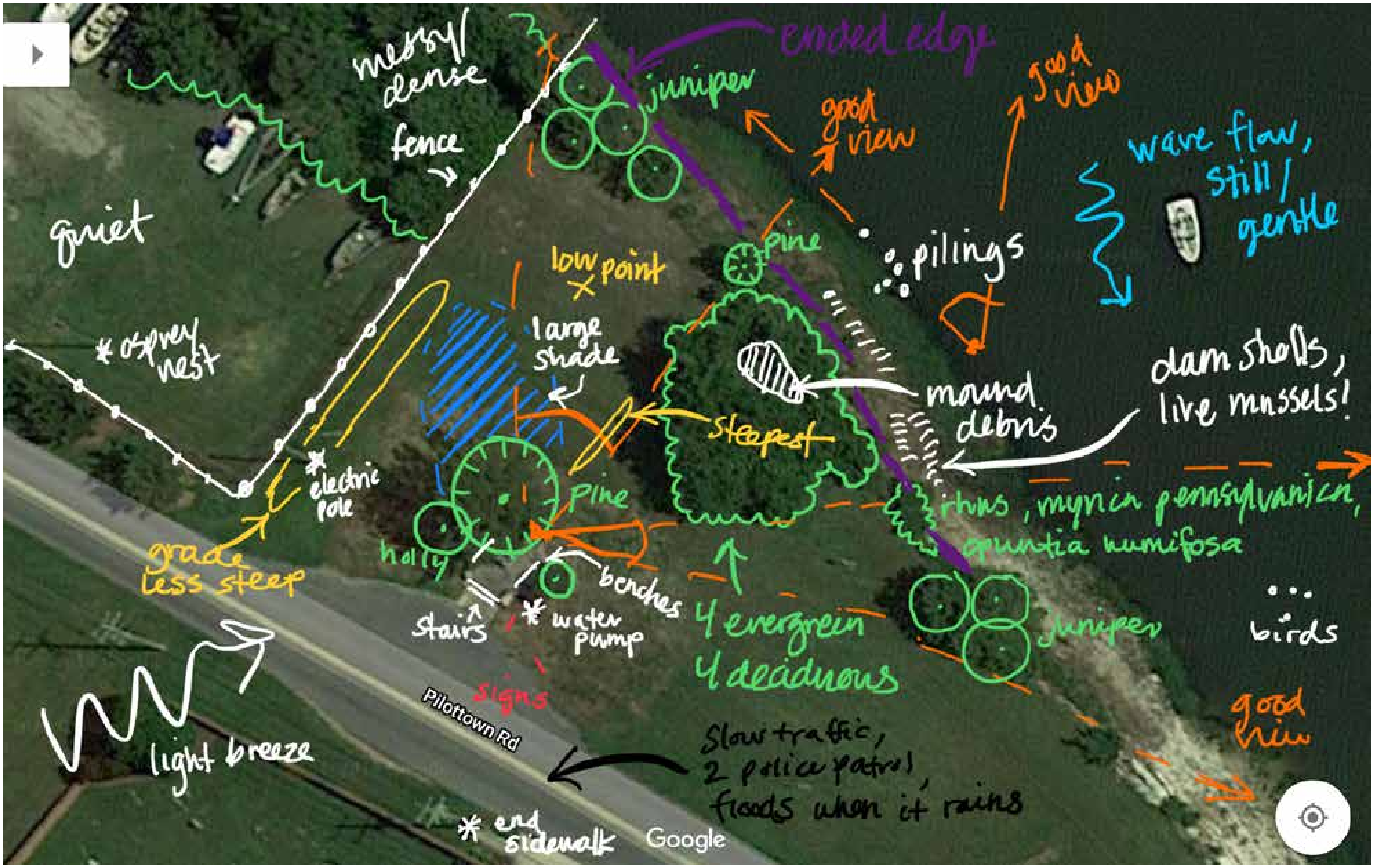


Figure 18: Site analysis mapping; aerial image from Google 2019.

OSPREY NESTING

Currently there is an active osprey nest onsite. Ospreys are habitual and return year after year to the same osprey nest (U.S. Fish and Wildlife Service, n.d.). The Migratory Bird Treaty Act (MBTA) protects these beautiful birds as well as their nests, but each state wildlife agency has different requirements. The Chesapeake Bay Field Office of the U.S. Fish and Wildlife Service is in charge of projects involving migratory birds in Maryland, Delaware, and Washington D.C. (U.S. Fish and Wildlife Service, 2018). In this region, nests are usually inactive from September to February, meaning they do not have any eggs in them or are not regularly visited by ospreys (U.S. Fish and Wildlife Service, 2018). As long as the nest is inactive, no permits are required to move a nest; however, a nest should only be removed if it is threatening human health or safety, if there is a risk to the osprey, or if the function of the property is being compromised (U.S. Fish and Wildlife Service, 2018). Ospreys may abandon a nest if there is too much human disturbance in the area. Disturbances can also cause the young to become scared and jump from the nests (DNREC, n.d.). It is particularly important that there are no disturbances to osprey nests during April, May, and June when the ospreys are the most sensitive and defensive of their nests (DNREC, n.d.).

When moving a nest, the structure should be secure before March 1 as osprey start returning to Delaware in mid-March (DNREC, n.d.). The osprey nest on the de Vries site has the ID 5991 and is nicknamed 125. This nest was first documented by Delaware Fish and Wildlife Nest directory 3 years ago and the last listed activity for the nest was also 3 years ago; however, the nest is inhabited for this season (Center for Conservation Biology, n.d.).

Figure 19: Osprey nest locations in Lewes via Google Maps.

Figure 20: Osprey nests and Horseshoe Crabs on site and at UD Lewes Campus.

HORSESHOE CRABS

Horseshoe crab nesting sites are a critical component of the coastal ecosystem in Delaware. Horseshoe crabs are a principal food source for over one million shore birds and support migratory populations. This shoreline provides habitat for horseshoe crabs to nest and some were observed by designers during a May site visit. The horseshoe crab is Delaware’s official marine animal. Horseshoe crab viewing is a recreational and educational opportunity visitors may take advantage of at high tide.

ATLANTIC RIBBED MUSSELS

Designers identified Atlantic ribbed mussels on the shoreline of the site during low tide. Atlantic ribbed mussels are filter feeding bivalves found in low marshes and mudflats throughout the Atlantic coast of North America. They have shiny, dark, ribbed shells that are 2-4" long. During low tide they are exposed in their massings along the coast. During high tide, they open their shells beneath the water and filter algae and other particles. Mussels can be incredibly effective at clarifying water, in fact "a large group of ribbed mussels can filter all of the water entering a marsh during each tidal cycle" (Delaware Sea Grant, n.d.).

Atlantic ribbed mussels are edible, though tougher than the blue mussel, and may be harvested during high tide when they are submerged. During low tide when they are exposed, "...ribbed mussels close their shells, keeping in waste products that can be toxic to humans" (CITE, n.d.). The ribbed mussel has several predators in the wild including mud crabs, shore birds (including rails and willets), and blue crabs.

Ribbed mussels can live for more than 15 years. A mussel's age can be determined by counting the number of ribs on its shell. They spawn one time each summer, with larvae that settle into the sediment. Once mature, a mussel will attach to marsh grass roots by secreting strong strands as binding. Mussels not only increase the habitat value and purify water, but naturally stabilize shorelines and so they are invaluable natural assets to their ecosystem.

Figure 21: Atlantic ribbed mussels at low tide.

Figure 22: Oysters at marsh edge.

OYSTERS

The Eastern oyster, Crassostrea virginica, is a native filter-feeding bivalve that inhabits bays, sounds, and tidal creeks along the coast of the U.S. and several countries in Central and South America. They have a wide range of tolerance to environmental conditions, but generally thrive in salinities of 14-28 ppt and require stable substrate in intertidal and sub-tidal places. Oysters are an important aspect of the history and economy in Delaware's coastal communities. Once thriving during the 1930's, disease, overharvesting, and other biological factors have resulted in a significant reduction in their population and therefore in the industry. Some programs are focusing on restoring the population to a higher level (though not a historical level) through planting and transplant programs (Delaware Estuary, n.d.). Oysters offer many ecosystem benefits, including habitat structure, reduction of wave energy, and clarification of waters. Reefs created by oysters can become habitat for a myriad of wildlife. Oysters mature in 1-3 years.

COMPLETE STREETS

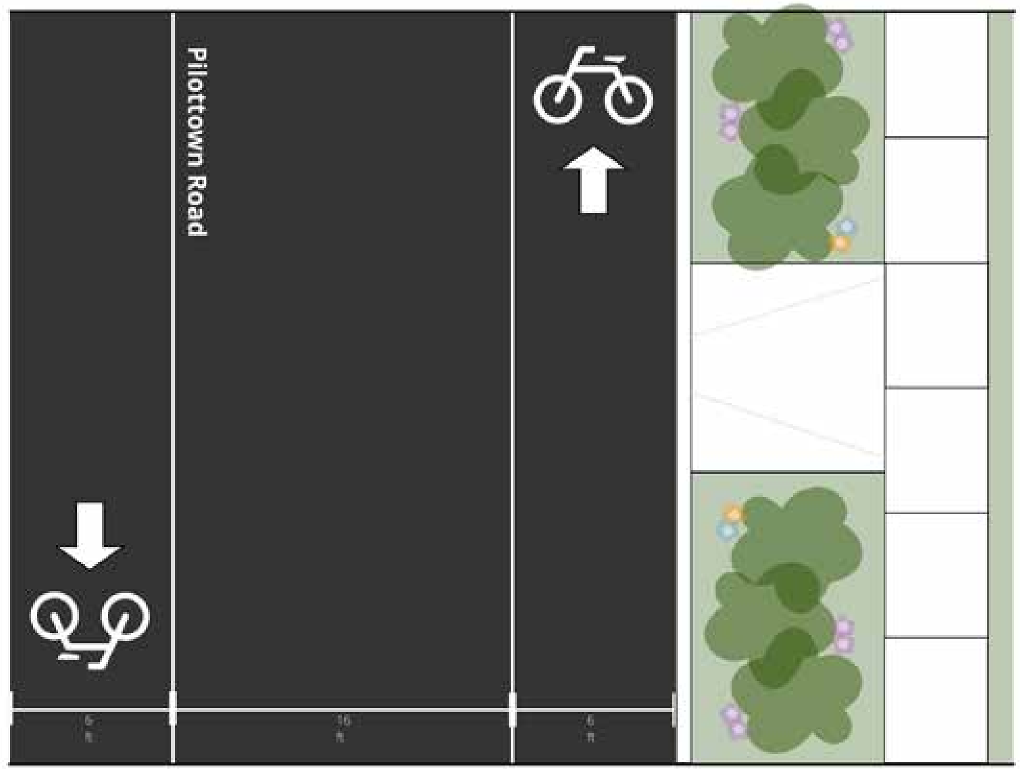
Currently, Pilottown Road is 28’ wide and is without continuous sidewalks in most sections. Designers are considering incorporating a complete street approach to improve safety and connectivity from Downtown Lewes to the UD campus via Pilottown Road.

Based on community needs, complete streets are adopted in order to create a safe environment for all modes of transportation to coexist, including walking, biking, public transportation, and individual cars. There are multiple complete street configurations that depend on existing conditions and needs of the community. A rural complete street is very different from an urban model; however, they are designed to accomplish the same function for the community. A complete street can include curb bumpouts, sidewalks, separate lanes, accessible pedestrian signals, and frequent and safe locations to cross the street. Incorporating a complete street design among the streets of Lewes is important in order to illustrate their value to the community.

Lewes’ streets should be accessible to people of all age groups and ability. Lewes has a majority aging population and a median age of 67 (Data USA - Demographics, n.d.). Incomplete streets put older populations at a greater risk. Only 6.3% of Lewes commuters indicate that walking is their general mode of transportation; however, adding a complete street has the potential to increase the number of walkers (Data USA, n.d.). As reported by Data USA, 31% of the Lewes population is obese (Data USA, n.d.). That is slightly lower than the national average of 39.8%; however, the complete street plan has the potential to decrease that sample population by encouraging an active lifestyle all while increasing safety (Centers for Disease Control and Prevention, 2018). Also, a complete street design along Pilottown Road will decrease the need to drive to the monument, thus decreasing the negative impact driving has on the environment.

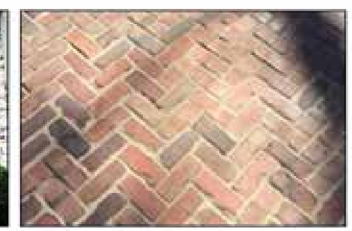
There is an active biking community in Lewes. Incorporating a complete street design will increase connectivity to existing bike trails and has the potential to increase visitation to the UD campus.

The adjacent diagram, Figure 27, was developed to conceptualize a continuation of an existing section of sidewalk starting at Canalfront Park that extends for a half of a mile north. This diagram indicates a continuation of the present sidewalk, two additional advisory shoulders, and buffer plants.



SIDEWALK MATERIAL IDEAS:





NATIVE PLANTS:

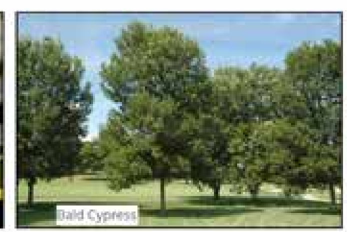


Figure 23: Potential design solution shows Pilottown Road as a complete street.

On March 15, 2019, CRDS designers held a community meeting to present on site analysis and GI research to approximately 24 attendees.

The first portion of the meeting oriented the participants to the location of the site as well as its current conditions. Attendees were briefed on the historic significance of the site, including how the site evolved over time, and the future sea level rise scenarios. The CRDS designers shared all of their findings with the audience including information from precedent case studies, onsite observed wildlife, and the analysis of connectivity between the monument and downtown Lewes.

After the initial lecture, Ed Lewandowski, Coordinator of Coastal Communities Initiative at Delaware Sea Grant, kicked-off the workshop portion of the event by reviewing the core values of Lewes with the audience before leading a discussion about how the de Vries Monument can embody those values. He started by framing a question for the participants: *What does a successful project look like, feel like, sound like, and even behave like?* He challenged the audience to think about similar historic sites and share what they liked and disliked about them. After the discussion, he distributed opportunity cards and the participants were asked to write down, *What educational, social, or community-based opportunities might further connect the community to this historic site.*

Following this exercise, the CRDS designers gave another presentation sharing the benefits of GI to the environment, the community, and the local economy. The presentation covered the twelve most common types of GI with examples of how each one might be applied to the current site.

In a charette-style mapping activity, the participants were asked to apply the GI information to the de Vries Monument site. In groups of approximately eight, participants placed different GI representational stickers on a site map to indicate which GI treatment they favored seeing onsite in the relative location. Afterward, each group was asked to share the favorite aspects of their collective design.

The response from the mapping activity showed that:

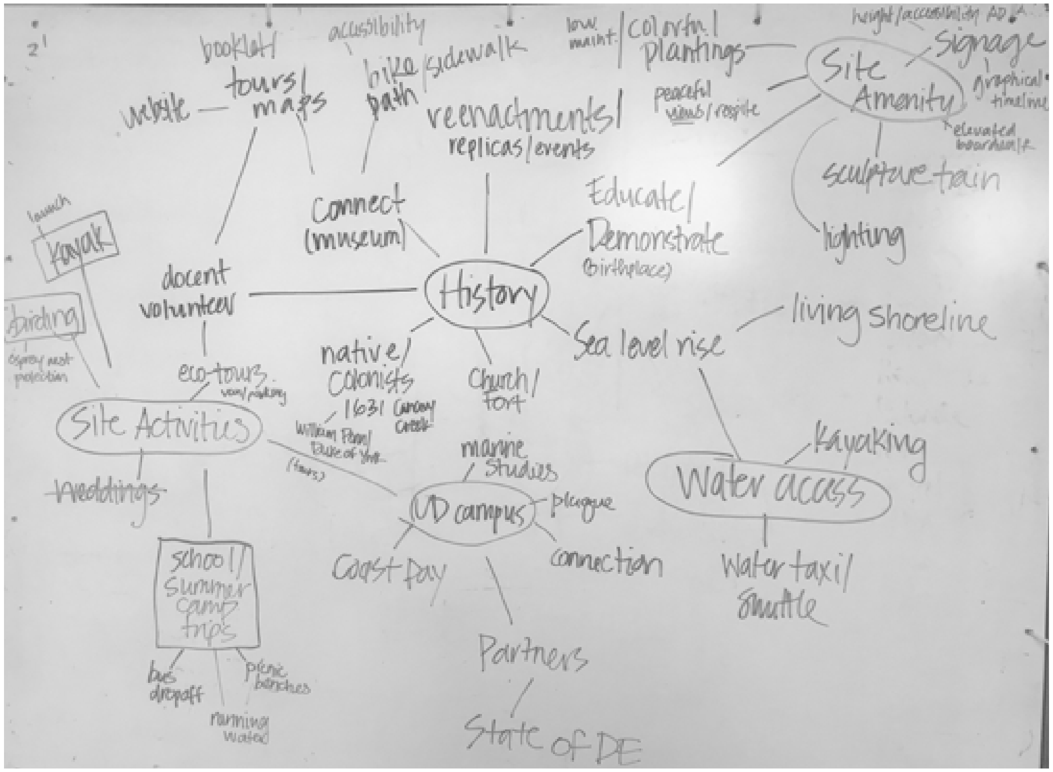
3 out of 5 participant groups agreed on the implementation of shade trees,
5 out of 5 participant groups agreed on the implementation of a living shoreline,
4 out of 5 participant groups agreed on the implementation of a rain garden,
3 out of 5 participant groups agreed on the implementation of a bioswale,
And 3 out of 5 participant groups agreed on the implementation of permeable pavers.

After the mapping activity, participants shared general feedback. All feedback was recorded and considered for incorporation into the next step of the design process.

Figure 24: Working groups during the community charette activity.

Following the charette and community input, the CRDS team synthesized feedback into a mind map to search for patterns in the information and draw further design inspiration and motivation. Each design decision was checked against the general consensus from the meeting. Preliminary functional diagrams consisted of placing a set of accessible pathways, a parking lot, a living shoreline, dock access, a crosswalk, and GI installments including rain gardens, bioswales, and shade trees which were favored by the community participants. From there, a scaled draft 1 conceptual design was developed for review.

Figure 25 (right): Mind mapping of community input.



MID-REVIEW

Concept Design I underwent a design critique termed the “mid-review.” The mid-review allows experts from various fields to critique the work and presentation of ideas and suggest changes. Guest critics Tim Cassidy, principal at Bernardon, Christian Hauser, associate director of Delaware Sea Grant and coastal engineer, and Jules Bruck, director of the UD Landscape Architecture program and practicing landscape architect, provided expert feedback from diverse perspectives. Recommendations for revision included:

- conducting further on-site observations such as wave energy, height of water table, soil quality, and bathymetric analysis to determine the feasibility of a living shoreline,
- redesigning a complete street that mirrors the existing precedent design in Lewes (such as wider shared use trails) and conducting further research into right-of-ways to determine the feasibility of a shared use path,
- reconsidering the use of permeable pavers in the floodplain where maintenance and removal of sediment could be problematic and expensive,
- reconsidering the dock design to ensure ADA compliance,
- reconsidering the placement of the osprey nest, and
- creating a more cohesive graphic design to ensure audiences are able to orient themselves to the location of the site with every graphic and map.

Figure 26: The mid-term design included an 8-space parking area, a dock, and a living shoreline treatment comprised of coir logs and oyster shell bags.

DESIGN REFINEMENT: POST-REVIEW

CRDS designers considered critique feedback and incorporated revisions into a second drafted site plan. Changes based on the feedback received include the pathway placement, living shoreline design and materials, pier function, form and size of pavilions, and parking area placement and size. CRDS designers conducted further site evaluation before presenting concepts to various regulatory agencies, iterating new site plans and finally presenting concepts to the Greater Lewes Foundation.

BATHYMETRIC SURVEY & LIVING SHORELINE

The Lewes-Rehoboth Canal connects the Delaware Bay and Rehoboth Bay. It is 10 miles long and has a maximum depth of 10′ near the Roosevelt Inlet, reducing to 6′ farther south down the canal (U.S. Army Corps of Engineers, n.d.). The Canal depth and width change at various locations along the canal. The de Vries Monument is located between location B and C on Figure xx below (U.S. Army Corps of Engineers, n.d.).

Critics suggested that CRDS designers conduct a bathymetric survey to more completely understand the underwater topography and therefore more accurately design the living shoreline treatment. The CRDS designers coordinated with Delaware Sea Grant Associate Director Christian Hauser to evaluate the nearshore bathymetry in early June 2019. Using an analog technique, the team measured bathymetry along four specified transects. The shoreline and observed water level (via NOAA Tides and Currents - Lewes Station) were used as reference points for the distance and elevation of the transects, respectively. By wading into the canal, the team took elevation measurements of the canal floor using a grade rod and the specified reference points. Elevation measurements were taken in one foot distance increments from the shoreline.

Results of this fieldwork were recorded and analyzed in Microsoft Excel and AutoCAD Civil 3D. Microsoft Excel allowed the team to model the two-dimensional cross-sections of the nearshore canal floor created by the horizontal distance and elevation points (pictured above in Figure xx). Jason Jerrytone, a Senior Chemical and Environmental Engineer and Project Manager at AECOM's Conshohocken office, assisted the CRDS team in utilizing AutoCAD Civil 3D to model the surface of the canal floor using the collected field data. AutoCAD Civil 3D was used to interpolate the bathymetric data points between the transects allowing the team to create sets of elevation contours of the canal floor as far as twenty feet from the shoreline. These contour lines were then used to model the surface of the nearshore canal floor. The results of this study are shown below in Figure __.

The results of the bathymetric study indicate steep slopes along the shoreline. These conditions would reduce the effectiveness of some previously considered living shoreline treatment elements including coir logs.

After returning to the site and reanalyzing the current conditions of the shoreline, it was determined that spot treatments would be the most effective and cost-sensitive option. Oyster bags have been identified as an optimal treatment because of their cost-effectiveness, ease of implementation, and ability to maintain existing vegetation and prevent erosion of the substrate. CRDS designers have connected with the Partnership for the Delaware Estuary (PDE) to discuss the potential use of the site to test biodegradable oyster bags made of an algae-based material, by recommendation of Danielle Swallow and Christian Hauser.

Amendments to a current living shoreline and shoreline stabilization will require a state and a federal permit. The CRDS and GLF plan to attend a Joint Permit Processing meeting at DNREC to discuss specifics of permitting for the final design. The Sussex County Conservation District offers a cost-share program, up to $5,000, for living shoreline projects that meet certain criteria.

Figure 27: The CRDS team measures bathymetry.

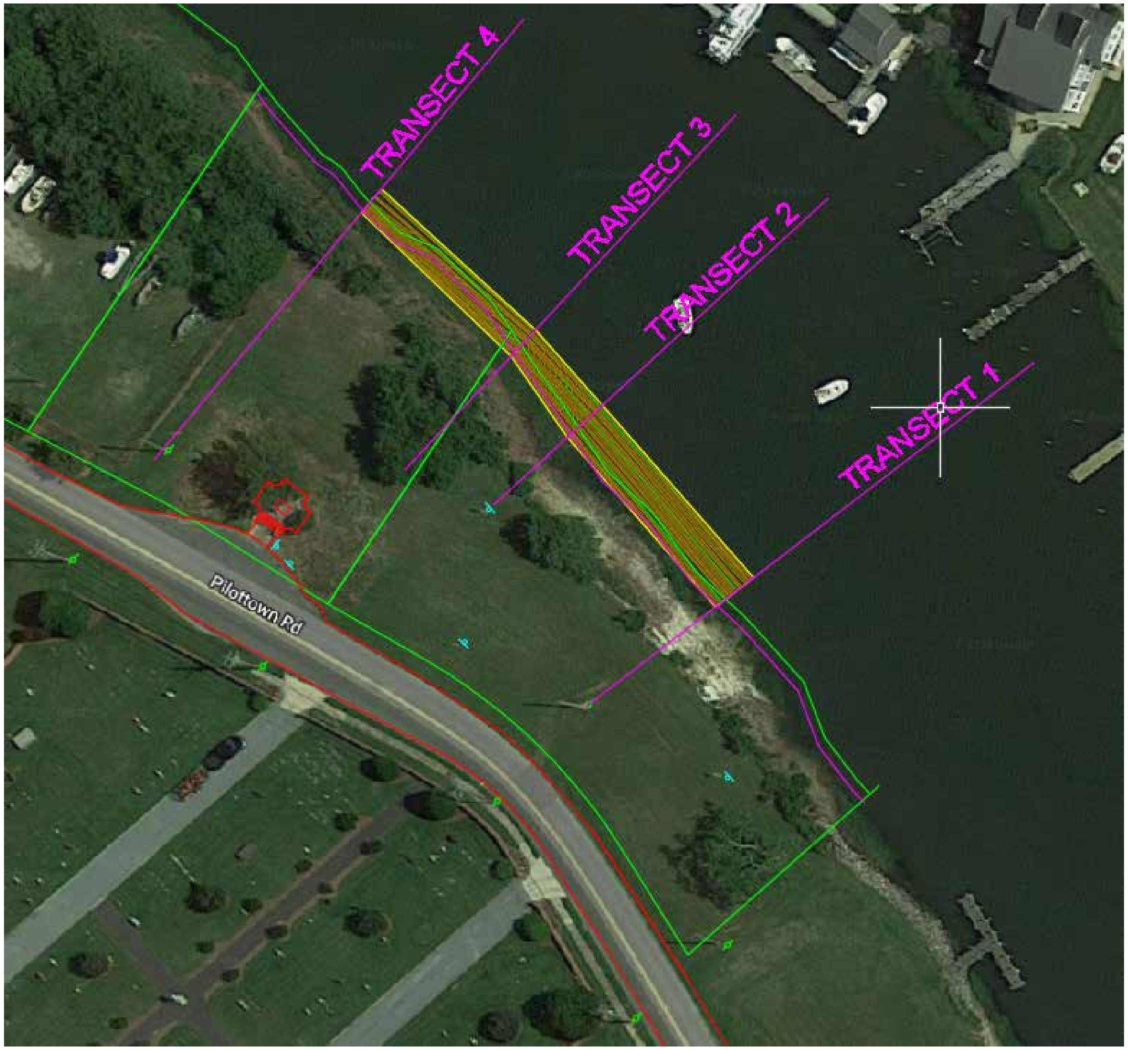


Figure 28: Transects perpendicular to shoreline drawn in AutoCAD and contours interpolated with AutoCAD Civil 3D.

Figure 29: Inland waterway channel depths for the Lewes - Rehoboth Canal.

RASCL PRESENTATION

Delaware Resilient and Sustainable Communities League (RASCL) is “a collaborative network of State nonprofit and academic partners working to create more resilient sustainable Delaware for everyone ” (Delaware RASCL, 2019). Danielle Swallow invited the CRDS to share the status of this project with RASCL members in June 2019. Through this meeting, the CRDS team was able to receive further feedback and reiterate the design and connect with the State of Delaware Principal Planner David Edgell for future projects as well as Brittany Hayward at DNREC concerning living shoreline considerations. CRDS hopes to continue involving RASCL members in the identification of future projects and pathways.

FINAL DESIGN

Following critique and stakeholder input, the following became the **primary site design criteria** in developing the final plan:

- Resilience against flooding and sea level rise
- Accessible parking
- Design within allocated land parcel
- ADA compliant pathways
- University of Delaware connectivity
- Lewes connectivity

CRDS Considered the Following Opportunities and Constraints in this design:

Opportunities:

- Enhance views, expand viewshed
- Control erosion
- Provide wildlife habitat
- Increase native vegetation and biodiversity
- Teach about Delaware history
- Protect osprey nest

Constraints:

- Steepness in slope
- Parcel boundaries / fence line
- Parking scale
- Connectivity/ pedestrian safety
- Access for bikers
- Osprey nest
- Accessibility to water

Figure 30 (opposite page): Final site design for the Zwaanendael-Devries Monument.

ZWAANENDAEL - DEVRIES MONUMENT

GAINEY, JOSH
RUGGIERO, EMMA
SWITLISKI, MARK

1 **Parking Area**
- 5 spaces, 1 ADA
- Expandable to 10 spaces
- Permeable Concrete
- Stone Retaining Wall
- Stairs to Pathway

2 **Zwannendael - DeVries Monument**
- Metal Grate ADA Ramp
- Bike Rack
- Sign: History Timeline

3 **Rain Garden & Bioswale**

4 **Pathways**
- ADA Grade
- Fine Crushed Gravel
- Sign: Osprey Nest & Rain Garden

5 **Seating Area**
- Picnic Tables
- Modular Shade Sails

6 **Instructional Pavillion & Meadow Buffer**
- Seating
- Modular Shade Sails
- Sign: Meadow Buffer, Living Shoreline, & Wildlife Habitat

7 **Living Shoreline**
- Spartina sp.
- Oyster Bags (test site)
- Pier & Outlook
- Interactive Elements

8 **Bike Lane, Sidewalk & Crosswalk**
- Continue Sidewalk
- Two-Way Bike Lane (Canal-side)

9 **Planting Beds**
- Surround Parking Area
- Monument Hillslope
- Buffer Boat Lot

10 **Landscape Palisades**

ADAPTABLE STRUCTURES

The proposed seating area, parking area retaining wall, instructional outlook, and boardwalk structures respond to changes as sea levels rise. The following sections show the current water level at mean high tide as well as low medium and high projections for sea level rise across three designed transects on site. While these projections do not reach the monument, they will have an impact on the rest of the site's design including the proposed pathways, seating area, parking area, and educational outlook.

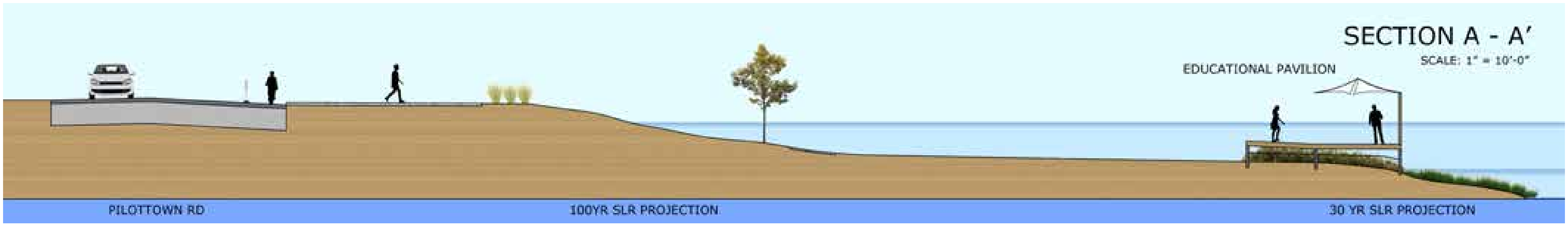


Figure 31: Section A-A' transects the NW side of the property, extending from a proposed Pilottown Road crosswalk through the sidewalk, pathway, palisade sculptures, boardwalk, and educational outlook. The boardwalk is supported by tall pilings that the deck can be detached from. In the future, the deck can be reattached at a higher point and retrofitted with a floating base. The outlook features the moveable shade sails as well as built-in seating and the same tall pilings that allow the deck to be floated and reattached.

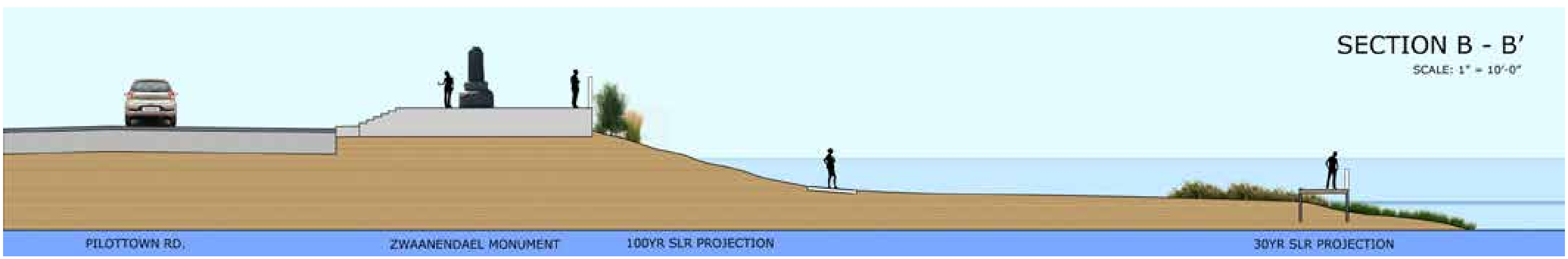


Figure 32: Section B-B' transects the center of the site through monument, pathway, boardwalk, meadow buffer and living shoreline. The design maintains the historic open viewshed with a low meadow riparian buffer.

Figure 33: Section C-C′ shows the parking and seating areas. The parking area will require a regrade so that all pavement is at a high elevation above the floodplain. An engineered retaining wall that allows for this regrade may function as a future seawall. The seating area features moveable shade sails clipped to tall pilings and picnic benches equipped with anchors to secure them to the pavers below. The design of this adaptable seating area allows for short term flooding without concern for floating projectiles. In the long term, all seating area elements may be easily removed except for secured pilings that may take on another use, such as a base for a floating dock.

Figure 34 (left): Rendering of the seating pavillion structure with shade sails.

PARKING

The parking design matrix shown below in Figure 35 catalogues seven considerations with a point system indicating the weight of each consideration to influence parking form and placement. The nine considerations for parking lot design include the utility poles, osprey nest, accessibility, amount of land outside of the current parcel boundary, number of parking spaces, sight lines, pedestrian and cyclist safety, floodplain and visitor experience.

		Zwaanendael Monment Parking Options						
		Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Constraints	Min. 10 Parking Spots on Site*2	☐	☑	☑	☑	☑	☐	☐
	Outside 100 yr Floodplain*3	☐	☑	☑	☑	☑	☑	☑
	Within allocated land parcel (75'NW)*1	☑	☐	☐	☐	☐	☐	☐
	ADA accessible*1	☑	☑	☐	☑	☑	☑	☑
	Vehicular Safety (road bend)*3	☑	☐	☐	☐	☐	☑	☑
	Avoid Utility Poles*2	☑	☑	☑	☑	☑	☑	☑
	10' Osprey Nest Buffer*1	☑	☑	☐	☑	☑	☐	☐
	Pedestrian Safety*3	☑	☑	☑	☑	☐	☐	☐
	Visitor Experience*1	☑	☑	☑	☑	☐	☑	☑
Total		12	13	11	13	9	10	10

Figure 35. Parking design matrix.

Options two and four consider a parking lot design on the southeast border of the property. This area avoids utility poles as well as the osprey nest, enhance visitor experience as well as allow for a greater number of spaces outside of the flood zone therefore requiring less fill.

Each on-site parking option may be amended with a University of Delaware pathway connecting the site to the large parking lot at the UD campus for overflow. This pathway, enhanced with shade trees, native plants, benches and signage, would parallel the cemetery wall, passing by the corners of the historic settlement and allowing for historical interpretation.

The CRDS has designated figure xx as the optimal solution. This configuration contains five spaces, one of which is ADA compliant, with an option to expand to ten spaces. This configuration will require a regrade and a retaining wall. The material is permeable concrete. In an August 13th meeting with DelDOT, it was stated that this location of the parking lot and crosswalk seemed ideal for sightlines and stop distances. The Greater Lewes Foundation has approved of a 5-parking space lot expandable to 10 and the connection to UD's parking lot for overflow, but are considering parking placement.

The permit application for a new parking area entrance is state mandated.
The permit can be accessed at this webpage: https://services.deldot.gov/EPSExternal/EPSpermit.

Up to ten bicycles can be parked at the rack located to the right of the monument entrance.

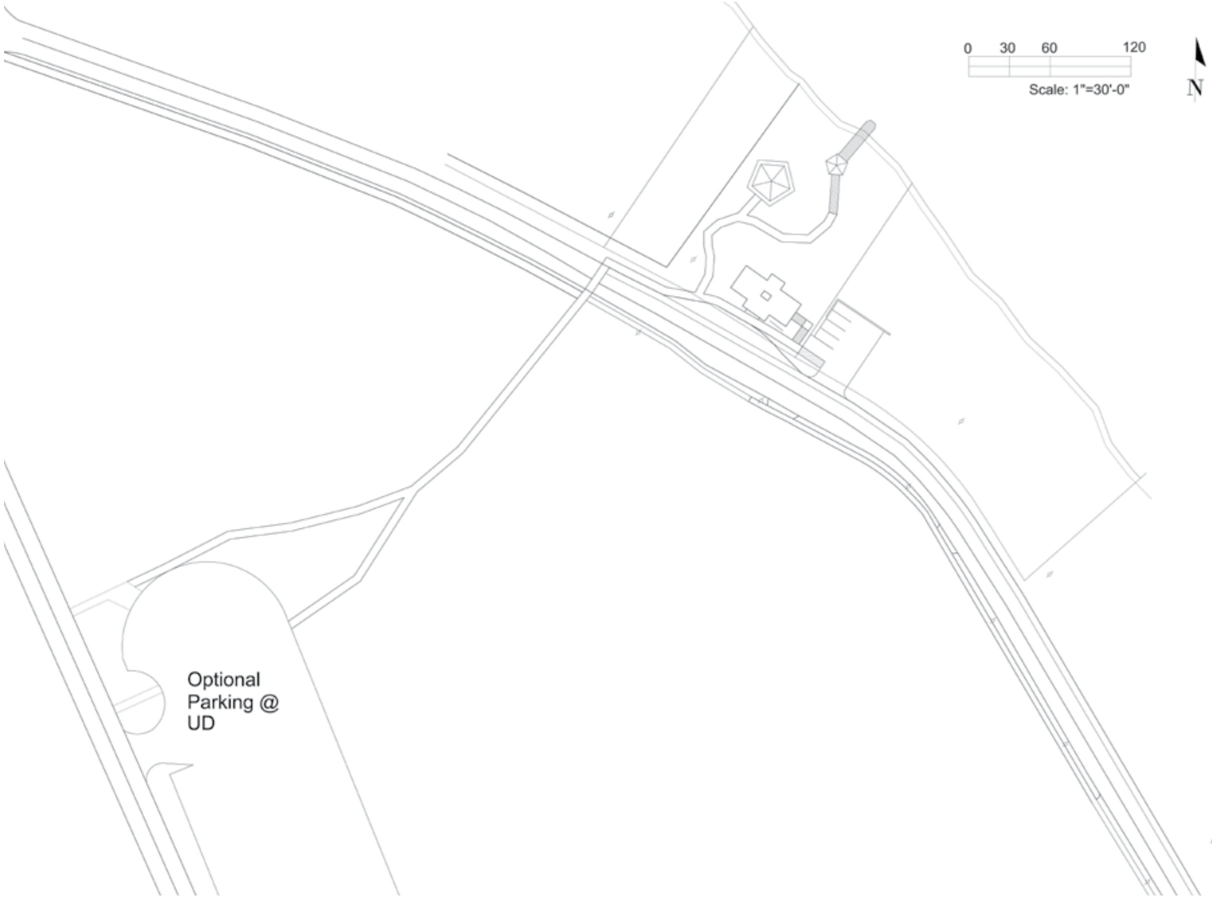


Figure 36: Final chosen parking design plan and proposed connection to UD parking lot for overflow.

Figure 37: Sketch showing axial view approaching the monument from downtown Lewes.

Figure 38: Lumion rendering of proposed pathway to UD parking.

PLANTED AREAS

Rain Garden:
A rain garden located to the left of the monument will provide a function of absorbing stormwater from Pilottown Road, while educating visitors on the benefits of green infrastructure in coastal areas. Stormwater will be conveyed through a curb cut in the sidewalk, to a bioswale, and into a first basin. Any further water will flow in a cut through the pathway to a secondary basin. Large debris filter out first, some water will infiltrate into the bioswale, and most water will flow into the rain garden using the existing slope for passive conveyance. The rain garden is located outside of the floodplain to avoid interception with the water table.

Shade Trees:
Large shade trees will line the Eastern border of the property to obstruct poor views of the UD boat lot. An opening in the trees near the osprey nest will allow for visitors to view the nest. No trees surrounding the nest will be taller than the nest itself, as to allow for a line of sight for osprey to the water. Shade trees near the parking area will reduce heat from the pavement, while shrubs below them will screen views of the cars in the parking lot as visitors approach the monument.

Meadow:
Meadows are an alternative to wooded riparian buffers that allow for open site lines and seasonal interest. This riparian buffer will allow the living shoreline marsh to migrate over time while providing habitat, shoreline stabilization and stormwater management.

Lewes in Bloom has been identified as a potential community partner in the management of some of the above planted areas.

MATERIALITY

The CRDS recommends the following materials:

- White fine-crushed gravel: for pathways to mimic and relate to Canalfront Park.
- Porous concrete or porous asphalt: to create a permeable parking outside of the floodplain.
- Metal grate: (as used in the Gordon's Pond Trail in Cape Henlopen State Park) for the ramp and boardwalk; allows for light to reach plants beneath the path, which is particularly important for the living shoreline.

Figures 39, 40 (right): metal grate material in use at Cape Henlopen State Park and white crushed gravel.

ADA COMPLIANCE

Major pathways are ADA compliant, allowing for an accessible route to the living shoreline and water's edge. An ADA compliant ramp is proposed next to the parking area, with slopes of [insert here]. The ramp connects the sidewalk to the monument platform, at an elevation of 16.9'. One accessible parking space is located near the monument ramp entrance and next to the sidewalk leading to the rest of the site's accessible 6' wide pathways. One portion of the pathway, from the parking lot to the seating area, is not accessible and uses stairs due to grade restrictions; however the seating area can be accessed by an alternate route. Design of this space follows the 2010 standards for ADA Standards for Accessible Design (U.S. Dept. of Justice, 2015).

PROGRAMMING & INTERPRETATION

Elements of site programming include palisade sculptures, interactive elements on the pier, and signage. Palisade sculptures resting into the landscape will recall the maritime history while providing a visual marker for the moderate sea level rise projection in 50 years. Interactive elements will include models of wildlife and simple water monitoring equipment; for example, visitors may count the rings of an Atlantic ribbed mussel to determine its age or determine current water quality through use of secchi disks.

Signage will provide environmental and historical interpretation throughout. Historical signage in the form of a visual timeline will convey the site history more graphically than current signage. Environmental interpretation will indicate the benefits of a rain garden and bioswale, a meadow buffer, living shoreline and the wildlife that inhabit these spaces including the osprey, mussels, oysters and horseshoe crabs.

GATEWAY TO UD LEWES CAMPUS

Improved connectivity from downtown Lewes along Pilottown Road will not only promote access to the De Vries site, but to the University of Delaware Lewes Campus. The CRDS team proposes UD flags to designate the transition into this space, an updated sign to bring attention to the campus and visual linkages to connect the site's maritime history to University of Delaware's maritime involvement.

Figure 41 (right): rendering of modernized entry sign to UD Lewes Campus

CONNECTIVITY

CRDS designers met with the Deputy Director of Operations and Support at the Delaware Department of Transportation (DelDOT), James Pappas, in early July 2019 to review the considerations the state has for Pilottown Road. Mr. Pappas provided feedback regarding the team's initial concepts for pedestrian and vehicular access routes to the monument site, including the ideal design standards of sidewalks and complications involved with moving in-use utility poles.

In mid-July 2019, CRDS designers rented bikes from Lewes Cycles Sports, located on East Savannah Road, to experience firsthand the connectivity to the Zwaanendael-de Vries monument site. The route originated from the Front Street and Savannah Road intersection and continued down Pilottown Road to the monument site. From there, the route continued down Pilottown Road, then left onto Park Road down an existing multi-use pathway until reaching New Road. The route followed New Road and connected back to Pilottown Road, before returning to Lewes Cycles Sports. Experiencing this route provided the CRDS designers with an enhanced understanding of the existing connectivity, safety concerns and opportunities to link established bike paths and implement a complete street.

In mid August 2019, the CRDS met with James Pappas, Scott Neidert, Jeff Niezgoda, Tom Nickel and Stephanie Johnson from DelDOT to consider the feasibility of the proposed connectivity plans for Pilottown Road. The team presented connectivity designs for Pilottown Road, Front Street, the extension of Pilottown Road that runs through downtown Lewes, and a portion of Savannah Road. Sections and plan views of the connectivity design plans for Pilottown Road, Front Street, and Savannah Road can be viewed in Figure 29 a, b and c respectively.

CRDS proposed a plan to establish a bike lane along the portion of Savannah Road that currently has parallel parking on both sides of the road, a two-way bike path along the canal side of Pilottown Road, and a vegetated median in the downtown portion of Front Street. Though DelDOT agreed with a need for connectivity improvements and that current conditions on Pilottown Road posed a high-stress situation for bikers, they voiced concerns about the right-of-way on Pilottown Rd and removal of parking spaces on Savannah Road. Several areas along Pilottown Road required a more involved design to ensure vehicle and pedestrian safety. One of these areas is the intersection of New Road and Pilottown Road.

Figure 42: Map of proposed connectivity.

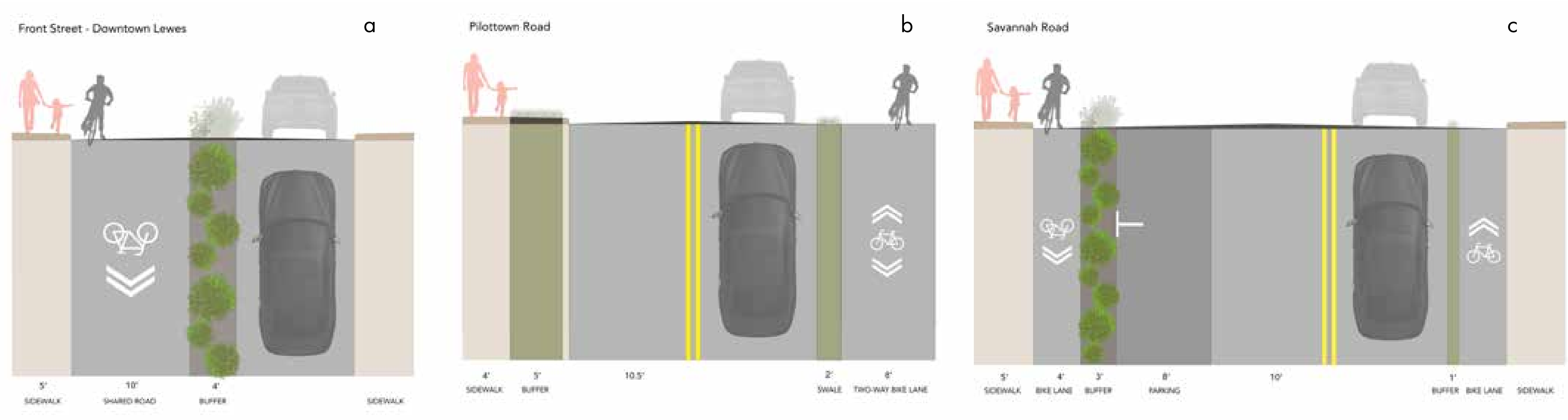


Figure 43: Design sections showing green street concept plans.

Prior to the mid-August DelDOT meeting, Danielle Swallow shared the New Road Corridor Master Plan with the team. In addition to added bike lanes, a roundabout, and other improvements to New Road, the plan described how the intersection of New Road with Pilottown Road would likely change. The CRDS designers reached out to Jim Klein, owner of Lardner/Klein Landscape Architects, P.C., the firm contracted for the New Road Corridor Master Plan. Mr. Klein informed the team that New Road would have shared use roadway for vehicles and bicyclists where it intersects Pilottown Road due to a narrow right-of-way. This information allowed the CRDS team to design the connectivity of Pilottown Road at this intersection to anticipate the expected increase in bicyclist and vehicular traffic. The design of this intersection is pictured below in Figure 29a.

Another area of interest was the intersection of Front Street and Savannah Road. This area poses a particularly stressful experience for bikers because of the lack of designated bike lanes. This intersection serves as the primary access route to Lewes's beach for residents and visitors travelling by bike or car. Because of this function and the limited road widths at the intersection, the CRDS team's proposed design only involved the incorporation of designated bike lanes at the entrances of the intersection. This design can be seen below in Figure 29b.

The Zwaanendael-de Vries monument is the final area of interest. The connectivity design of Pilottown Road in front of the monument site was intended to work seamlessly with our proposed site design seen in Figure xx and the connectivity plans proposed for Pilottown Road in Figure 29c.

STAKEHOLDER & AGENCY FEEDBACK

The CRDS designers presented the final concept design to UD, DNREC, and finally GLF, iterating and adapting the design with continued feedback.

UD COLLEGE OF EARTH, OCEAN, AND ENVIRONMENT

CRDS designers presented to the UD College of Earth, Ocean and Environment on August 5th, 2019 and engaged in a conversation about the design with Jules Bruck, Ed Lewandowski, Danielle Swallow, Caitlin Olsen, Chris Petrone, Peter Krawchyk, Sherry O'Rourke, and Estella Atekwana. Designers recieved design feedback concerning desire lines from the parking lot, the boardwalk and pier structure, and sight lines from the monument that prompted designers to reconfigure the pathways, move structures away from the center of the monument viewshed, and to establish a promenade instead of a stand alone pier at the water's edge. Additional suggestions for consideration included prevention of the use of the park at nighttime, showing sketches of the park to convey the design, reconsidering the design in a less car-centric manner, identifying and contacting stakeholders who own homes across the canal,

DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL

At a Planners Technical Advisory Committee (PTAC) meeting coordinated by Michael Tholstrup, the Climate Adaptation and Sustainable Communities Planner with DNREC in Dover on September 11th, 2019, the CRDS received feedback in regards to the feasibility of the design from a permitting standpoint. A concern about the amount and positioning of the boardwalk prompted CRDS designers to reduce the amount of boardwalk from a narrow loop at the edge of the living shoreline to a linear stretch further inland and to remove an extension of pier into the canal. It was suggested that CRDS meet with DNREC for a Joint Permit Processing (JPP) meeting to further consider permits needed and adjustments required for the plan to comply with permitting standards moving forward.

Additional suggestions for moving forward included meeting with DNREC's floodplain program, meeting with DNREC's stormwater permit program for offsetting parking construction, analyzing past aerial imagery, and considering site maintenance.

THE GREATER LEWES FOUNDATION

CRDS designers presented finally to the GLF board members on September 27th, 2019. Those in attendance included Jules Bruck, Ed Lewandowski, Danielle Swallow, Chris Petrone, Theodore Becker, Mark Chura, Joe Stewart, Dennis Forney, Evan Park, and Brian Dembeck, Emma Ruggiero, Mark Switliski, and Joshua Gainey.

The GLF was receptive to the GI, walking trail, and signage concepts put forth by the CRDS. A formal agreement between UD and the GLF will need to be settled before specifics on the parking lot design and other elements can be solidified. Brian Dembeck, the University of Delaware Director of Real Estate and Development will discuss the lease agreement with Peter Krawchyk, the University Architect, and then provide a draft sheet for terms to the GLF.

Representatives from the GLF, UD, and CRDS plan to meet with DelDOT to finalize concepts for the parking lot design and review entrance plan specifics before attending a Joint Permit Processing meeting at DNREC. The GLF will submit the Entrance Plan with the parking lot on the left-hand side and the crosswalk in its current location to DelDOT to review.

Figure 44: The CRDS team presents to the GLF.

PATH FORWARD

The CRDS is currently awaiting the terms of the lease agreement between UD and the GLF before moving forward with any conceptual redesign. The GLF has an interest in continuing to work with the CRDS for another term, January - June 2020, to design for the monument itself. It is proposed that Rodney Robinson, a landscape architect, act as an advisor for the team as they evolve the design and create construction documentation. Further, the GLF has proposed that the CRDS participate in hosting another community outreach session. The CRDS hopes to implement certain coastal design features in the near future via grant proposal as a phase I.

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