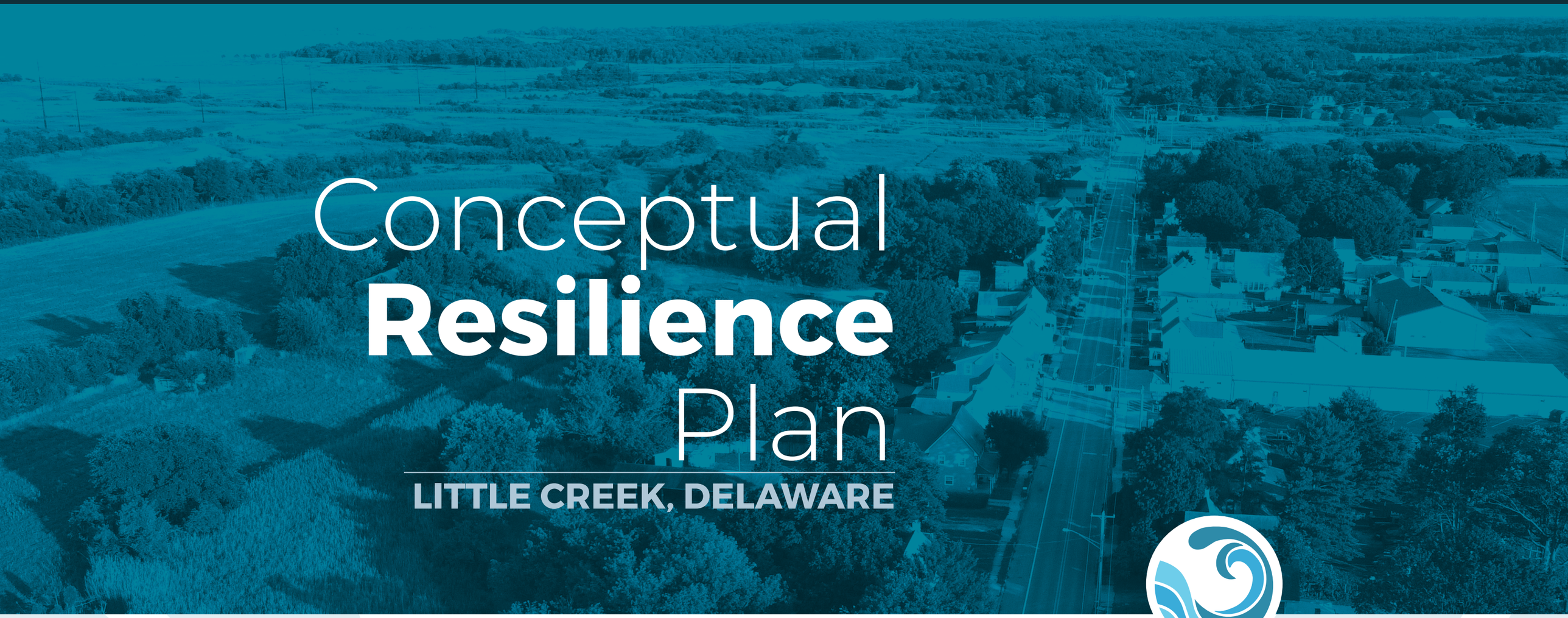

Conceptual **Resilience** Plan

LITTLE CREEK, DELAWARE

Prepared for the Town of Little Creek
and Presented August 3, 2020

CRDS
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DESIGN STUDIO

Thank You

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The Coastal Resilience Design Studio (CRDS) is an interdisciplinary team of student designers, researchers and engineers exploring creative and thoughtful solutions to the many challenges facing Delaware's coastal communities.

The CRDS equips communities with tools, designs, and adaptation strategies aimed at mitigating disruptions from short-term hazardous events and long-term environmental changes.

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Please visit our webpage to view our past and ongoing projects and for contact information online at:

https://sites.udel.edu/bsla-crds/

CONTENTS

INTRODUCTION

PRIMARY OBJECTIVES

The Town of Little Creek is a coastal community vulnerable to and experiencing the impacts of sea level rise. Residents of Little Creek envision maintaining small-town character and providing opportunities to showcase the town's maritime history "while allowing for modest growth and redevelopment that is consistent with its rural surroundings, while adapting to sea level rise" (Comprehensive Plan, 2016). The CRDS is collaborating with the Town of Little Creek to develop a Concept Plan that addresses flooding and quality of life for residents centered on the specific needs and desires outlined in a thorough community survey (the Town of Little Creek Working Waterfronts Initiative). **The primary project objectives, based on the identified community needs, include:**

- Addressing hydrological issues and recurring flooding of roadways and commercial properties,
- Establishing connectivity within the town to local amenities and to surrounding amenities including the Little Creek Wildlife Area, Port Mahon, Pickering Beach, Kitt's Hummock, and the Ted Harvey Conservation Area, and
- Designing safer 'complete streets', which Smart Growth America defines as streets "designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities", with a focus on green infrastructure and traffic calming.

TOWN OF LITTLE CREEK BACKGROUND

Little Creek is a small, rural community located in eastern Kent County, DE between the City of Dover and the Delaware Bay. The town was established as a commercial shipping hub for the city of Dover and was very productive in the 1800's with thriving oyster and canning industries. The success of the oyster industry in Little Creek began to fade by the start of the 20th century, leaving few economic opportunities in the town (History of Little Creek, n.d.). The town is approximately 65 acres, broken into 122 parcels. Current demographic data from Environics Spotlight indicate there are 187 current residents and 78 households. The median age is 49.1. Situated just north of the Little River, Little Creek has a rich maritime history and in 2007 became a destination stop along Delaware's Bayshore Scenic Byway, designated as one of the seven "discovery zones" residing along a waterway (Delaware Bayshore Byway Corridor Management Plan, 2020). As such, the town is an asset to preserving the scenic viewshed and natural qualities of the American landscape envisioned as part of the Obama Administration's Great Outdoors Initiative.

Delaware's coastal wetlands are recognized for significant ecological and habitat value at a global scale, including by the Nature Conservancy and the National Audubon Society. Relevant designations given to the Delaware Bay area include Migratory Shorebird Site of Hemispheric Importance, Wetland of International Significance, and Important Bird Area of Global Significance (Delaware Bayshore, 2020). Over 400 species of birds and other wildlife, including horseshoe crab, osprey, and bald eagle reside in this area and rely on the health of the wetland. Disturbance in this habitat has allowed for invasive Phragmites australis to colonize and become a significant threat to biodiversity.

Active land use within the town is primarily residential with several commercial and civic enterprises, such as a public accessible boat ramp and dog park. The surrounding areas are agricultural land and protected wetlands. Glenn Gauvry, current Mayor of Little Creek, represents the town acting as the client and main point of contact for CRDS with respect to this project.

CONCEPTUAL RESILIENCE PLAN

RESIDENT CONCERNS

A community questionnaire conducted in 2015 for the Working Waterfronts Initiative provided a platform for residents to voice several needs and concerns. Residents would like to preserve Little Creek's small-town rural atmosphere, restore working and recreational use to the Little River, and address resiliency in relation to sea level rise. Other identified concerns included stormwater management, mosquito control, truck traffic on Main Street (Route 9), and a lack of bike routes.

Residents expressed desires for a town park and a public water system.

Town residents have voiced concerns about truck traffic and overall speeding through the town. Recordings of traffic count and vehicle speeds over the course of four weeks in May 2020 has reinforced the need to address these concerns. According to this data, 60% of vehicles recorded were traveling faster than the 25 MPH speed limit.

As part of the community questionnaire, residents were asked about the threat of sea level rise. All but one of 39 respondents believe that sea level rise is occurring and is a threat to the town. In addition, 91% of respondents support government spending on resilience projects (Comprehensive Plan, 2016).

The CRDS's involvement will promote the vision of town residents and reflect the needs identified by the community.

HYDROLOGICAL ISSUES

There is significant flooding in Little Creek after rain events. Damaged stormwater infrastructure and sediment build-up have greatly reduced the effectiveness of four existing discharge areas along the eastern edge of the town. Flooding at the intersection of Main St. and Port Mahon Rd. can be seen in the above photo.

The presence of an upstream dam built on private property in the 1970's and reduced use of the waterways may have caused decreased flow and increased sedimentation in the Little River. Recent dredging of the river east of the Little Creek Bridge was conducted in 2015 to facilitate flow at the cost of approximately $1,000,010 in state funds and will be required as siltation continues. The Little Creek Fire Department uses the Little River to access the Delaware Bay for rescue missions, so dredging is tied to public safety as well as the fishing and recreation economy (Delaware DNREC, 2015)

ADDITIONAL RESEARCH

To address the recurring issues noted above, the CRDS must gather and analyze additional existing conditions information. This includes current stormwater drainage features and flows, erosion and degradation along the Little Creek, percentage of impervious cover, analysis of possible impervious removal, effective areas for green infrastructure implementation, and feasible connectivity routes. Additionally, CRDS must conduct reviews of precedent cases for horizontal traffic calming solutions and small-scale dam removal consequences to justify proposed ideas. Additional research can be found in the Community Discovery process on pages 71 and 81.

DESIGN GOALS

CRDS will design:

- **Improvements for movement and infiltration of stormwater**, through the implementation of stormwater best management practices (BMPs). The studio will make recommendations to address surface water that is causing nuisance flooding on various parcels throughout the town
- **A walking trail**, with interpretive elements highlighting the history of the town's waterfront, to provide connectivity throughout the town
- **A cost-effective, passive road design** that slows traffic without vertical traffic measures such as speed bumps, and promotes multi-modal travel

Additional areas of focus include:

- Enhance the **commercial district** and add **micro-retail**
- Maximize **safe building construction** in the flood plain while considering sea level rise
- Review & Revise **municipal codes** in conjunction with SCCI and IPA recommendations
- Undertake a **community branding** process

Community Branding

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COLOR PALETTE

BRAND TYPEFACES

I am your Primary Typeface

I am your Secondary Typeface

I am your Accent Typeface

BRAND STATEMENT

Nestled on the shore of the Little River is a small coastal community with a rich maritime history and a strong agricultural heritage. As a jewel along the Bayshore Byway in the tidal marshes of Kent County, our 187 full time residents cherish authentic small town life and from the halls of our Fire Company to our old Stone Tavern, our history and dedication to our neighbors is evident. We are proud of the place we call home, a place where being small is in our nature.

WAYFINDING SIGNAGE

PRIMARY GATEWAYS

These gateways are the primary intersection points and main entry ways to town. They need to be highly visible and introduce the brand.

BUILDING MARKERS

The markers can be either wall mounted or monument style and denote important landmarks in the downtown district.

PARKING SIGNAGE

Identifying parking is important in creating a parking system in downtown. Visitors are more likely to walk a block or two to shop if the signage system leads them directly to a public parking lot and tell them how to proceed. The parking markers can be by themselves or as attachments to trailblazer signs.

INFORMATIONAL KIOSKS

Informational kiosks serve as the transition point for vehicular traffic to pedestrian traffic. These kiosks should be located at major public parking resources and should include a map and the shopping & dining guide, along with the walking tour brochures.

TRAILBLAZERS

Trailblazers are the directing signs leading motorists to the main attractions in the area. These should have a maximum of three locations per sign and carry motorists from gateway to parking lot. Colors can be used to distinguish between different districts and can become smaller as the scale and speed of the roadway narrows.

STREET BANNERS

Banners are very popular and help to add color and movement to the lanes of travel, acting as a speed calming device. They too can be color coded by district and can promote local events, as well as promoting the brand.

The Concept Plan

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LITTLE CREEK, DE
MASTER PLAN

1 BUFFERED BIKE LANE
2 CROSSWALKS
3 GREEN INFRASTRUCTURE: BIOSWALE
4 GREEN INFRASTRUCTURE: BIOSWALE
5 LITTLE CREEK PARK
6 DOG PARK
7 PARKSIDE TRAILHEAD & BIOSWALE
8 MULTI-USE BIKE AND WALKING TRAIL
9 GREEN INFRASTRUCTURE: RESTORED WETLAND
10 STONE TAVERN TRAILHEAD

11 CROSSWALKS
12 PAINTED PARKING LANE
13 GREEN INFRASTRUCTURE: BIOSWALE
14 GREEN INFRASTRUCTURE: BIOSWALE
15 THE PILINGS AT WATERMAN'S VILLAGE: POP UP COMMERCIAL SPACE
16 RIVERSIDE TRAILHEAD
17 OBSERVATION TOWER
18 PLANTED MEDIAN & CROSSWALK
19 WATERMAN'S VILLAGE: COMMERCIAL SITE
20 GREEN INFRASTRUCTURE: RESTORED WETLAND

0' 30' 60' 90'

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Stormwater

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TWO YEAR STORM FLOOD EVENT







Photos taken in Little Creek on July 10, 2020 by Mayor Glenn Gauvry in the midst of a storm event generating ~3.71 inches of rainfall. This is considered a two year rain event in Kent County, or a storm of such magnitude that occurs on average once in every two years.

STORMWATER CONTROL & PLANNING

Residents of Little Creek know well the prevalent areas of flooding along Main Street. With flooding being one of Little Creek's most significant resiliency issues, a strategy to mitigate stormwater collection in streets and on private and public properties became a design priority. Addressing stormwater will not only prevent the hazards associated with today's everyday storm, but provide a buffer for tomorrow's larger storm event as climate change increases the incidence of more extreme storms.

STORMWATER OBJECTIVES

- Provide an opportunity for Little Creek to independently manage stormwater outside of existing infrastructure
- Address storm event flooding with green infrastructure treatments that convey water slowly where infiltration is not possible
- Increase residence time of water in areas where water can safely and effectively infiltrate to improve water quality and quantity

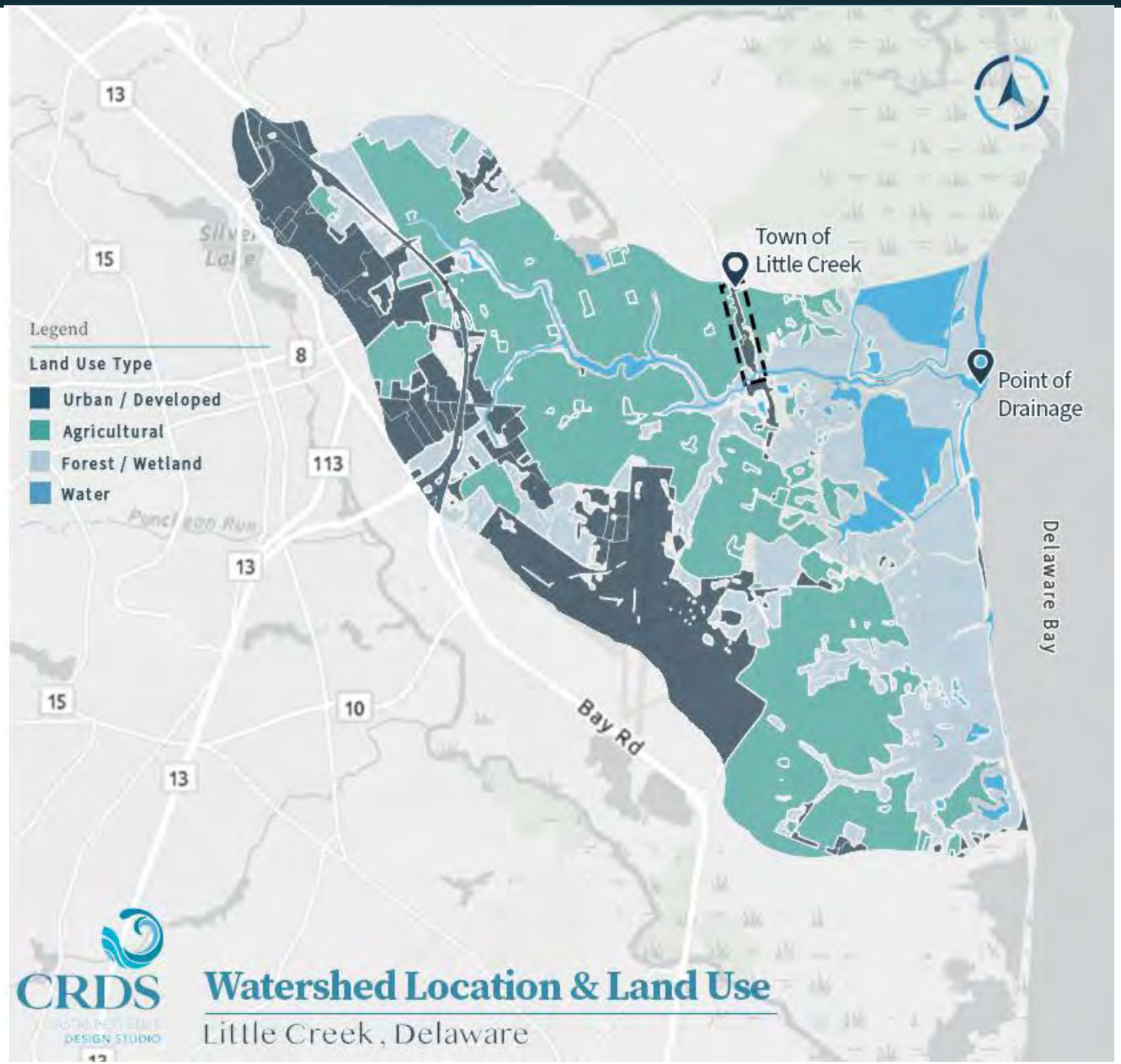
WATERSHED LOCATION AND LAND USE

The greater watershed is known as the Little Creek Watershed, which drains approximately 23 square miles to the Delaware Bay via the Little River. The mainstem of Little River is five miles long and flows east through the town of Little Creek. The lower three miles of the Little River is characterized as saline wetland habitat (Delaware Watersheds, n.d.). In the 23-mile drainage area, the dominant land use is agricultural (40%); the remainder of land uses are characterized as forest and wetland (saltwater and fresh) (32%) and urban (19%) (USGS Streamstats, n.d.).

These waterways are impacted by nutrient and bacterial pollution, with 5.5 miles of the Upper Little River and 2.9 miles of the Lower Little River listed on the Federal Clean Water Act list of Impaired Waterways: 303(d). According to the total daily maximum loads (TMDLs) established for the Little Creek Watershed by DNREC, 40% reductions in both phosphorus and nitrogen, as well as a 75% reduction in enterococcus bacterial loads must be met to restore health to the waterway.

The Little River receives inputs from mostly nonpoint sources of pollution throughout the watershed. Nonpoint source pollution is contamination from diffuse sources, such as agricultural or urban runoff. Nitrogen and phosphorus pollution stem from agricultural fertilizers and feedlots, while bacterial inputs are mainly from animal feedlots, domestic pet wastes and septic systems.

Impervious surfaces including roads, buildings, sidewalks, and parking lots cover ~8.9% of the land in the greater Little Creek Watershed and include portions of the Dover Air Force Base as well as residential developments in the city of Dover (USGS Streamstats, n.d.). Impervious surfaces have a direct impact on the town's water quality and quantity as they prevent infiltration of rain water to the groundwater aquifer and contribute to flooding.



STORMWATER FLOOD AREAS

The two main areas experiencing severe flooding due to stormwater are at the intersection of Port Mahon Road x Main St. and at Lowe St. x Main St. In the northern portion of town, flooding accumulates on the street and on the post office parking area, as well as in the park. In the southern portion of town, water accumulates on the street and on commercial property.

1. Runoff from neighboring farmland enters Little Creek town limits and flows through a ditch between two houses. The ditch leads via a 30" diameter culvert to the stormwater system but is overloaded and floods property and the roadway.

2. Ditches fill up along Port Mahon Road, draining toward the post office.

3. Same as photo 2, facing Main Street.

4. Flooding accumulates in the post-office parking area.

5. Pool accumulating in low areas of Little Creek Park, parallel to Main Street. A discharge pipe located within the strand of phragmites leads to a drainage way to the Little Creek, but is not functioning to allow for water movement.

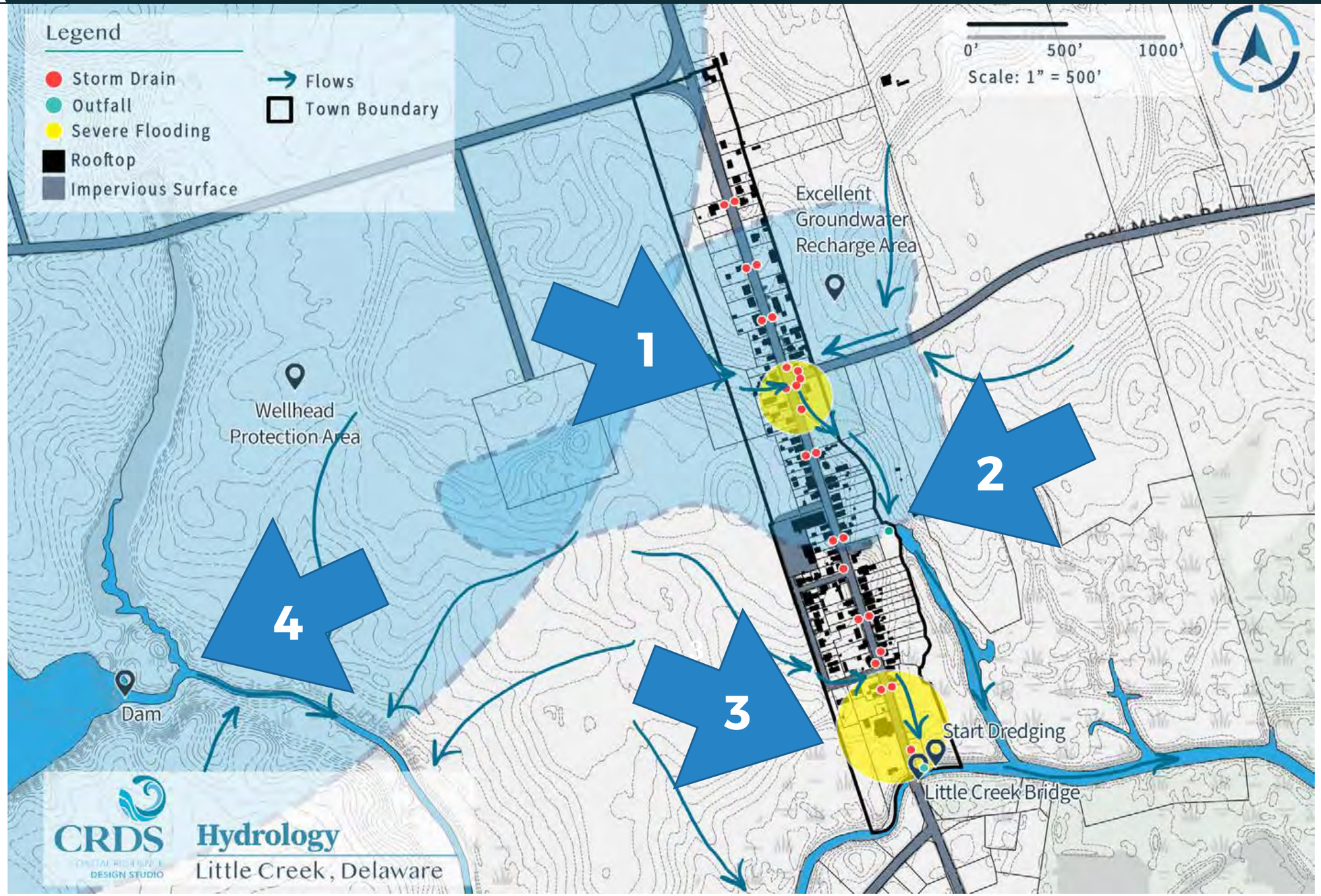
6. Intersection of Lowe St. and Main St., where the Deli and future general store is located. Storm drains are full and water pools in low-lying elevation.

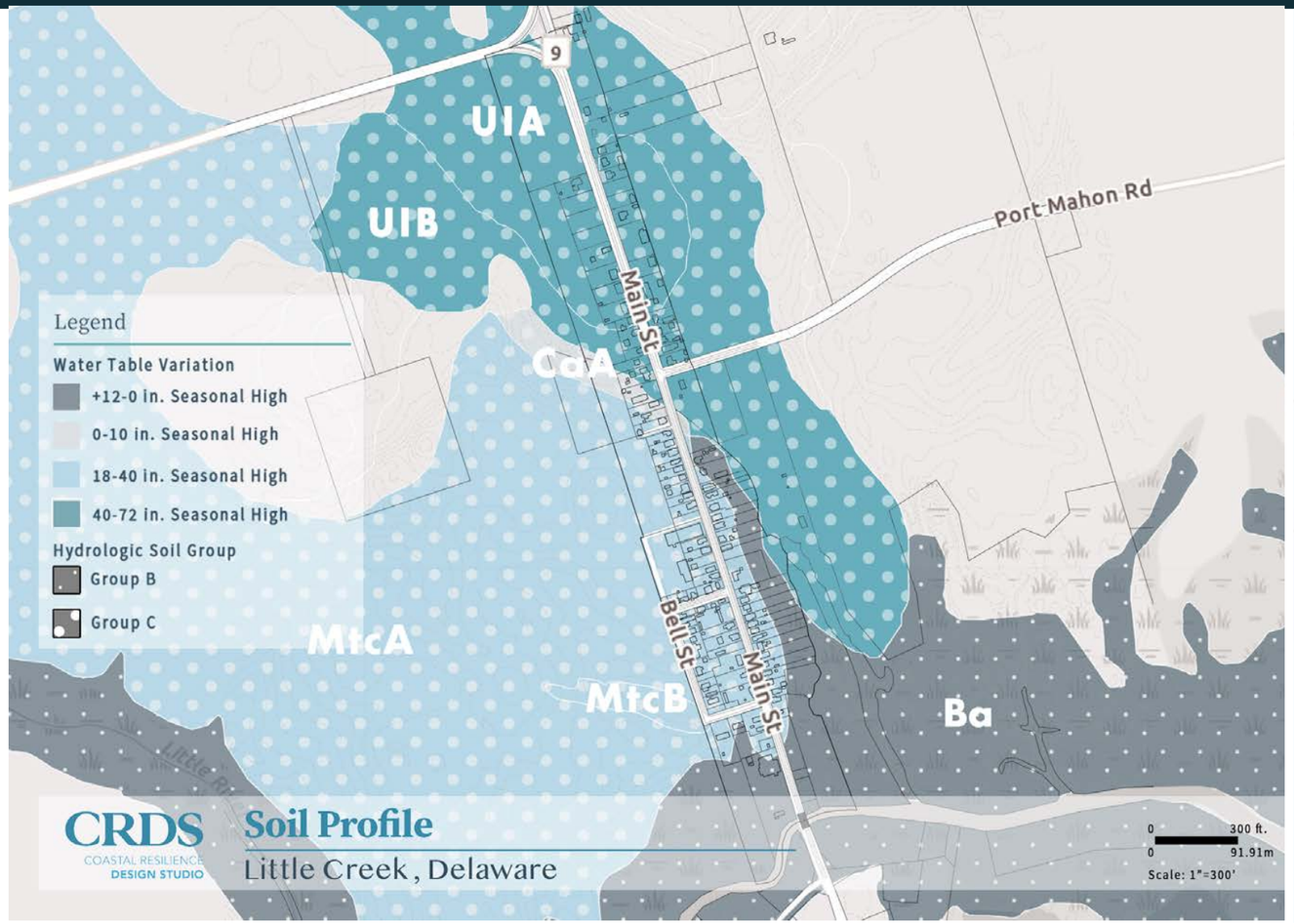
CAUSES OF STORMWATER HOTSPOTS

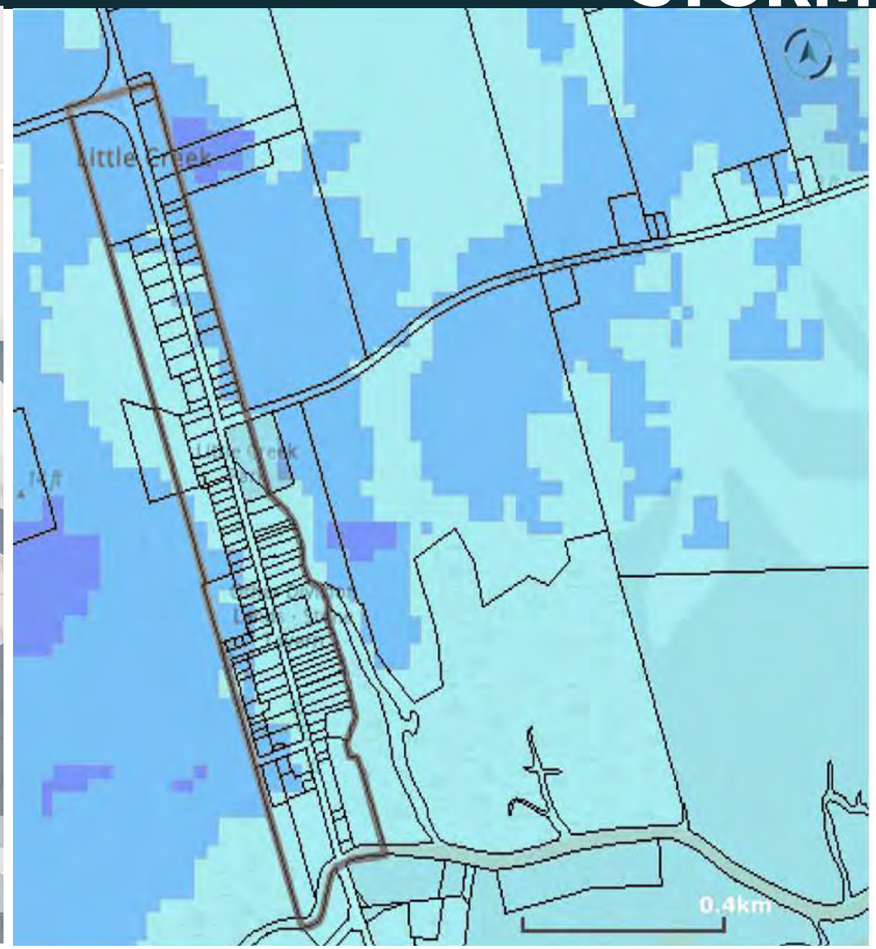
The two main areas where severe flooding occurs are highlighted in yellow. The northern flood area is influenced by surrounding agricultural runoff and subsurface drainage from an adjacent tile field drainage. Drainage enters town limits via a ditch between two private residences (arrow 1), enters the stormwater system via a storm drain across from the intersection of Port Mahon Rd. x Main St, and flows to an outfall in Little Creek Park within a stand of phragmites. This outfall is difficult to access, overcrowded with sediment and debris, and does not allow for the neccessary movement of water; this leads to large areas of pooling water at the Little Creek Park. From the stand of phragmites, water flows along a tributary toward the Little River, but is impeded by a blockage where water is constricted to flow through a small sedimented culvert (arrow 2). Above the culvert is a land bridge used by the adjacent landowner for property access.

The southern flood area (arrow 3) is influenced again by agricultural drainage but also tidally influenced by the Little River. Tidal flooding is related to sea level rise as well as sedimentation of stormwater infrastructure caused in part by an upstream private dam (arrow 4). Agricultural runoff from fields west of town drain via a swale into a ditch along Bell Street. Water accumulates and overflows, flowing past Bell Street to eventually reside in the lowest area at the intersection of Lowe Street and Main Street. Further issues with tidal flooding occur at the commercial area north of the bridge. This is believed to be caused in part by the dam constructed upstream on private property in the 1970's that has reduced the flow in the Little River and allowed sediment to block Little Creek's outfalls.

Flooding areas are exacerbated by the outdated and poorly functioning stormwater infrastructure system. More information and details regarding the stormwater infrastructure system are provided in the Community Discovery Process section of this report.







DESIGN LIMITATIONS

Designing green infrastructure requires accounting for infiltration capacity at each proposed site. Both the high water table and poorly infiltrating soils established throughout Little Creek are limiting design constraints for green stormater infrastructure. The hydrologic soil group in most areas of town are group C, meaning they have poor infiltration capabilities. Additionally, the depth to the water table is very low (less than three feet) throughout most areas of town. Many green infrastructure strategies address water quality and quantity issues by allowing water to collect and infiltrate. Since the majority of water during storm events is not able to infiltrate given these constraints, the following design solutions carefully consider how to retain and covey water more slowly.

Agricultural Buffer & Swales

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NORTH AGRICULTURAL BUFFER & SWALE: EXISTING CONDITIONS

Agricultural buffers and vegetated swales are two types of green infrastructure that do not have infiltration requirements to function properly; these treatments are repeated throughout the design to enhance water quality and quantity through plant uptake.

The primary location where runoff enters town is from the N-NW agricultural field that lets out to the drainage ditch within town limits (photo 4). Topography naturally drains surface waters to this ditch, and piped outfalls from tile drainage also lead subsurface flow to the ditch (photo 3).

Water runs through the ditch almost daily (photo 1), and during storm events the ditch is overwhelmed and water floods out onto the neighboring yards (photo 4). There is little buffer between the agricultural fields and the water flow (photo 2), which in part drains a natural wetland to the N-NW. The ditch is not well maintained and has been scoured deeply by moving water.

A culvert at the end of the ditch drains the flow to the stormwater system and to natural wetlands to the S-SE, but due to blockages within that system, the water does not move effectively.

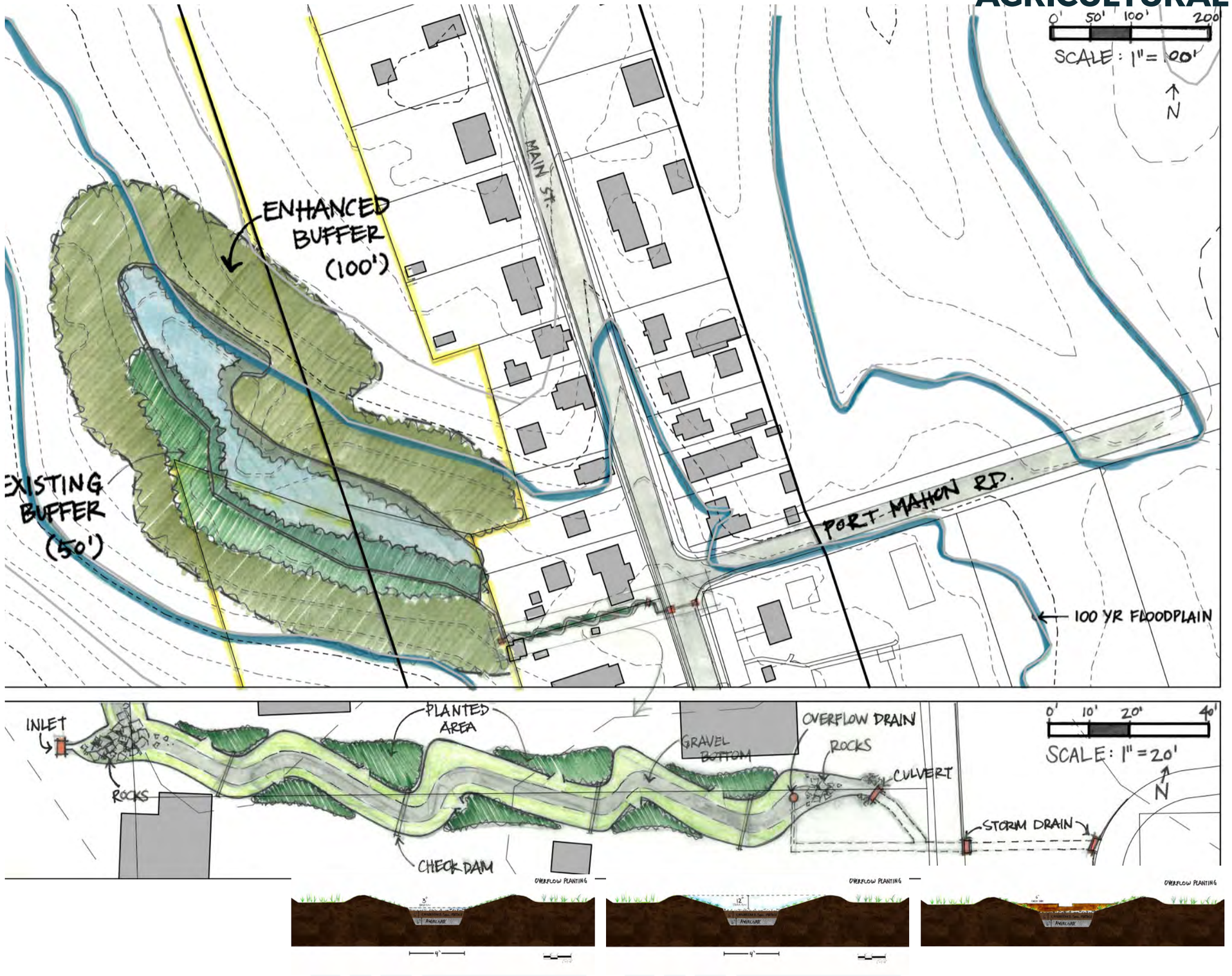
Working with surrounding agricultural land owners to enhance riparian and ditch areas would improve water conveyance, benefitting both the land owner and the Town of Little Creek.

NORTH AGRICULTURAL BUFFER & SWALE: PROGRAM

- **Increase size of existing riparian buffer** surrounding existing wetland from 50' → 100', increasing habitat and increasing water uptake
    - ~146,000 sq. ft. or 3.35 acres of farmland converted to shrub/forest buffer
    - Potential financial incentives to farmers via USDA CREP program which leases land long-term for conservation efforts
- **Create a bioswale with meanders**, native planted areas for overflow during storm events and check dams to slow and infiltrate water
    - Dissipate water energy with rocky inlets/ outfalls
    - Increase infiltration capacity with an engineered soil matrix
    - Include an overflow drain that leads to stormwater system
- **Enlarge size of culvert** draining the ditch

(top) Aerial image showing the drainage ditch between properties within town limits and the adjacent agricultural field.

(right) Overgrown vegetation and sediment impede water flow from the ditch through shown culvert that leads to the Little Creek stormwater system.



N. AGRICULTURAL BUFFER AND SWALE: DESIGN

This plan shows the existing buffer (dark green) around an existing wetland and a proposed enhanced buffer on agricultural property owned by two separate owners. As surface water runs off down the natural grade to the wetland, a riparian area will slow water, filter out pollutants and nutrients, and transpire water. This will enhance wildlife habitat, protect the existing wetland, and reduce flow downstream entering Little Creek.

A meandering bioswale is shown between the private residences to enhance the existing ditch. Surface water and subsurface flow from tile drainage will flowing into the ditch naturally or by inlet to a rocky forebay to dissipate water energy. Water will flow along a gravel bottom with vegetated side-slopes eventually to an enlarged culvert leading to the Little Creek stormwater system. During storm conditions, check dams will hold back and slow the water, which will flow into planted areas that become inundated during high flow conditions. An overflow drain will move excess water to the stormwater system before it is able to flood out. Sections below show the gentle slope, check dams, planting areas, engineered soil matrix, and aggregate material that improve the infiltration and safe conveyance capabilities of an enhanced bioswale during baseflow and storm flow conditions.

SOUTH VEGETATED SWALE: EXISTING CONDITIONS

To the S/SW of town, a surface swale cuts across agircultural fields west of Bell Street (below), emptying runoff into a grassy roadside ditch (photos 1 and 2). Runoff crosses Bell Street, and travels down Lowe Street, to reside in the topographic depression at the intersection of Lowe and Main Streets (photos 4 and 5).

SOUTH VEGETATED SWALE: PROGRAM

- **Create a bioswale with meanders**, native planted areas for overflow during storm events and check dams to slow and infiltrate water at the agricultural runoff outlet

- **Connect bioswale to existing riparian buffer** at the northern edge of Little River wetland

- **Implement roadside bump-out bioswales** along Lowe Street at all storm drains to hold and drain water, preventing pooling in the street

SOUTH VEGETATED SWALE: DESIGN

Agricultural runoff approaching Bell Street will enter a meandering bioswale graded to flow to an existing riparian buffer at the north edge of river-adjacent existing wetland. This swale has the potential to capture runoff from the existing fire department parking area in addition to runoff from the West.

Runoff moving down Lowe Street toward Main Street will enter roadside bioswales through curb cuts. Native plantings will enhance street beautification while functioning to hold and uptake water, as shown in the precedent image below. More information about roadside bioswales will be detailed under “Traffic Calming”.


Image: Mitt Watershed Council

Little Creek Park

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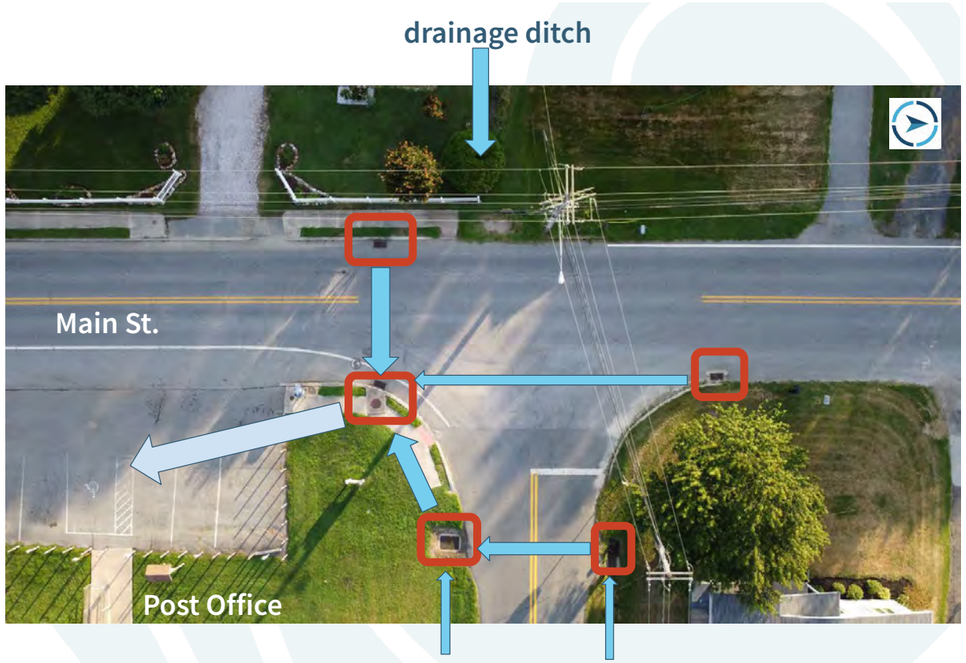
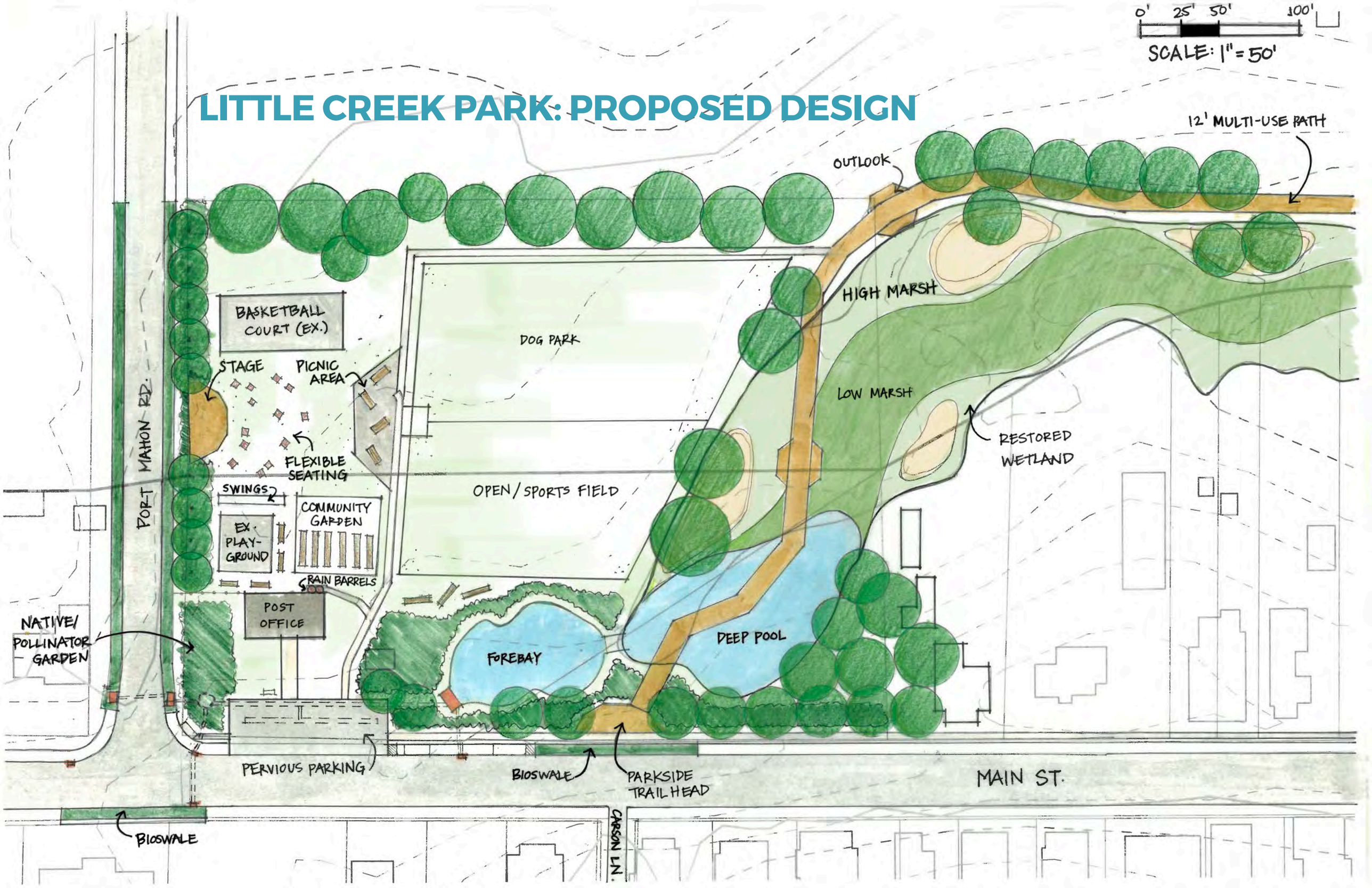
LITTLE CREEK PARK: EXISTING CONDITIONS

All existing stormwater catch basins in the northern part of town converge to one point underground beneath the Little Creek Park (below). The collected stormwater travels to an outfall amid a stand of invasive Phragmites *australis*, where sediment and lack of slope encourage water to collect and back up, pooling in the open space in Little Creek Park parallel to Main Street (photos 3 and 5).

Little Creek Park is already equipped with several amenities such as the playground, basketball court, seating area and dog park, which were past community-led projects (photos 2 and 4).



LITTLE CREEK PARK: PROPOSED DESIGN



We envision Little Creek Park as a vibrant gathering space where residents and visitors can walk, play, bike, encounter wildlife, garden or just enjoy being outside and connecting with the community. A great place for families, pet lovers, or those looking to get some exercise, the park design proposes amenities such as a trailhead to a 12-foot wide multiuse path with outlooks above a restored wetland, native gardens, and ample seating for picnicking or watching a live performance. In addition, the park will be equipped with green infrastructure features (bioswales, rain barrels for use in the community garden and a restored wetland) that not only mitigate stormwater and promote resilience, but beautify and enhance the outdoor experience.

LITTLE CREEK PARK PROGRAM:

- **Convey all stormwater from inlets to a forebay** that drains to a restored wetland
- **Create a native plant / pollinator garden** with an underdrain leading water to forebay
- **Create bioswales in bump-outs** along Main St. and Port Mahon Rd. with curb cuts leading water to forebay
- **Replace post office parking lot with pervious pavement** and an underdrain that flows to the forebay
- **Update park amenities to include a fuller breadth** as noted from the LC Comprehensive Plan: multi-use trail with lookouts; bench seating; community garden; stage with moveable seating; picnic area; sports field; educational signage

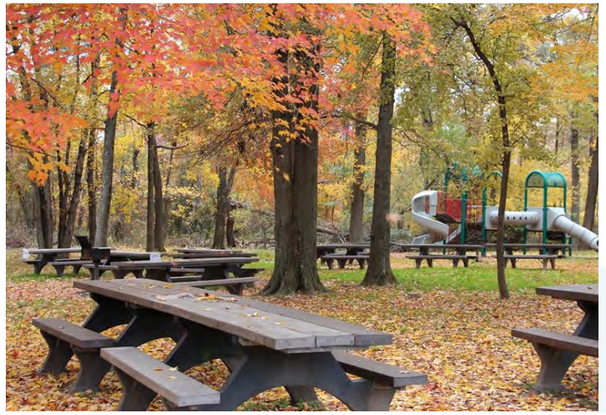
Park Stage

The park could become a vibrant gathering space in town, with events such as Little Creek Live.

PRECEDENT PHOTOS

Moveable seating via Project for Public Spaces

Community garden space via Greening Forward



Park picnic area via the National Park Service

Pollinator garden via Xerces Society

Restored Wetland

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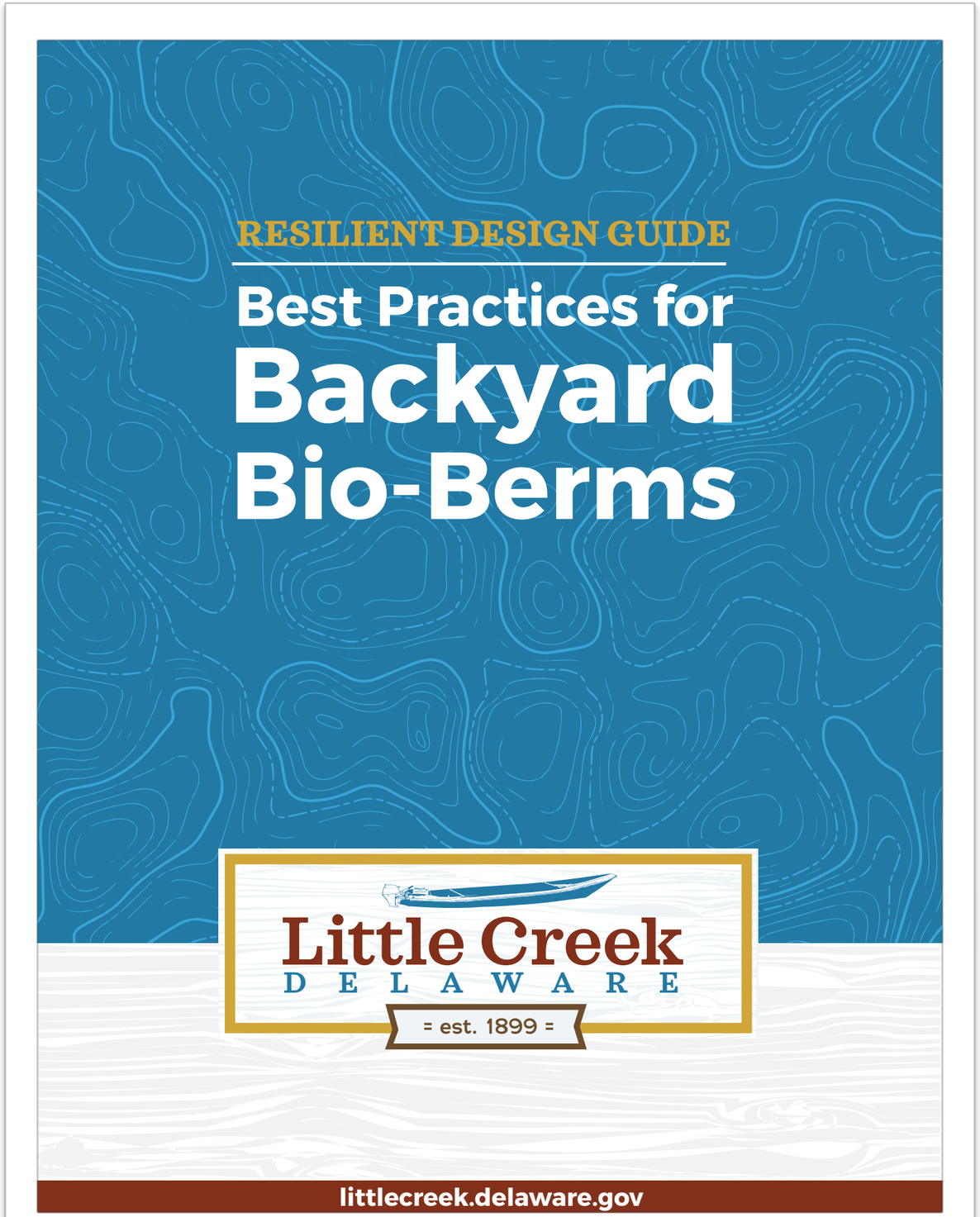


RESTORED WETLAND: DEVELOPING A COMMUNITY & HOMEOWNER EDUCATION PLAN

Holistically addressing resilience for Little Creek means not only implementing green infrastructure on town property and along roadways, but encouraging property owners to protect their land and residences with natural and effective design solutions as well. A 'Resilient Design Guide: Best Practices for Backyard Bio-Berms' could be one such program to encourage homeowner education and implementation of design strategies that offer protection from sea level rise and intensified storms. Outlined topics may include the benefits of native wetland buffers, best practices for removing invasive species and collecting that biomass to create sustainable natural berms at the wetland edge, and a list of native plant species with varying light and soil condition requirements.

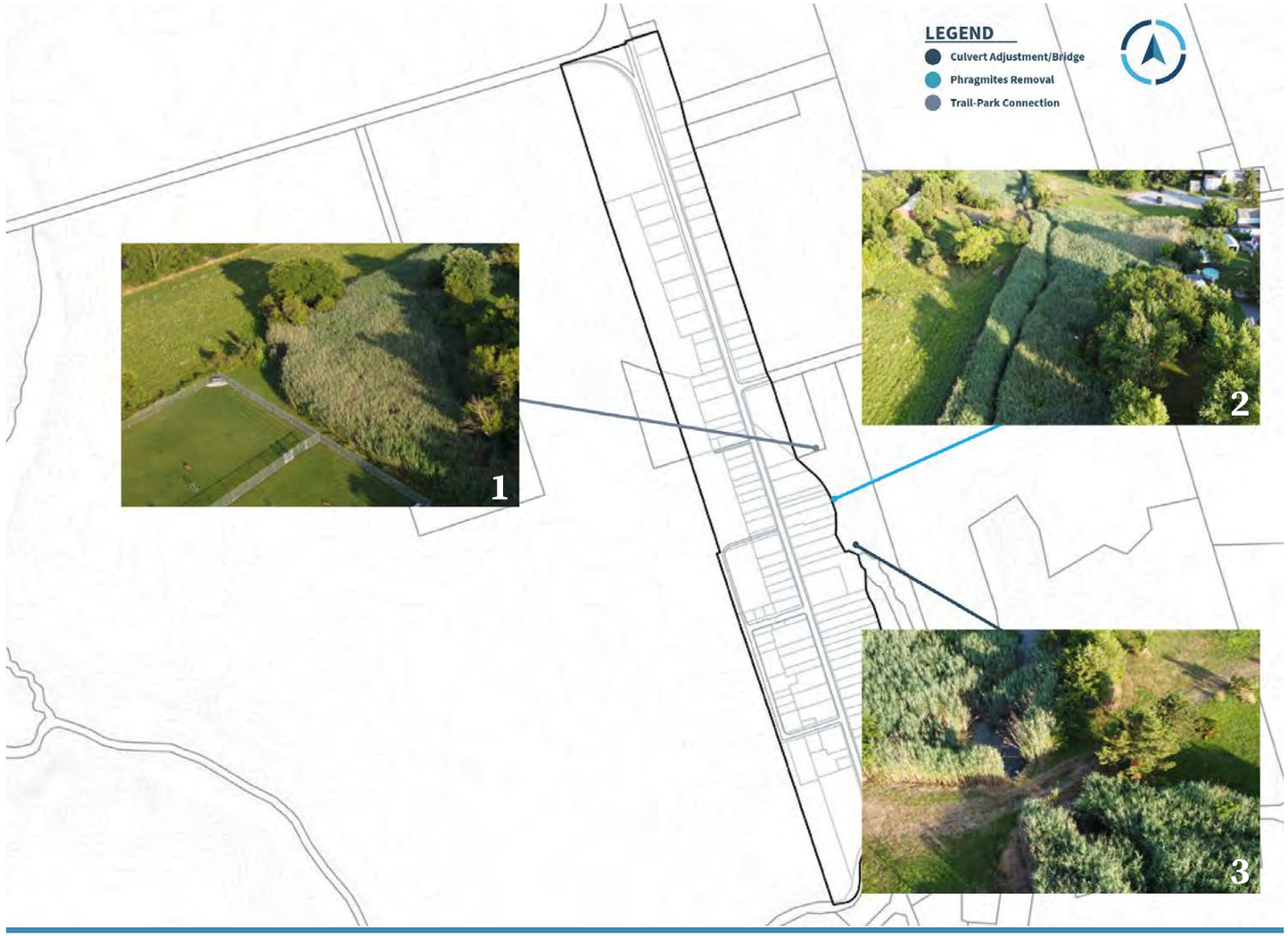
RESTORED WETLANDS

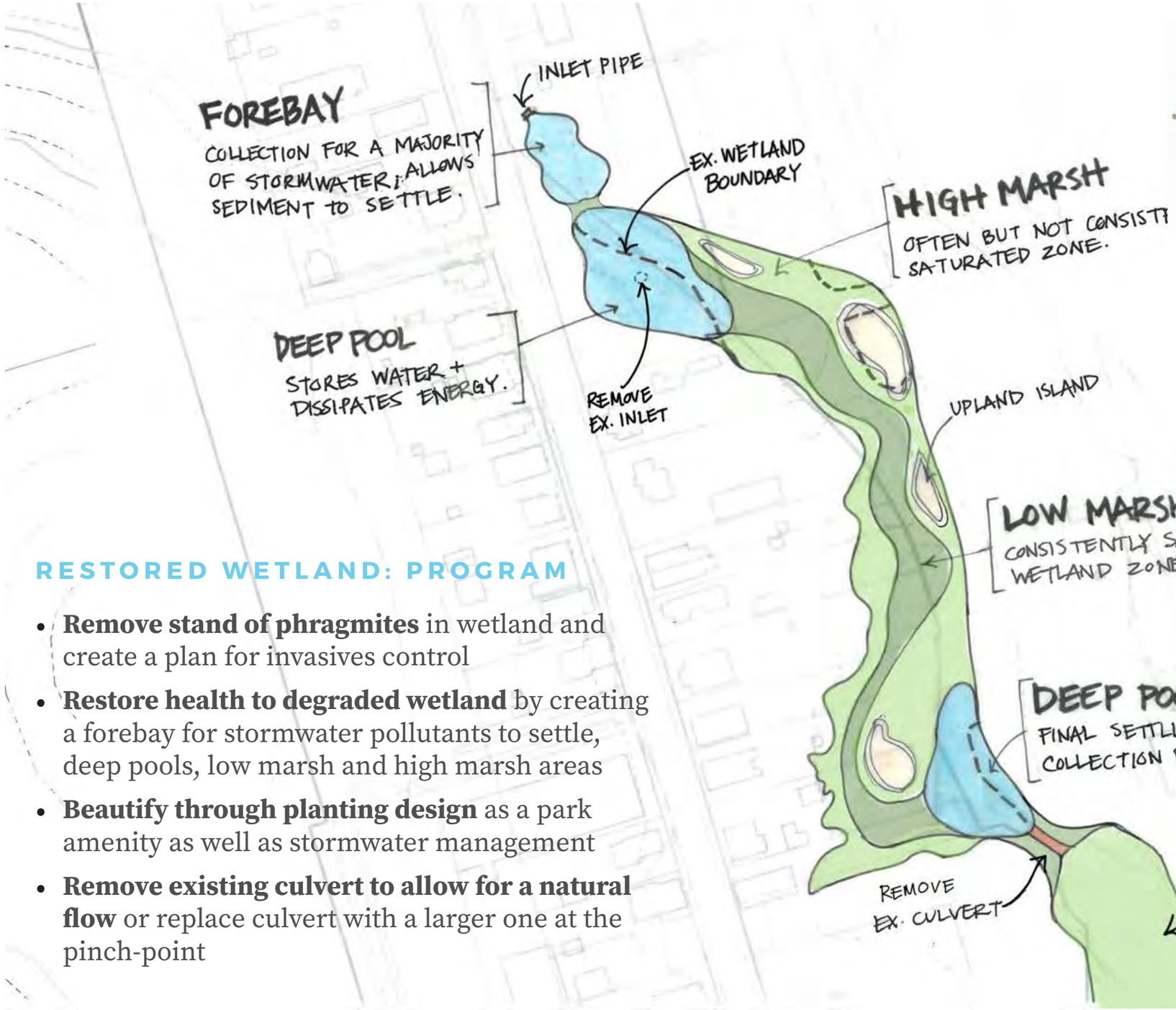
RESTORED WETLAND: EXISTING CONDITIONS

The final focus of green stormwater treatments is on restoring the native wetland that begins in Little Creek Park (photo 1). General disturbance to the native wetland environment has led to the establishment of invasive Phragmites *australis* as the dominant plant species, reducing biodiversity and the health of the natural ecosystem (photo 2). One major disturbance includes a pinch point where the natural flow of water from the park area has been blocked by the insertion of a land-bridge and funneled through a culvert underneath, preventing natural tidal flow (photo 3).

RESTORED WETLAND: DESIGN

The design of the restored wetland focuses on removing invasive species, regrading, and revegetating with a diversity of native plants throughout diverse wetland conditions. Varied water depths throughout a wetland encourage natural colonization of diverse plant species and wetland creatures to inhabit the space. Deep pools and native plants will discourage mosquito growth and encourage their natural predators. Water will flow along consistently inundated low marsh areas. High marsh areas provide a buffer for water to rise during storm events. Upland islands with trees will provide shade along the pathway, adding more niche space in this varied environment. A long term management strategy to reduce invasive pressure will be required to maintain the beauty and functionality of the design. Establishing a path that crosses the wetland at the Little Creek Park will encourage visitors to interact with a healthy wetland environment, with educational signage conveying the importance of these ecosystems. Finally, removing the existing culvert and land bridge downstream will allow the stream to flow naturally and reduce flooding upstream.

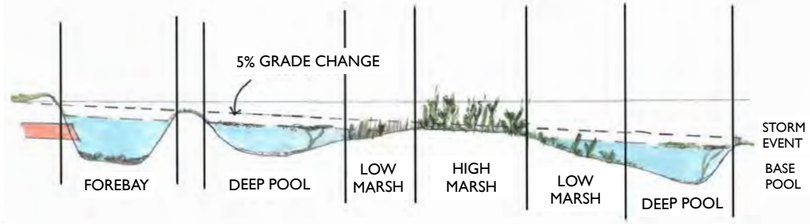




RESTORED WETLAND: PROGRAM

- **Remove stand of phragmites** in wetland and create a plan for invasives control
- **Restore health to degraded wetland** by creating a forebay for stormwater pollutants to settle, deep pools, low marsh and high marsh areas
- **Beautify through planting design** as a park amenity as well as stormwater management
- **Remove existing culvert to allow for a natural flow** or replace culvert with a larger one at the pinch-point

RESTORED WETLAND SECTION



Wetland Storage Capacity

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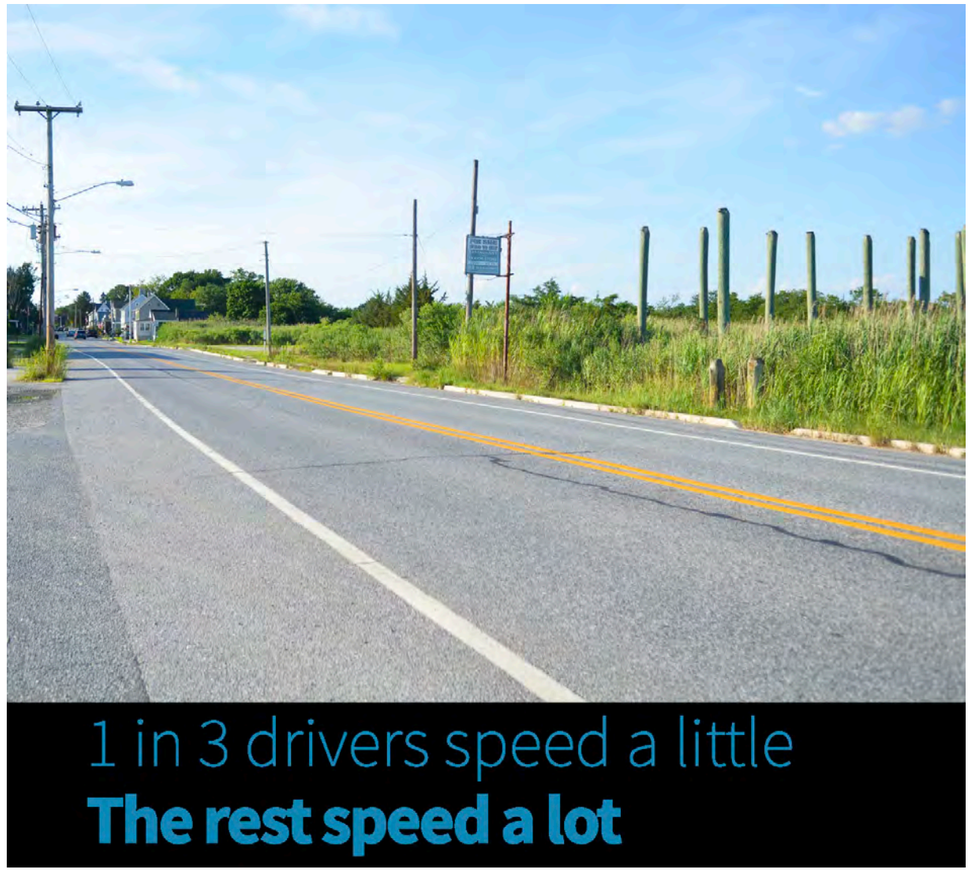
Traffic & Connectivity

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

TRAFFIC CALMING

OBJECTIVES

- Address flooding issues along Main Street
- Provide traffic calming through town using the Complete Streets model
- Reconnect the community with the Little River
- Provide a walking trail and observation tower
- Improve bike access and safety
- Maintain the small town feel
- Resiliency should be a common thread in all design recommendations



TRAFFIC COUNTS

			Total cars	25-29 Mph	30-34 Mph	35-39 Mph	40-44 Mph	45-49 Mph	50 Mph and Over	Total > 29 Mph
PRE COVID-19 SHUTDOWN	February 2020 **35 Days**	Totals % of Total **Avg per day**	24,187 **691**	7,782 32.17%	7,541 31.18%	3,831 15.84%	3,059 12.65%	1,554 6.42%	420 1.74%	16,405 67.83%
COVID-19 SHUTDOWN	March 2020 **35 Days**	Totals % of Total **Avg per day**	19,485 **557**	6,958 35.71%	6,195 31.79%	2,967 15.23%	2,150 11.03%	1,040 5.34%	175 0.90%	12,527 64.29%
	April 2020 **28 Days**	Totals % of Total **Avg per day**	16,523 **590**	6,029 36.49%	5,381 32.57%	2,485 15.04%	1,625 9.83%	795 4.81%	208 1.26%	10,494 63.51%
	May 2020 **27 Days**	Totals % of Total **Avg per day**	17,833 **660**	7,116 39.90%	5,794 32.49%	2,570 14.41%	1,495 8.38%	689 3.86%	169 0.95%	10,717 60.10%

SIDEWALK INVENTORY

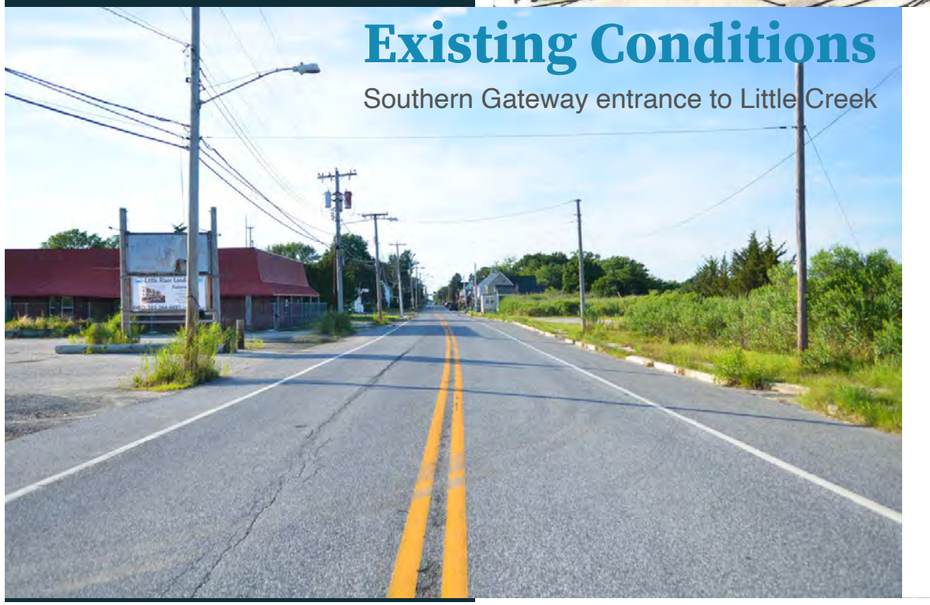
WHY COMPLETE STREETS IN LITTLE CREEK?

- Enhance Little Creek as a destination on the Bayshore Byway
- Increase pedestrian access and safety with crosswalks
- Enhance the community and visitor experience in the community
- Provide traffic calming and facilitate foot traffic
- Provide an opportunity for added stormwater mitigation
- Incorporate native species of plants and trees to improve stormwater absorption, enhance habitat for native wildlife, and provide locally driven beautification for the community

GATEWAYS

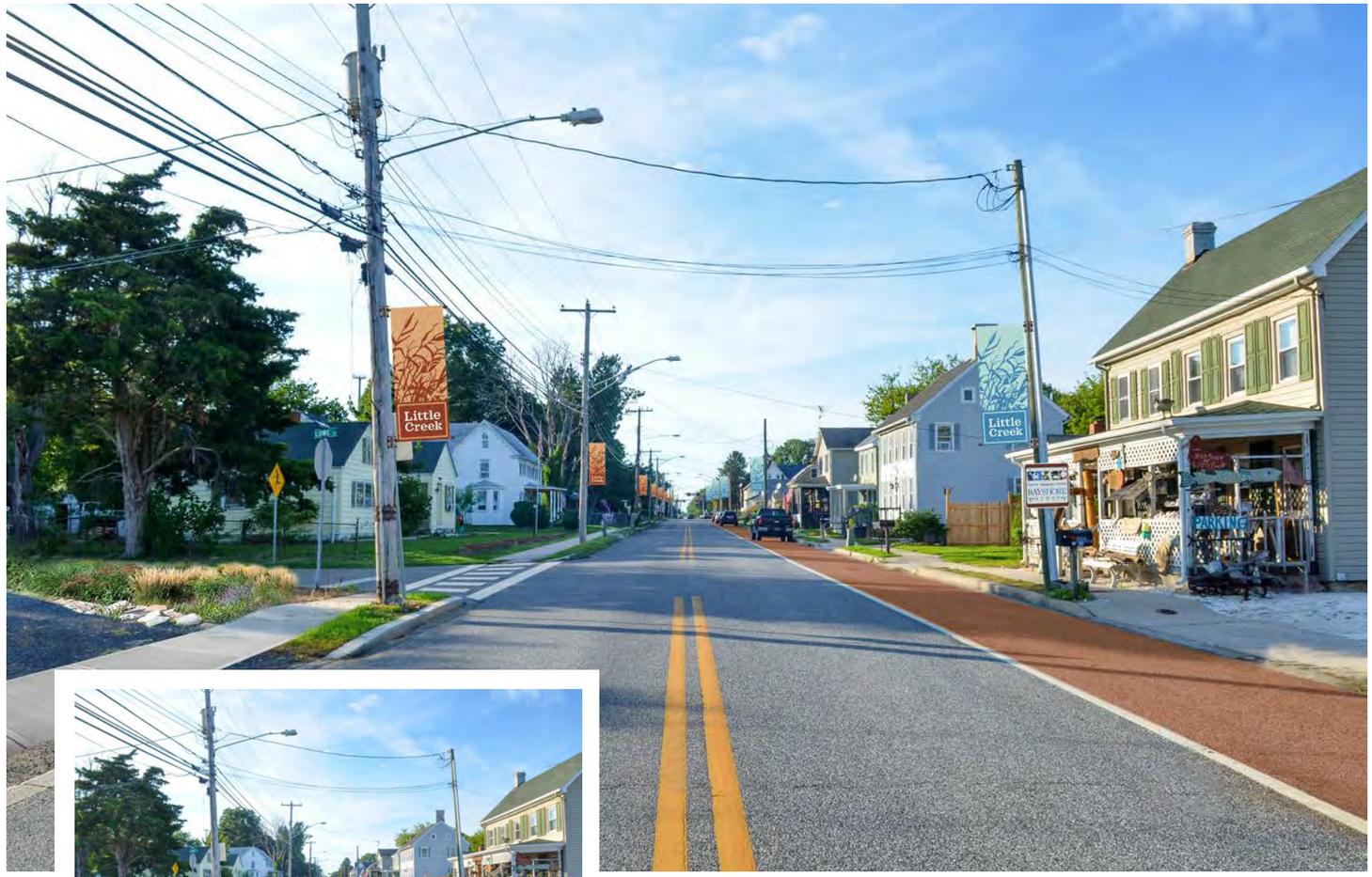
GATEWAY TREATMENTS

The current gateway entry points into Little Creek do little to encourage slowing traffic to the 25 mph posted speed limit. CRDS recommends addressing this issue in several ways. First, adding center planted medians at both the northern and southern town gateway entry points. The medians signal a change in place and a change in expected pace. Additionally, the medians will guide vehicles around a subtle lane shift, helping to slow traffic to the posted speed. Secondly, CRDS recommends adding a pedestrian crosswalk in the southern gateway median. Enhanced walkability and pedestrian safety will become very important as redevelopment begins in the commercial district. In addition, adding street banners will help to visually constrict the roadway from above and subliminally signal the arrival to a place where vehicles and pedestrians coexist.



Existing Conditions

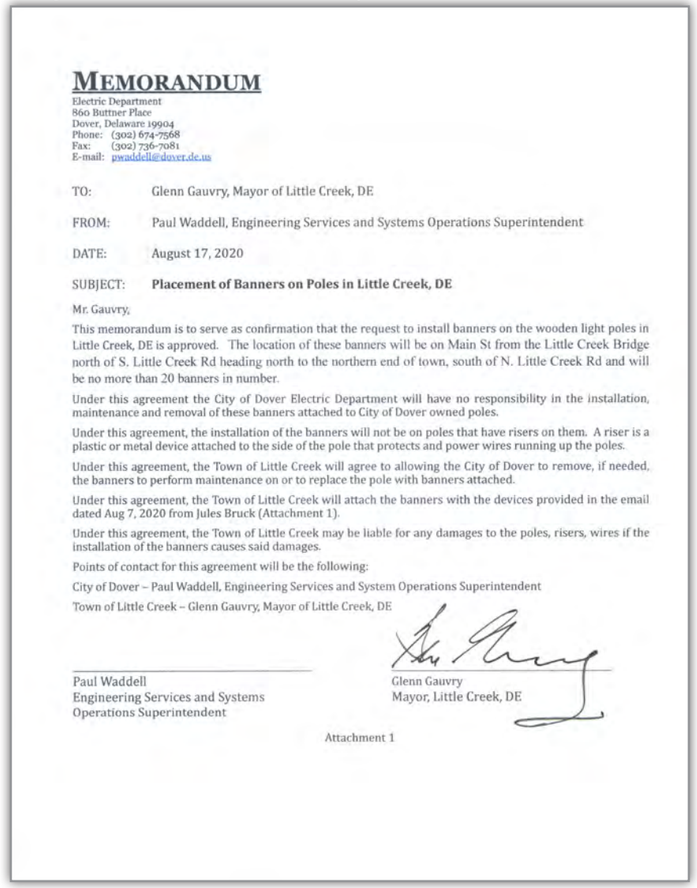
Southern Gateway entrance to Little Creek



This is a photo rendering of Main Street with the addition of street banners and a painted parking lane, both treatments are designed to visually constrict the roadway and slow traffic.

STREET BANNERS FOR TRAFFIC CALMING

A site visit took place on August 21, 2020 to locate specific poles to receive banners. The MOU from the City of Dover was used to define appropriate poles, as well as considerations such as dense foliage and distance from the roadway.



MEMORANDUM

Electric Department
860 Buttner Place
Dover, Delaware 19904
Phone: (302) 674-7568
Fax: (302) 736-7081
E-mail: gwaddell@dover.de.us

TO: Glenn Gauvry, Mayor of Little Creek, DE

FROM: Paul Waddell, Engineering Services and Systems Operations Superintendent

DATE: August 17, 2020

SUBJECT: **Placement of Banners on Poles in Little Creek, DE**

Mr. Gauvry,

This memorandum is to serve as confirmation that the request to install banners on the wooden light poles in Little Creek, DE is approved. The location of these banners will be on Main St from the Little Creek Bridge north of S. Little Creek Rd heading north to the northern end of town, south of N. Little Creek Rd and will be no more than 20 banners in number.

Under this agreement the City of Dover Electric Department will have no responsibility in the installation, maintenance and removal of these banners attached to City of Dover owned poles.

Under this agreement, the installation of the banners will not be on poles that have risers on them. A riser is a plastic or metal device attached to the side of the pole that protects and power wires running up the poles.

Under this agreement, the Town of Little Creek will agree to allowing the City of Dover to remove, if needed, the banners to perform maintenance on or to replace the pole with banners attached.

Under this agreement, the Town of Little Creek will attach the banners with the devices provided in the email dated Aug 7, 2020 from Jules Bruck (Attachment 1).

Under this agreement, the Town of Little Creek may be liable for any damages to the poles, risers, wires if the installation of the banners causes said damages.

Points of contact for this agreement will be the following:

City of Dover – Paul Waddell, Engineering Services and System Operations Superintendent

Town of Little Creek – Glenn Gauvry, Mayor of Little Creek, DE

Paul Waddell
Engineering Services and Systems
Operations Superintendent

Glenn Gauvry
Mayor, Little Creek, DE

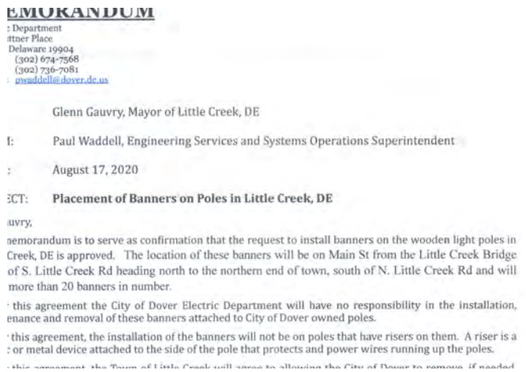
Attachment 1

Pole Numbers Identified:

4	32
7*	33
12	35
15	36
20	37
21	38*
22	39
25	40
26	42
27	43
28	44
30	46
31	

*Poles with transformer

This list is a working document and is subject to final approval from the town of Little Creek and the City of Dover.



EMORANDUM
: Department
ittner Place
Delaware 19904
(302) 674-7568
(302) 736-7081
gwaddell@dover.de.us

Glenn Gauvry, Mayor of Little Creek, DE

I: Paul Waddell, Engineering Services and Systems Operations Superintendent

: August 17, 2020

ECT: **Placement of Banners on Poles in Little Creek, DE**

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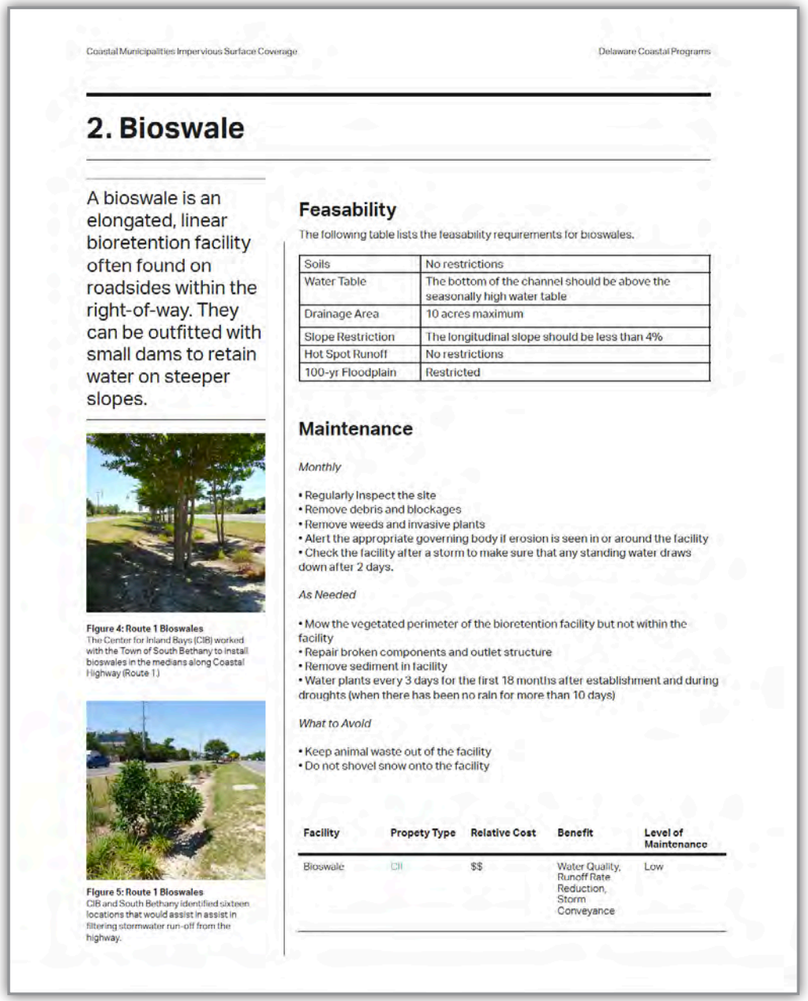
Proposed banner designs and suggested mounting hardware to affix banners to wooden utility poles using a spring mounted strap system.

BIOSWALES

WHY BIOSWALES

- When placed in the right-of-way, a bioswale performs the traffic calming function of a bump-out but also works for stormwater control.
- Poor soils + high water table constrain the design options for green infrastructure
- Slow, retain, and clean water for short periods of time before it moves into the Little River through the established stormwater system
- Low maintenance, native plantings reinforce the local aesthetic and create micro habitats



Coastal Municipalities Impervious Surface Coverage — Delaware Coastal Programs

2. Bioswale

A bioswale is an elongated, linear bioretention facility often found on roadsides within the right-of-way. They can be outfitted with small dams to retain water on steeper slopes.

Feasability

The following table lists the feasability requirements for bioswales.

Soils	No restrictions
Water Table	The bottom of the channel should be above the seasonally high water table
Drainage Area	10 acres maximum
Slope Restriction	The longitudinal slope should be less than 4%
Hot Spot Runoff	No restrictions
100-yr Floodplain	Restricted

Maintenance

Monthly

- Regularly inspect the site
- Remove debris and blockages
- Remove weeds and invasive plants
- Alert the appropriate governing body if erosion is seen in or around the facility
- Check the facility after a storm to make sure that any standing water draws down after 2 days.

As Needed

- Mow the vegetated perimeter of the bioretention facility but not within the facility
- Repair broken components and outlet structure
- Remove sediment in facility
- Water plants every 3 days for the first 18 months after establishment and during droughts (when there has been no rain for more than 10 days)

What to Avoid

- Keep animal waste out of the facility
- Do not shovel snow onto the facility

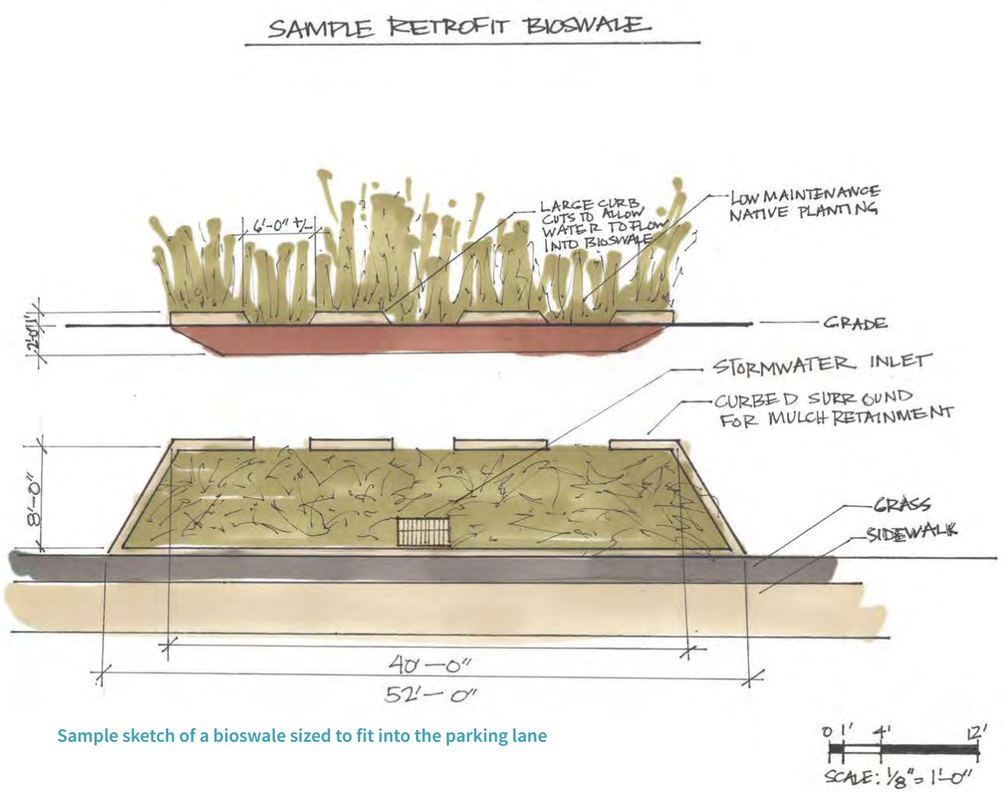
Facility	Propety Type	Relative Cost	Benefit	Level of Maintenance
Bioswale	CR	$$	Water Quality, Runoff Rate Reduction, Storm Conveyance	Low

Figure 4: Route 1 Bioswales
The Center for Inland Bays (CIB) worked with the Town of South Bethany to install bioswales in the medians along Coastal Highway (Route 1.)

Figure 5: Route 1 Bioswales
CIB and South Bethany identified sixteen locations that would assist in assist in filtering stormwater run-off from the highway.

National Association of City Transportation Officials

Bioswales constrict the roadway for traffic calming



Sample sketch of a bioswale sized to fit into the parking lane

PRECEDENT STUDY

Bioswale design and Center median Installation along Highway 1

Bethany Beach, Delaware

2.1.5 Inlet Retrofits

Within N4 (South Bethany) there were many inlets located in small depression areas. Examples are provided in Figure 9. One potential retrofit to improve stormwater quality before entering the inlet is to remove the pavement and rip-rap surrounding these inlets. Grass and native vegetation can then be planted around the inlets to serve as pretreatment.

Figure 9. Inlets surrounded by rip-rap and concrete in N4 (South Bethany) that can be modified to remove the impervious cover and include grass/native vegetation pretreatment.

Bioswales

Connectivity & Traffic Calming Context Map

LITTLE CREEK, DELAWARE

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

CRDS recommends using bioswales in any location along Main Street where a bump-out might be needed to calm traffic.
Recommended bioswale locations are as follows:

B1: East Side of Main St. in the commercial district, retrofitting around current stormwater inlets.

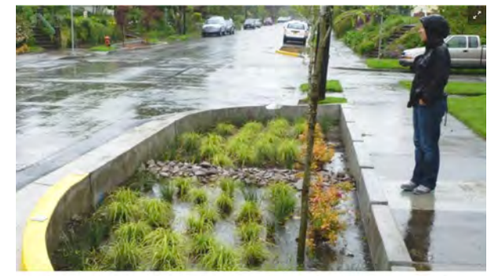
B2: The corner of Lowe St. and Main St. to help slow and control water from encroaching into the market parking lot.

B3: East Side of Main St. along the Little Creek Park, retrofitting around one of the current stormwater inlets near Carson Ave.

B4: Located in the shoulder and right-of-way of the west side Main St. at the intersection of Port Mahon Rd. This bioswale is recommended to be in conjunction with the stormwater design for the ditch.

B5: The eastern side of Port Mahon Rd and Main St. intersection incorporating a northbound crosswalk to a shared use path.
*Exact locations determined after engineering study is complete.

PRECEDENT IMAGES



Bioswales have many benefits, including a reduction in strain on a city's municipal sewer system. Less water in sewers generally leads to cleaner rivers and waterways. Click through the gallery for more about Portland's bioswales.

BAYSHORE BIKEWAY

REGIONAL CONNECTION

Little Creek is less than 6 miles east of the state capitol, Dover, Delaware. Within a 7 mile radius, residents and visitors have access to multiple museums, the viewing platform at the Little Creek Wildlife Area, two public beaches, a brewery, and Dover International Speedway, home to the regional NASCAR races.

Little Creek is also a community along Delaware's Bayshore Byway. The Bayshore Byway is a scenic, two-lane road that follows the Delaware River and Bay Estuary along the largest preserved coastal marshland on the east coast. Route 9 provides great views of spring and fall bird migration.

The byway offers a "road less traveled" experience through some of Delaware's most celebrated ecological assets. t

BAYSHORE BYWAY

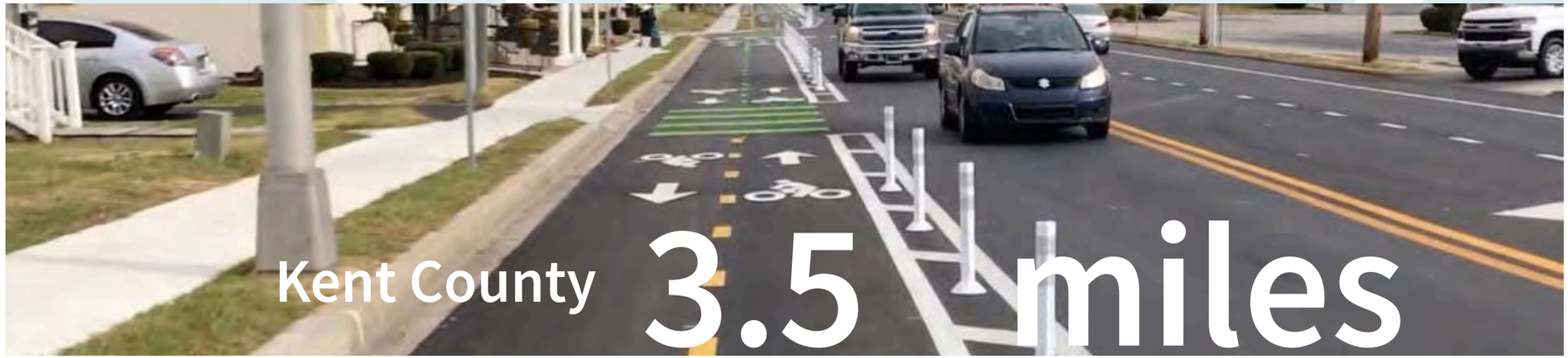
New Castle | Delaware City | Port Penn | Leipsic
BAYSHORE River Towns
Little Creek | Frederica | Milford | Milton

Augustine | Woodland | Pickering | Kitts Hummock | Bowers
BAYSHORE Beaches
South Bowers | Slaughter | Pitney Hook | Broadkill | Lewes

CRDS
COASTAL RESILIENCE DESIGN STUDIO

Regional Amenities & Connectivity

Little Creek , Delaware



DELAWARE BIKE TRAIL MILES

Although Kent County has recently completed the beginning phase of the Senator Bikeway through downtown Dover, the county overall has significantly fewer dedicated bike trail miles than New Castle or Sussex Counties.

BIKE SAFETY IN LITTLE CREEK

After reviewing the road widths along Main Street, it became clear that an alternative solution would be neccessary to maintain cyclist safety. Choosing to keep the resident's on street parking and adding bioswale bump-outs for traffic calming, the roadway cannot safely accomodate a bike lane.

This analysis led to suggesting the walking trail requested by the community be enlarged in scope to become a multi-use trail through Little Creek, and an overall bikeway system beyond.

BAYSHORE
Bikeway

Elevated Boardwalk

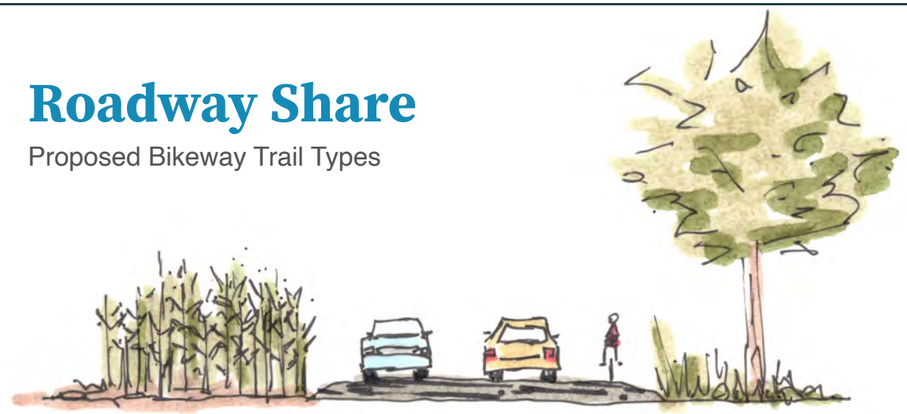
Proposed Bikeway Trail Types

Grade Level Trail

Proposed Bikeway Trail Types

Roadway Share

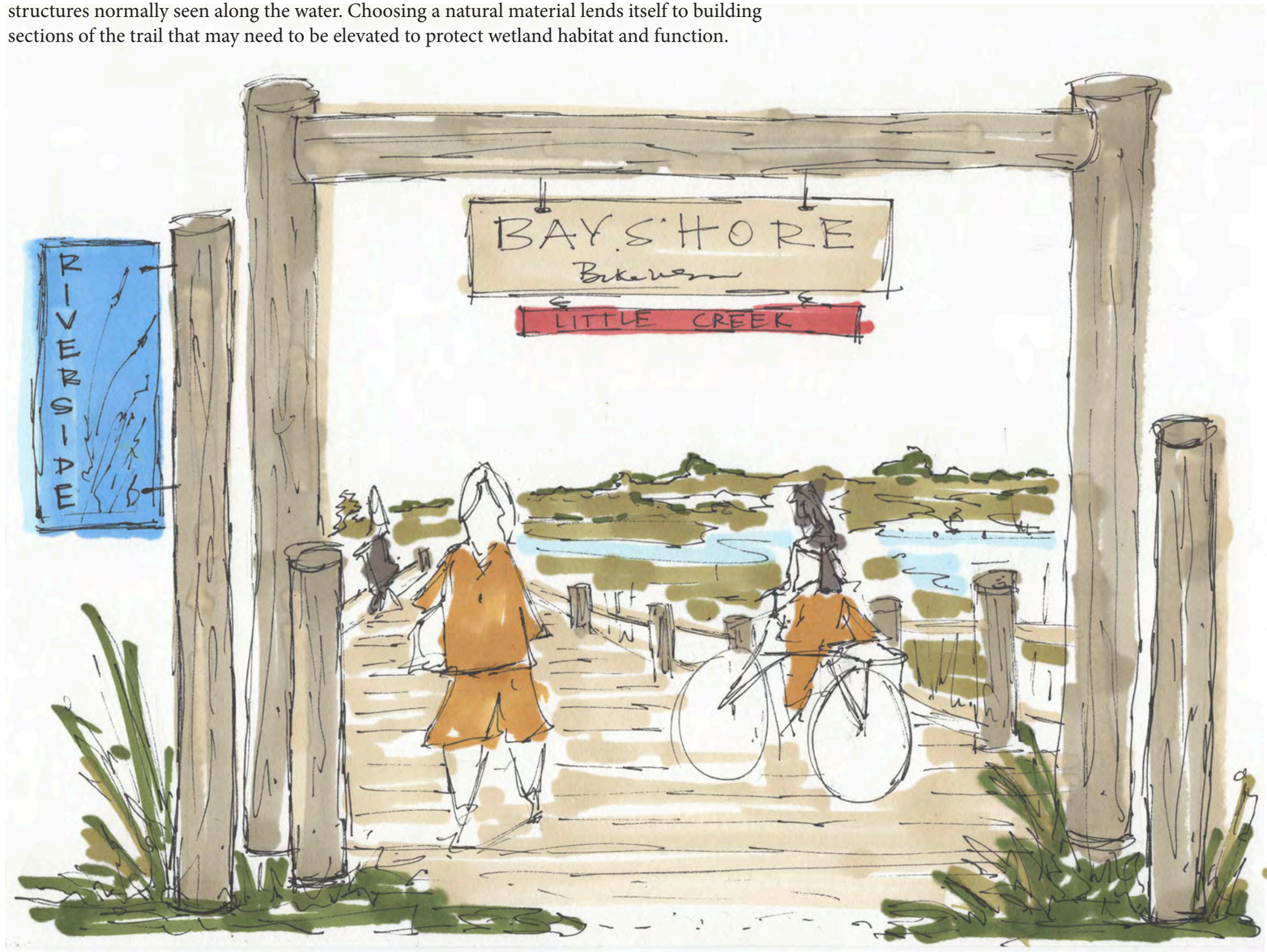
Proposed Bikeway Trail Types

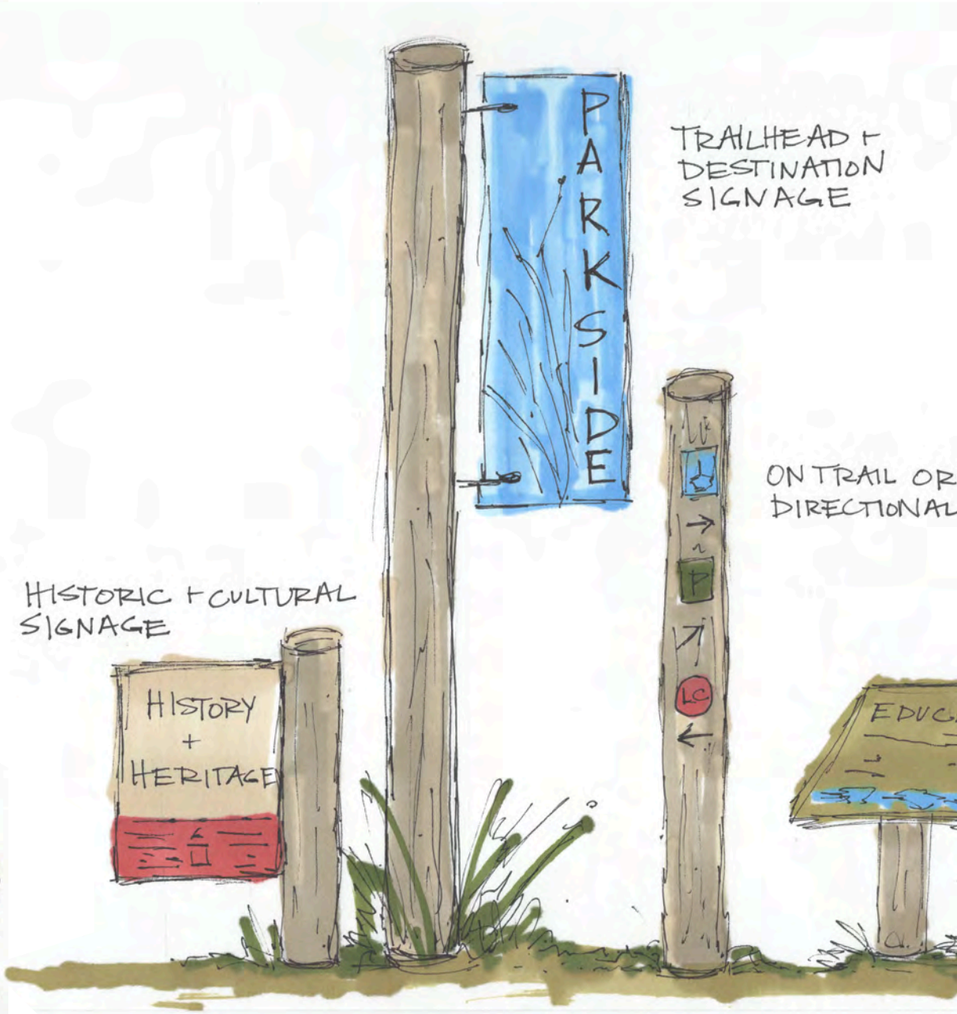


BAYSHORE BIKEWAY

TRAILHEAD DESIGN

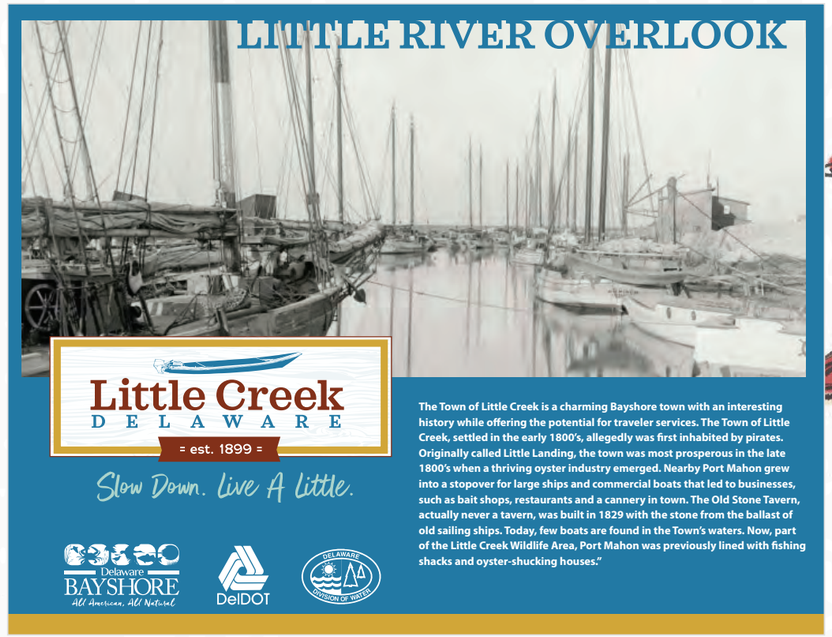
Playing off of Little Creek's signature pilings, as seen along Main Street and Port Mahon Road, the conceptual design for the Bayshore Bikeway trailheads and sign posts mimic the vertical structures normally seen along the water. Choosing a natural material lends itself to building sections of the trail that may need to be elevated to protect wetland habitat and function.





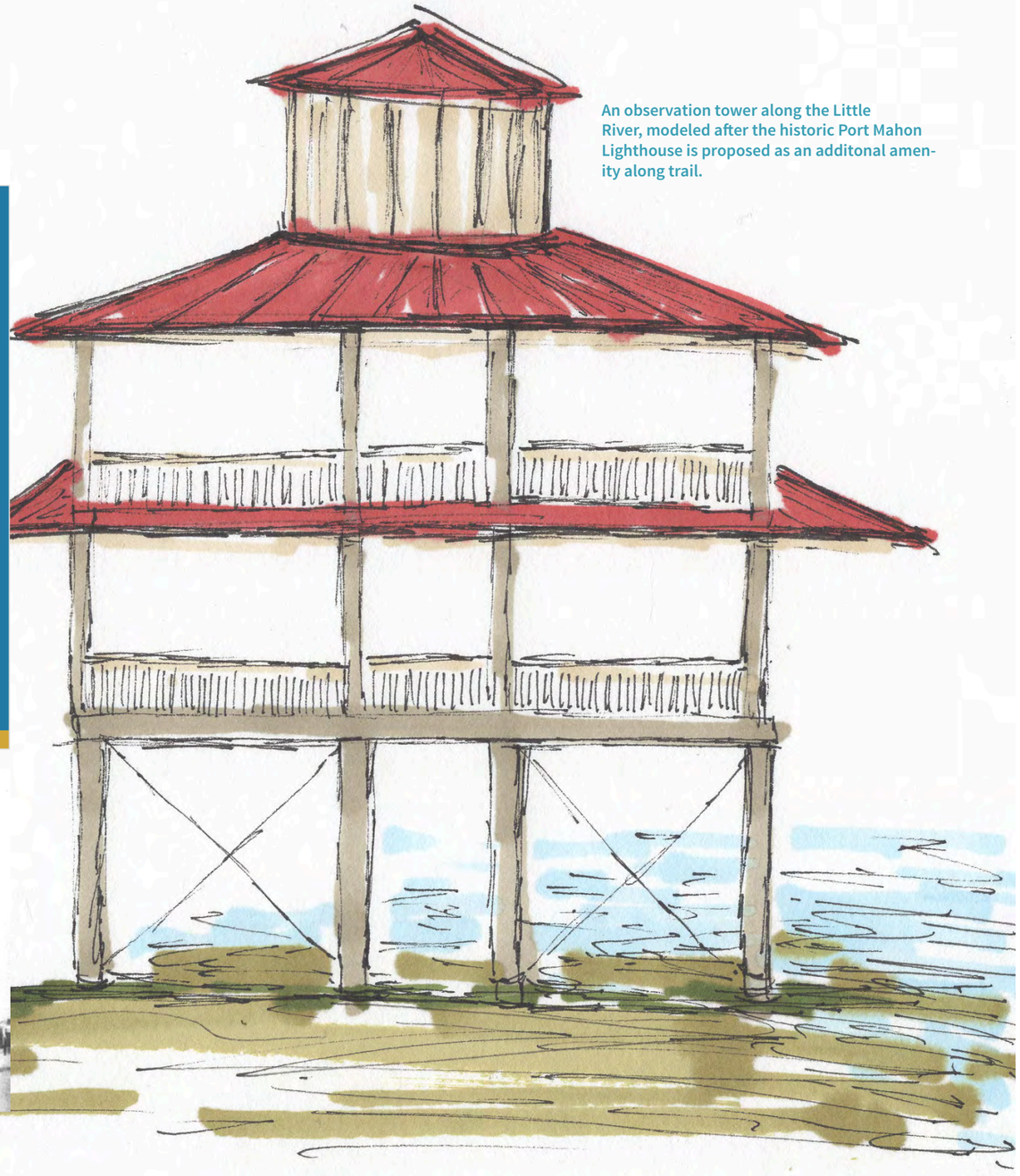
INTERPRETIVE SIGNAGE

Finding a new way to connect residents and visitors to the Little River is an important consideration. This is an opportunity to revisit Little Creek's maritime history through interperpretive signage along the trail.



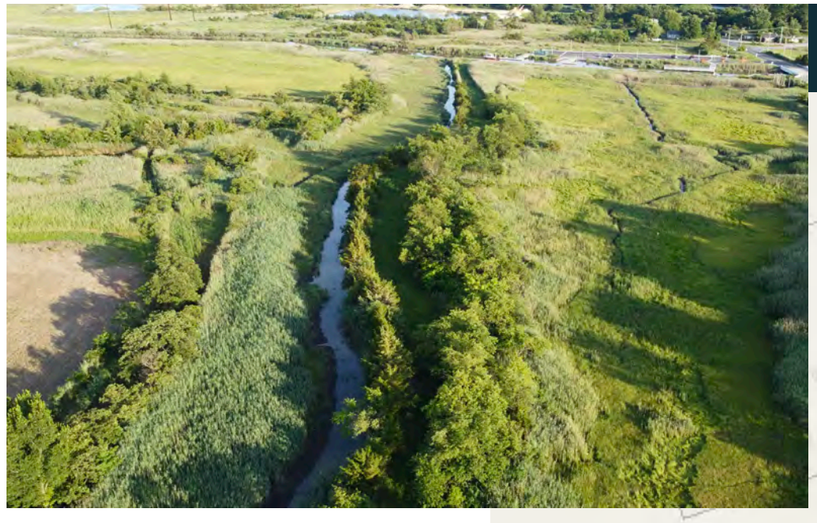
Trailhead Banner System

Port Mahon Lighthouse



An observation tower along the Little River, modeled after the historic Port Mahon Lighthouse is proposed as an additonal amenity along trail.

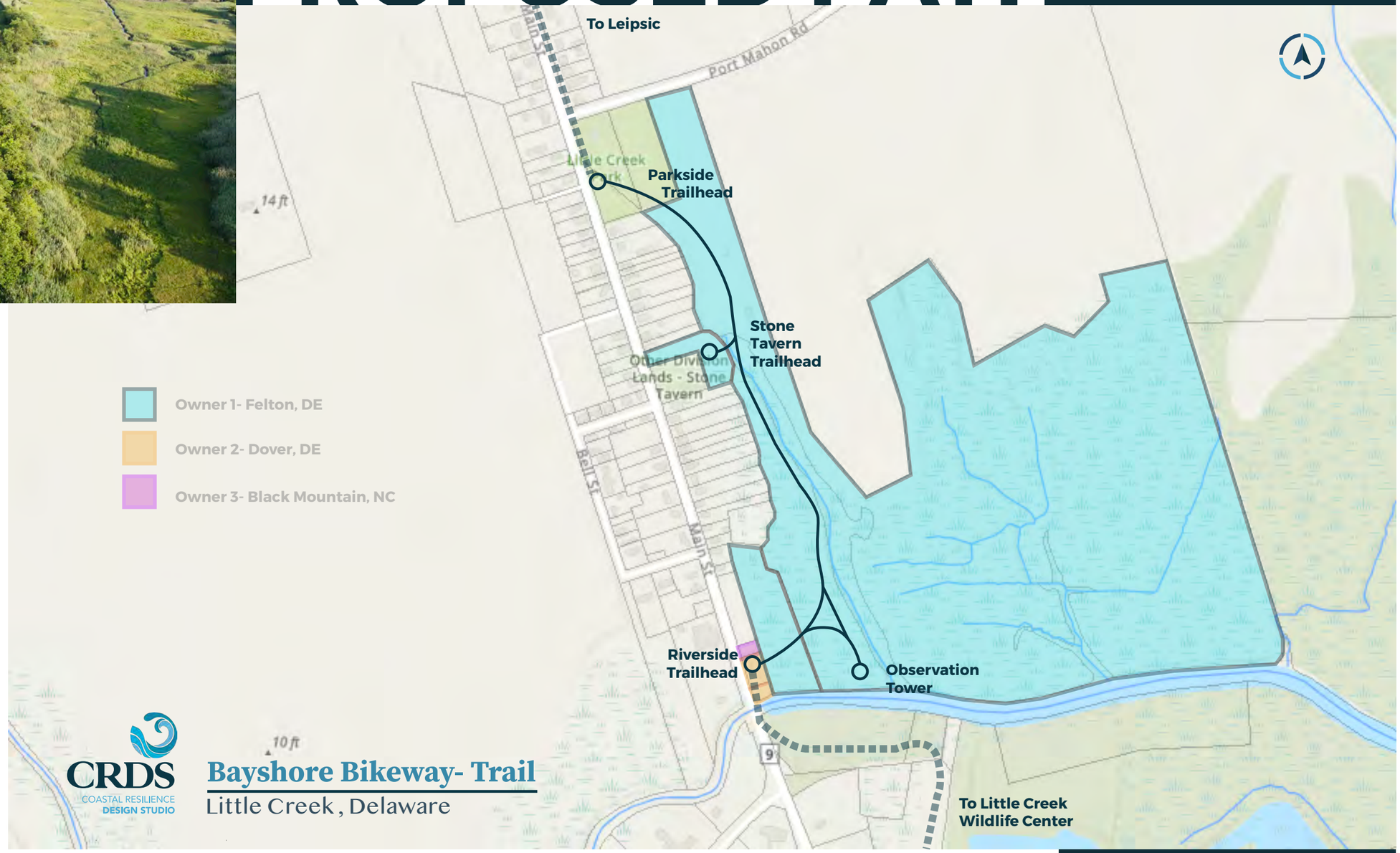
PROPOSED PATH



This aerial image shows an existing cut trail that runs along the edge of a tributary of the Little River.

TRAIL LOCATION

The proposed multi-use trail location is shown on the map along the western side of the Little River tributary.
It includes three strategically placed trail-heads and an observation tower modeled after the historic Port Mahon Lighthouse.
Property ownership varies and includes federal lands. CRDS continues to engage in discussions with all parties to determine the feasibility of the proposed trail location.



CRDS
COASTAL RESILIENCE DESIGN STUDIO

Bayshore Bikeway- Trail
Little Creek , Delaware

BEYOND BIKES

Low impact events can be a great way to build community and excitement behind the brand and subsequent projects.

BAYSHORE BYWAY Bloodthirsty 5k LITTLE CREEK, DE

Trailheads

Connectivity & Traffic Calming Context Map

LITTLE CREEK, DELAWARE

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

Three potential trailhead locations serve different needs for individual users, but all provide a safe and visible entry and exit to the proposed trail.

T1:RIVERSIDE

Located in the heart of the commercial district, this trailhead offers users the opportunity to explore and enjoy access to the the trail in the commercial district alonside dining, retail, kayak rentals, and weekly pop up markets. A crosswalk through the planted median on Main Street makes pedestrian access and safety a high priority and highlights a change of pace as drivers enter the town of Little Creek.

T2: STONE TAVERN

Located near the historic Stone Tavern building, accessed through an adjacent property, this trailhead serves as a midpoint entry or exit for users who do not wish, or are not able to use the full length of the trail. This could be a family with young children looking for a shorter adventure, or a local resident hopping off to go home. Because Main Street is almost entirely residential, there is not an opportunity to get off the trail at other times without encroaching on private property.

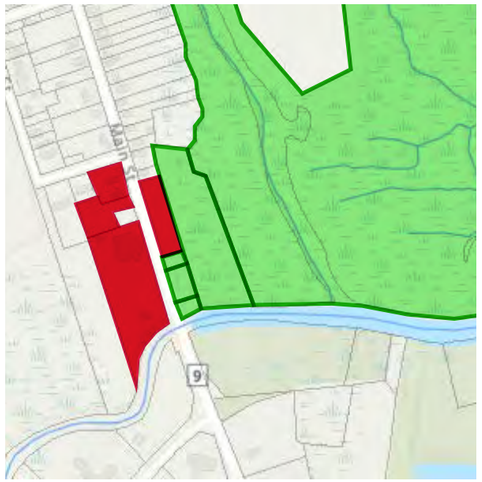
T3:PARKSIDE

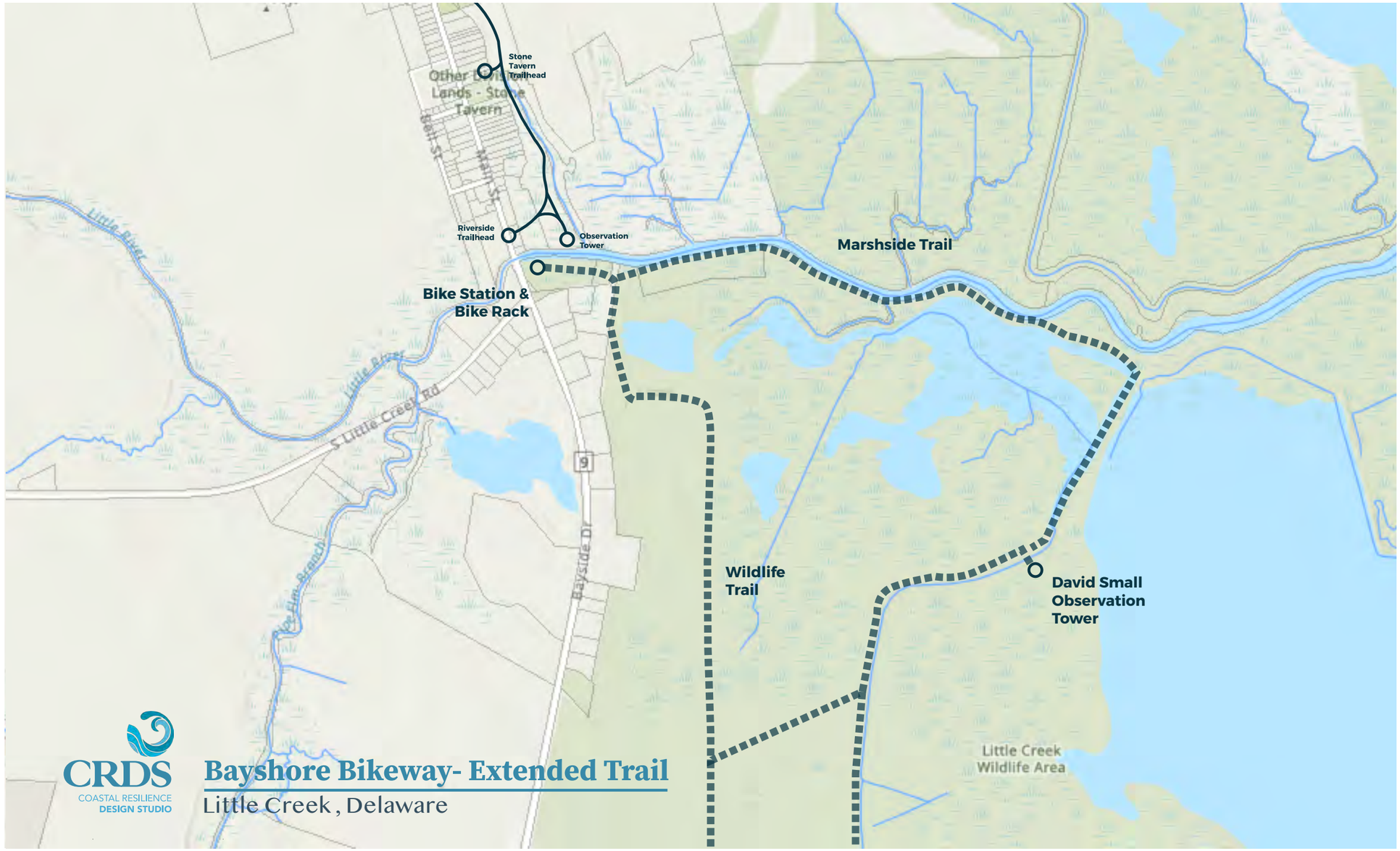
Located in Little Creek Park, this trailhead location serves multiple functions. It is visible and welcoming to the residents of Little Creek as they use the current amenities nearby - the post office, dog park, playground, and other proposed park additons. This trailhead connects to the multi-use trail as it crosses over the proposed restored wetland. The restored wetland offers a vital stormwater service to the town. Adding a trailhead location here has the opportunity to elevate the infrastructure into a beautiful community park trail while also protecting it from damage and accidental mowing.

PROPOSED BIKEWAY EXTENSION

Currently, the Bayshore Byway is largely an automotive experience. CRDS is proposing phased goals aimed at connecting the bikeway south to the Little Creek Wildlife Center, and north to Leipsic, through a buffered shared path along Route 9, eventually converting to a marked sharrow lane. This would require extensive state agency coordination and cooperation to acheive an amenity of this size and scope in Kent County.

The Bikeway would offer all the Bayshore Byway communities an opportunity to offer unique biking & walking experiences in their community. The ultimate goal would be to continue the bikeway north, through all the Bayshore Byway towns, to Delaware City.





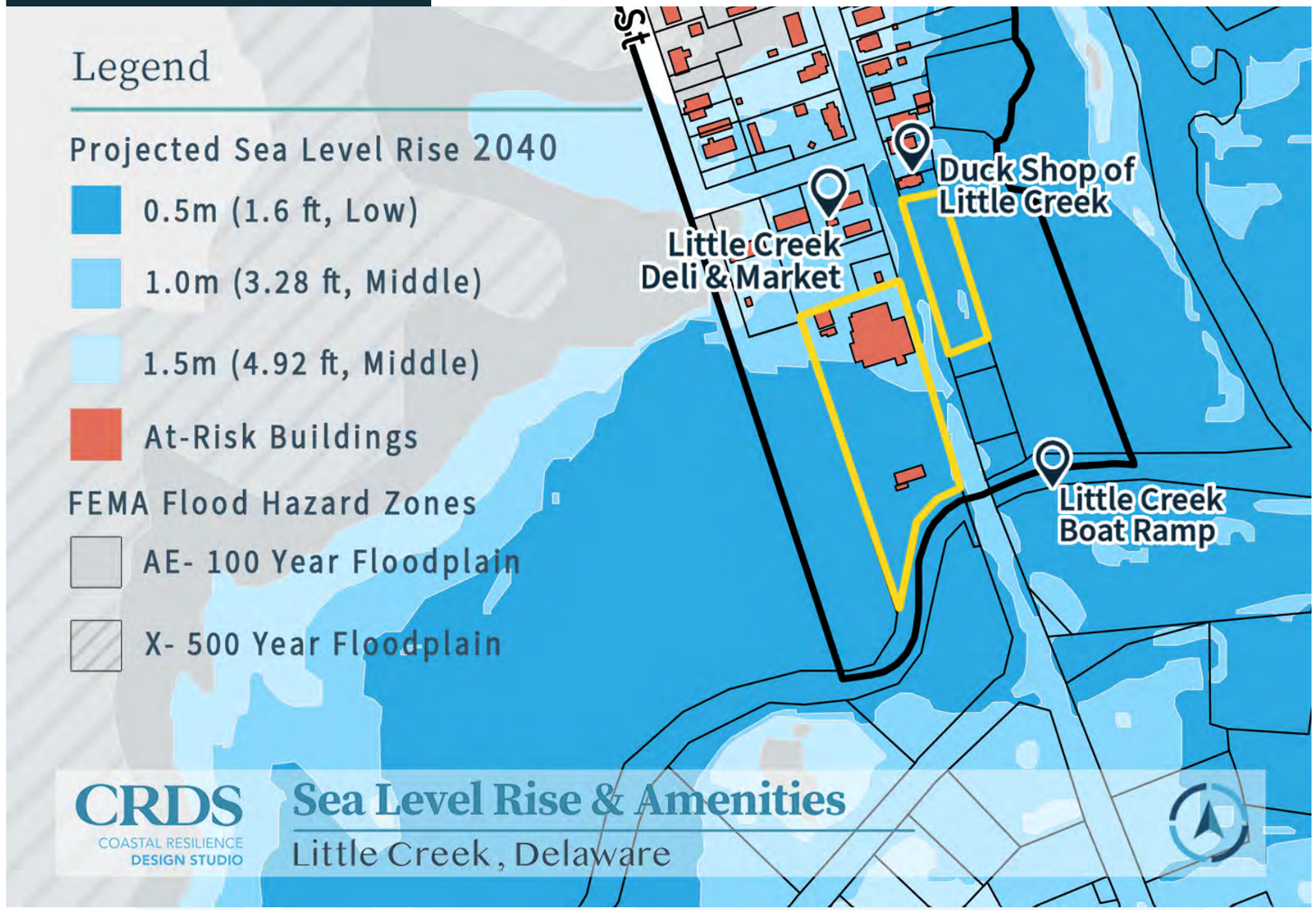
CRDS believes it is important to consider not only physical resiliency, as it relates to sea level rise and stormwater solutions, but also economic resiliency. Many of Delaware's small coastal towns were built on industries that no longer exist, or if they do, exist in dramatically smaller economic footprints. Large scale public sector investment in community amenities have the opportunity to generate the private investment that is needed.

Commercial Redevelopment

CRDS
COASTAL RESILIENCE
DESIGN STUDIO


Wetlands
Riparian Buffer Area
Setbacks
Cavaliers Aux Property
-No permenant structures are allowed on the parcel
Main St.
62%
Undevelopable
Little Creek Deli & Market
-Future Site of Filling Station, Charging Station,
Ice Cream Vendor, Kayak Rentals
Cavaliers Property
-Buildings scheduled to be demolished
-Wetland within the boundaries
-Frequent Flooding on the South End
CRDS
COASTAL RESILIENCE
DESIGN STUDIO

COMMERCIAL PROPERTY UNDERSTANDING



The existing Cavaliers property and adjacent Cavaliers Aux property are currently unused. These sites experience significant issues, like recurring flooding and setbacks. However, the size of the properties and proximity to the Little River offer an opportunity to establish a thriving commercial center for residents and visitors to enjoy in Little Creek.

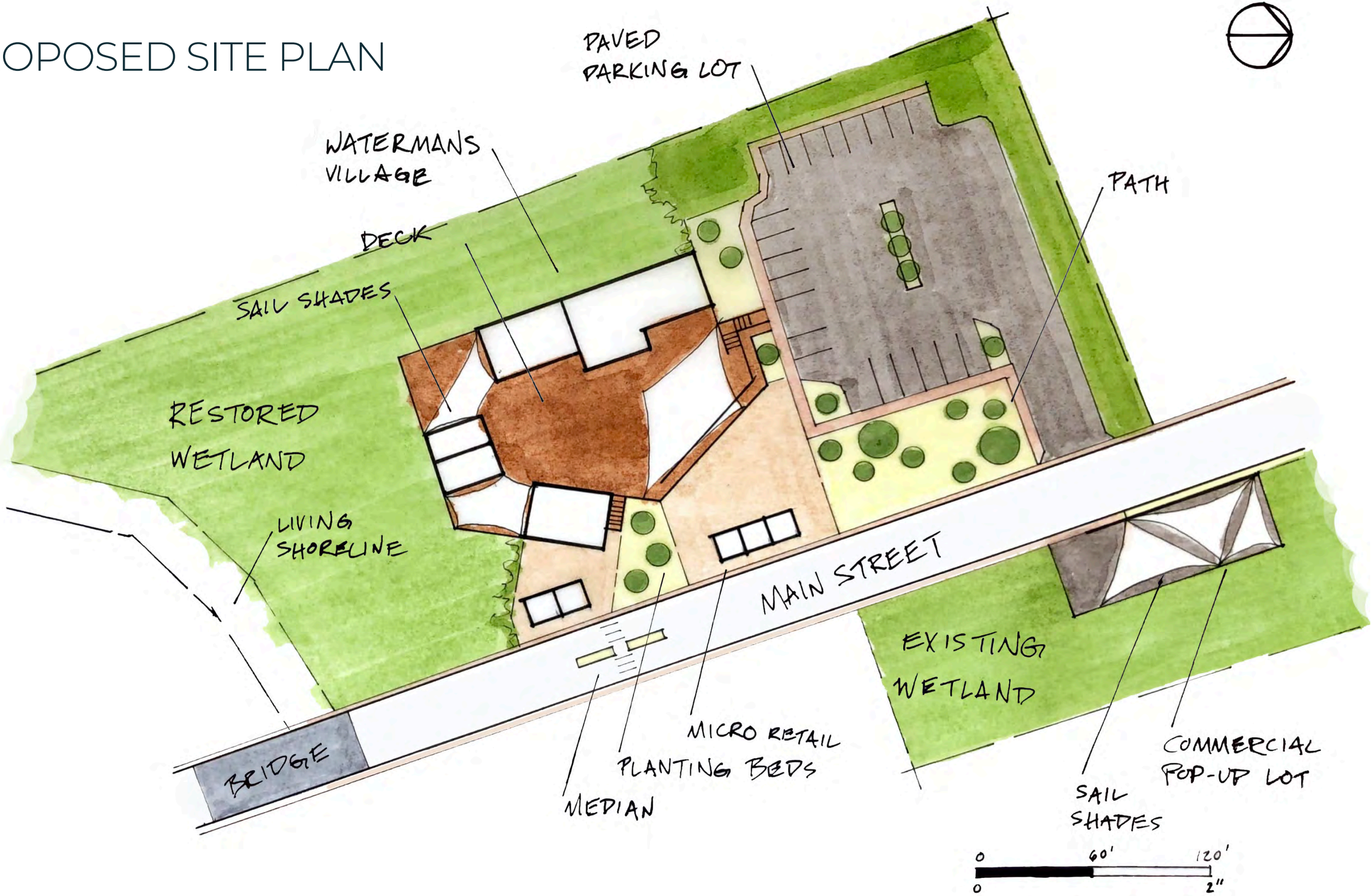
The **Cavaliers property** contains two abandoned structures. Floodwaters from the Little River encroach on the southern end of the property, washing sediment and material onto the pavement. **Sea level rise** data predicts the majority of the property will be inundated during floods by 2040. As indicated in the existing conditions image, **62% of the property is un-developable** due to wetland and riparian buffers, as well as property setbacks. Invasive **Phragmites australis** borders the southwestern side of the parcel.

The **Cavaliers Aux property** is partially paved and located in designated wetlands. The **existing pavement is deteriorating** and overrun by vegetation in areas. **Permanent structures cannot be built** on this parcel due to Federal Emergency Management Agency wetland restrictions.

COMMERCIAL OBJECTIVES

- Incentivize private investment in Little Creek
- Create an inviting commercial district
- Establish a connection to the Little River
- Honor maritime history and small-town character
- Mitigate current and future flooding on site
- Increase wetland habitat
- Increase the riparian buffers
- Create elevated views of the Little River

PROPOSED SITE PLAN



COMMERCIAL PROPERTY PLANS

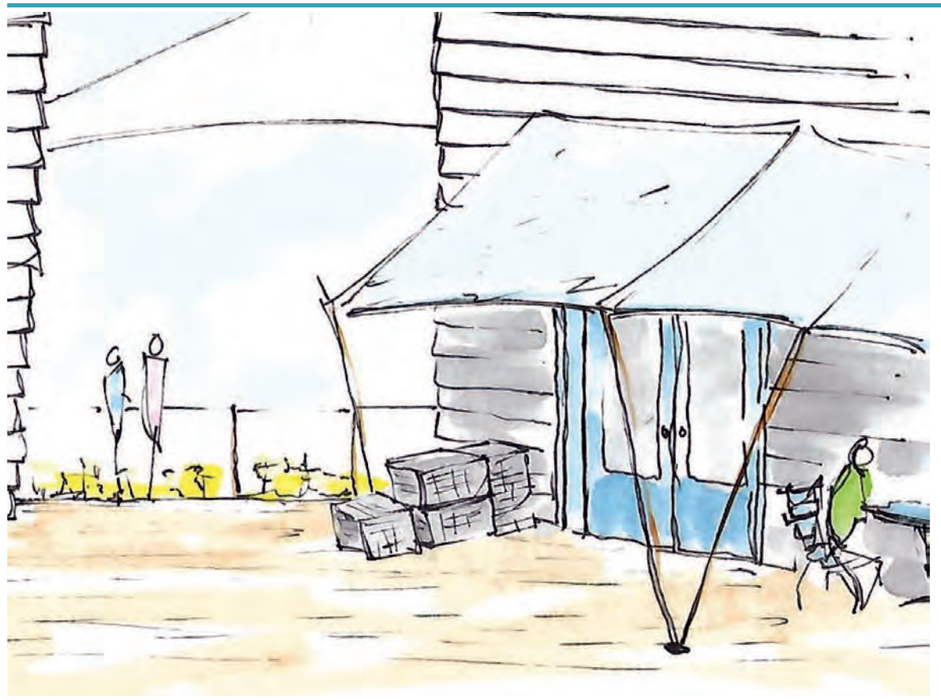
The commercial property plan transforms the Cavaliers parking lot with abandoned buildings into a modern, sustainable, and thriving center for commerce on the Little River. Residents can visit **Waterman's Village for shopping and outdoor dining** with picturesque views of the river and surrounding wetlands.

The **Pilings at Waterman's Village** (labeled as commercial pop-up lot) offers **quaint micro-retail spaces** for quick investment opportunities.

The plan also includes a **restored wetland** to offset recurring flooding and projected sea level rise. A **living shoreline** would expand habitat and improve the water quality of the Little River. In addition, **native planting beds** beautify the ground level around Waterman's Village and add to infiltration capability.

Tony's Seafood Restaurant, Marshall, CA

Structure exterior aesthetic precedent



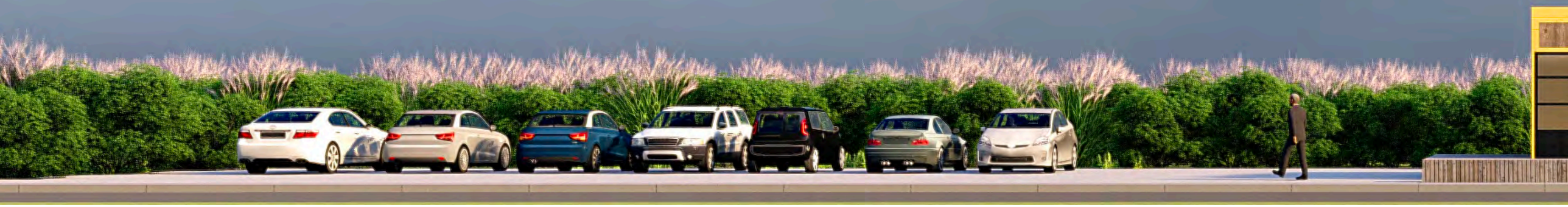
WATERMANS VILLAGE

At Waterman's Village, five new commercial buildings encourage private investment and create an inviting shopping and dining experience. The structure is elevated on pilings to ensure its longevity in the face of flooding and sea level rise. Elevating Waterman's Village opens up sweeping views of the natural landscape and also harkens back to the local, maritime character of the Delaware Bayshore.

Waterman's Village is accessible for all, and includes shaded outdoor seating. There is ample parking to accomodate Little Creek residents and visitors along the Bayshore Byway. At ground level, five additional micro-retail spaces offer street side retail opportunities.

WATERMANS
Village

THE PILINGS AT WATERMAN'S VILLAGE



The Pilings at Waterman's Village is a flexible commercial design answer for FEMA restrictions. Due to the preserved wetland status on the Cavaliers Aux property, permanent structures are not permitted.
Micro-retail storefronts are impermanent structures that encourage quick investment due to their small size and scale. This solution is perfect for small retail storefronts, a kayak rental, or a bait and tackle store. This design includes room for parking and maximizes the amount of wetland to absorb storm and flood waters.

Sail shades accompanied by market stalls could serve as an alternative or an addition to micro-retail. With this option, residents could enjoy farmer's markets, seafood markets, and beer gardens.

Example of micro-retail at Anchor Square in Pascagoula, Mississippi

The Pilings at Waterman's Village

MICRO-RETAIL

Small business incubators with little upfront investment

- Permitted in the floodplain
- Built on wheels
- Less than 200 sq ft
- Mobile in case of flooding
- Quaint and small town character

Above: Example of a pop-up market,
Below: Example of sail shades, by Superior Awnings

The Pilings existing parcel

The Pilings reimagined

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Community **Discovery** Process

LITTLE CREEK, DELAWARE

Prepared for the Town of Little Creek
and Presented August 3, 2020

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

Little Creek, Delaware

The **Design** Process

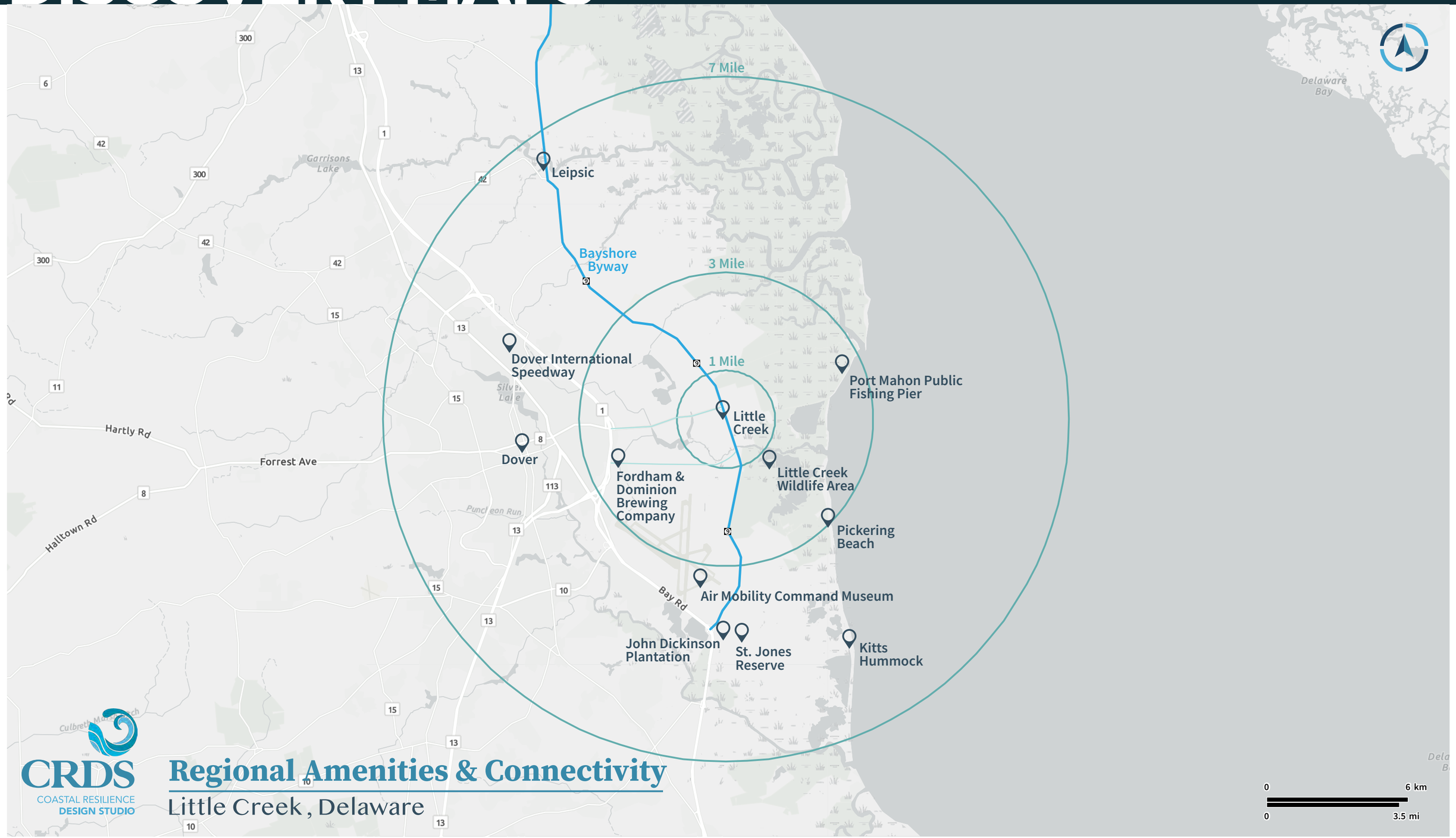
The Coastal Resilience Design Studio endeavors to understand the needs of each community and what makes each place unique before any design solutions are offered.

The Studio's iterative process uses interdisciplinary site research, multiple site visits, community input, stakeholder and agency feedback, and multi-stage technical and professional reviews.

After the analysis phase is complete, the Studio develops multiple solutions, converging toward a set of design recommendations to present back to the community for additional feedback.

This document details the collective research and analysis that was used to derive all proposed design solutions.

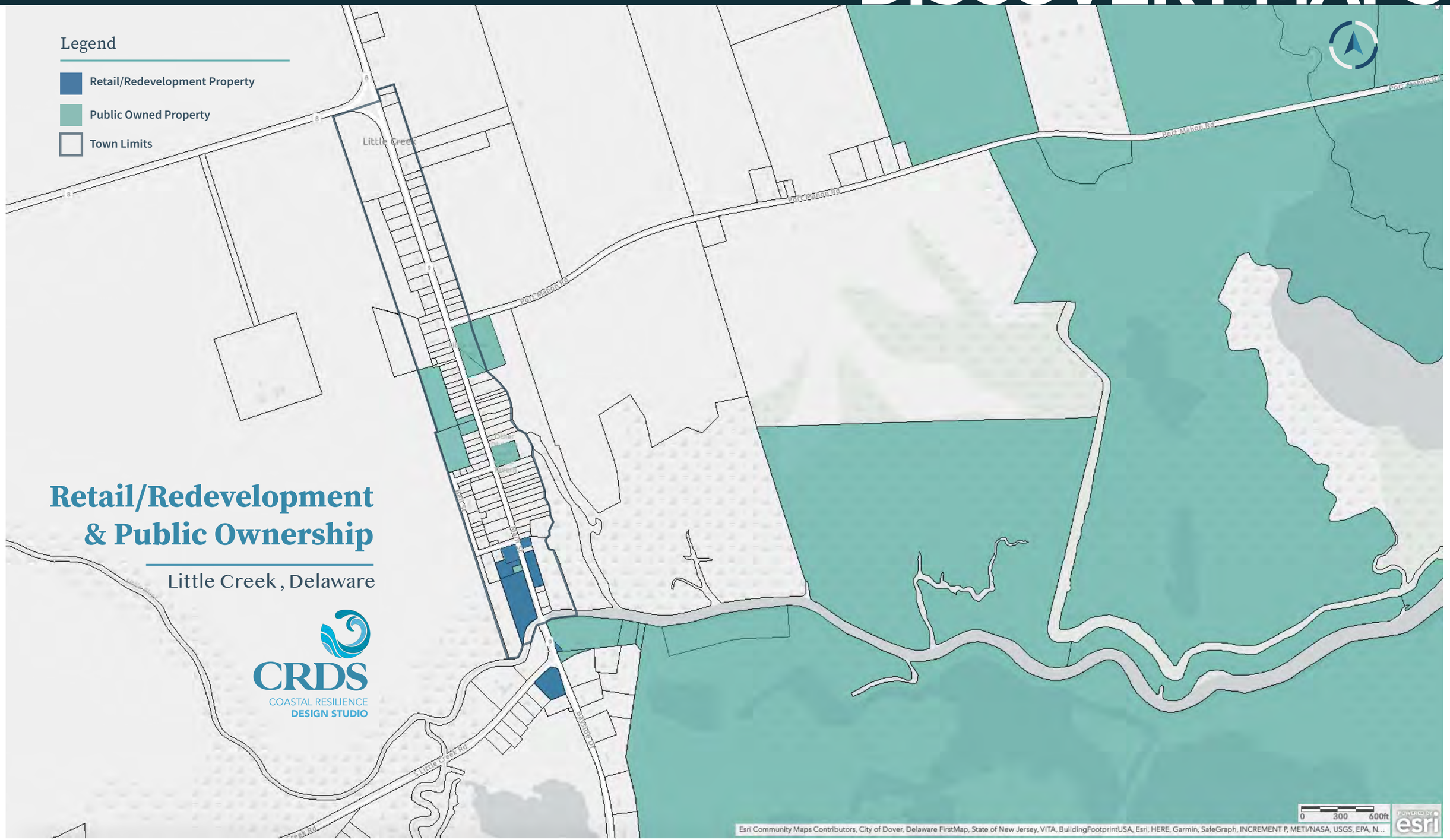
DISCOVERY MAPS



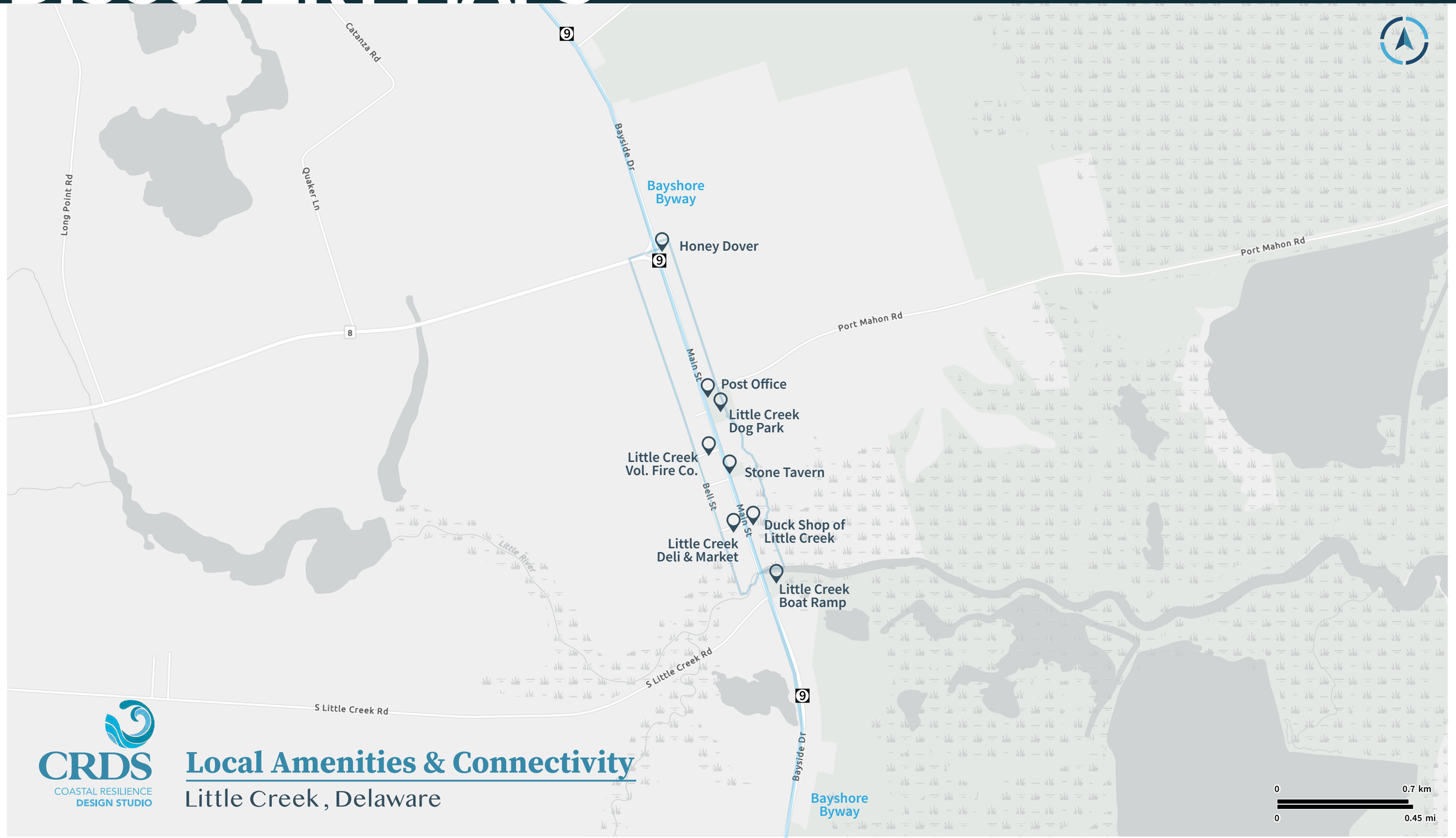
CRDS
COASTAL RESILIENCE DESIGN STUDIO

Regional Amenities & Connectivity

Little Creek , Delaware


Legend
Retail/Redevelopment Property
Public Owned Property
Town Limits
Little Creek
Port Mahon Rd
Port Mahon Rd
Port Mahon Rd
Bayshore Dr
E Little Creek Rd
Retail/Redevelopment
& Public Ownership
Little Creek , Delaware
CRDS
COASTAL RESILIENCE
DESIGN STUDIO
0 300 600ft
Esri Community Maps Contributors, City of Dover, Delaware FirstMap, State of New Jersey, VITA, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, EPA, N...
POWERED BY esri

DISCOVERY MAPS



CRDS
COASTAL RESILIENCE DESIGN STUDIO

Local Amenities & Connectivity

Little Creek , Delaware

Little Creek
DELAWARE

COMMUNITY INPUT SUMMARY

COMMUNITY SURVEY
JULY 2015

COMMUNITY VISIONING
OCTOBER 20, 2015

SEA LEVEL RISE
DECEMBER 7, 2015

TRANSPORTATION
FEBRUARY 8, 2016

STRATEGIES MEETING
MARCH 8, 2016

COMMUNITY ASPIRATIONS

1. Residents wish to preserve the **small-town character** by balancing any **new development** with preservation of **agricultural lands and open space**.
Annexation and new residential developments are generally not desired and are not a priority;
2. Residents desire to **re-establish public access** to Little River for commercial fishing and for recreational boating and fishing; thereby restoring their working **waterfront and maritime heritage**; and
3. Residents recognize that **sea level rise** is happening and they generally support action to adapt and become a **resilient community**.

COMMUNITY DEMOGRAPHICS

187
POPULATION

78
HOUSEHOLDS

$46,250
MEDIAN HOUSEHOLD INCOME

31
AVERAGE COMMUTE TIME

49.1
MEDIAN AGE

DEMOGRAPHIC DATA FROM ENVIRONICS SPOTLIGHT/CLARITAS & DATAUSA.IO/DELOITTE

Demographics & Community Survey Results

As of June 2020, Little Creek consists of 78 households and 187 individual residents. The median age is 49.1 and the average commute time is 31 minutes, suggesting most people work outside of the town limits.

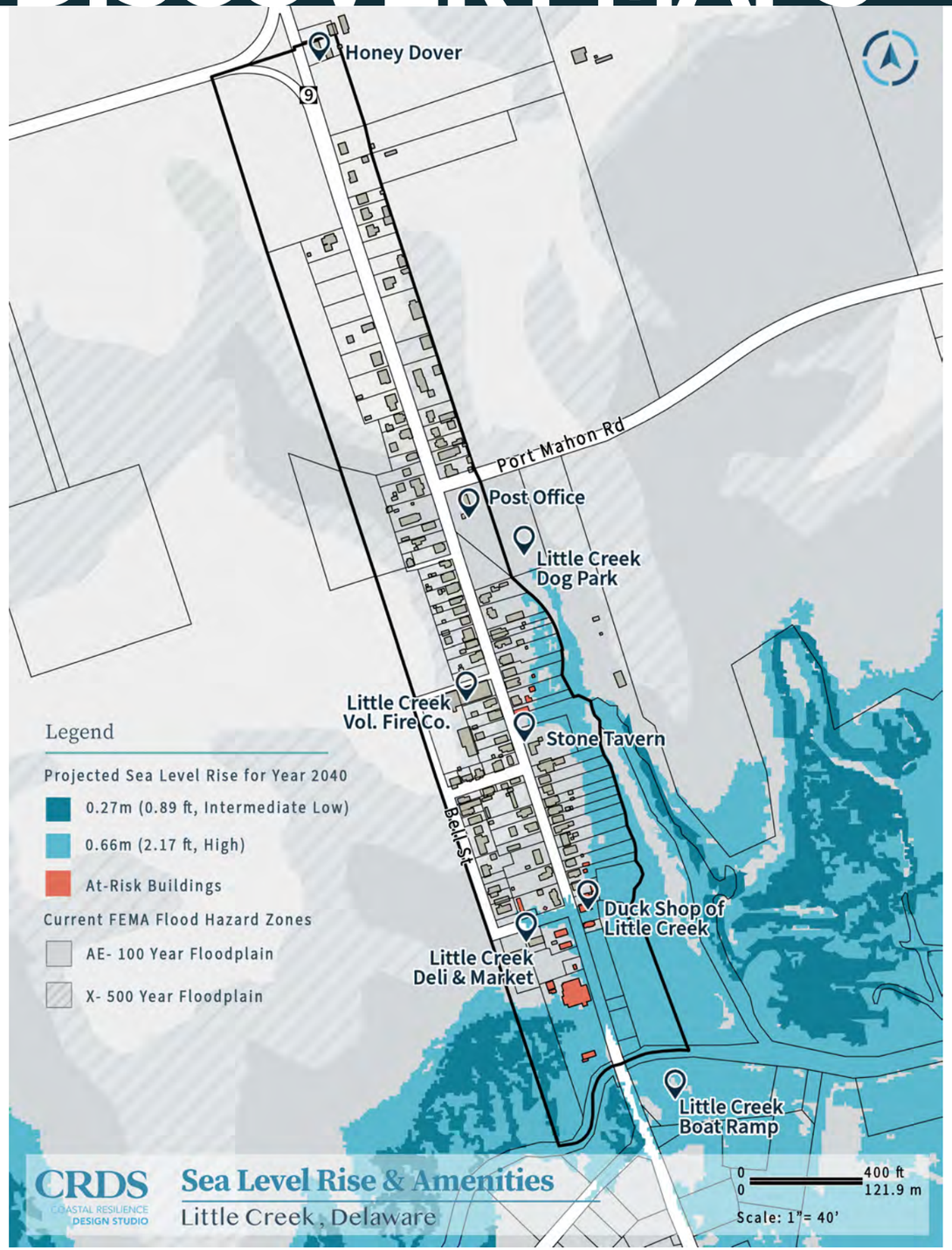
Due to the aging population of Little Creek, infrastructure and roadway maintenance is important to allow for continued accessibility. However, as sea levels continue to rise, persistent flooding in downtown will likely increase beyond the abilities of the current infrastructure and more drastic measures may be needed before the year 2100.

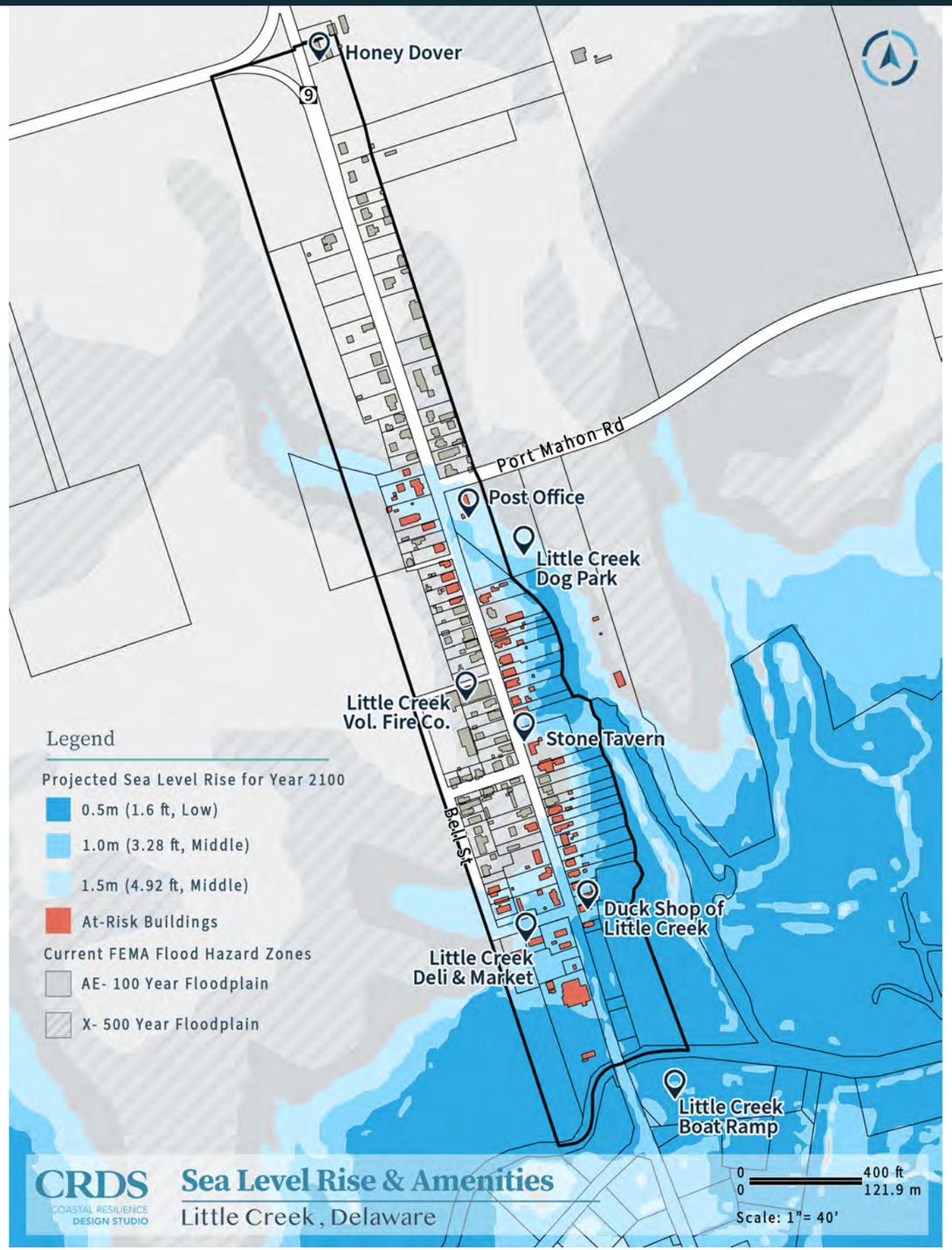
A series of community input surveys and sessions conducted between 2015 and 2016 revealed several main goals of the Little Creek residents and stakeholders.

Residents wish to preserve the small town character of Little Creek. Any new development should be balanced with the preservation of agricultural lands and open space. Residents would like to re-establish public access to the Little River for commercial fishing as well as recreational boating and fishing, thereby restoring their working waterfront and maritime cultural heritage. The community recognizes that sea level rise is happening and generally supports action to adapt and become a resilient coastal community. At this time, annexation and new residential development is not considered a priority.

Although the community is small, there is opportunity for investment in Little Creek that aligns with the residents' goals.

DISCOVERY MAPS





Sea Level Rise (SLR) in Delaware

Sea level is rising globally. As the earth gets warmer, ocean water expands, and glaciers melt, causing global sea level increases. The low mean elevation and localized land subsidence in Delaware amplify sea-level rise (SLR) impacts. The result is a rate of SLR that is twice the global average. Between 8% and 11% of land in Delaware may be covered with water during high tide by 2100 (Preparing for Tomorrow's High Tide: Recommendations for Adapting to Sea Level Rise in Delaware, 2013).

The Town of Little Creek is especially vulnerable to SLR. Two-thirds of the town resides within the floodplain and are at a minimum 0.2% annual risk for coastal flooding (Little Creek, Delaware Comprehensive Plan, 2016).

The primary transportation infrastructure, including Main Street and Port Mahon Road, are often subject to flooding, mainly during high tide and storm events. The Little River borders the south of Little Creek and flows to the Delaware Bay. After significant rainfall events, the sediment buildup in the Little River and nonfunctional stormwater infrastructure contribute to flooding that lasts for up to four hours after the event.

The current coverage of Little Creek during high tides is two percent of the town's land. Coverages will increase to 17%-40% by the year 2100, a significantly higher number than the aforementioned statewide estimate (Little Creek, Delaware Comprehensive Plan, 2016). The impacted areas will include commercial property, homes, a historic property, the wastewater pump station, domestic water wells, roads, protected wetlands, and a riparian buffer. The impacted amenities, as well as the extent of SLR in Little Creek are shown in Map X. Low lying areas will become permanent pools, and agricultural land will be unable to support traditional crops. Furthermore, saltwater intrusion into groundwater and surface water poses a considerable issue. Drastic inundation is also projected for the year 2040. Projections outlined by Map Y predict a 0.89 to 2.17 ft sea level rise inundation in Little Creek. These areas will be covered in salt water and faced with the aforementioned, associated issues if mitigation strategies are not implemented.

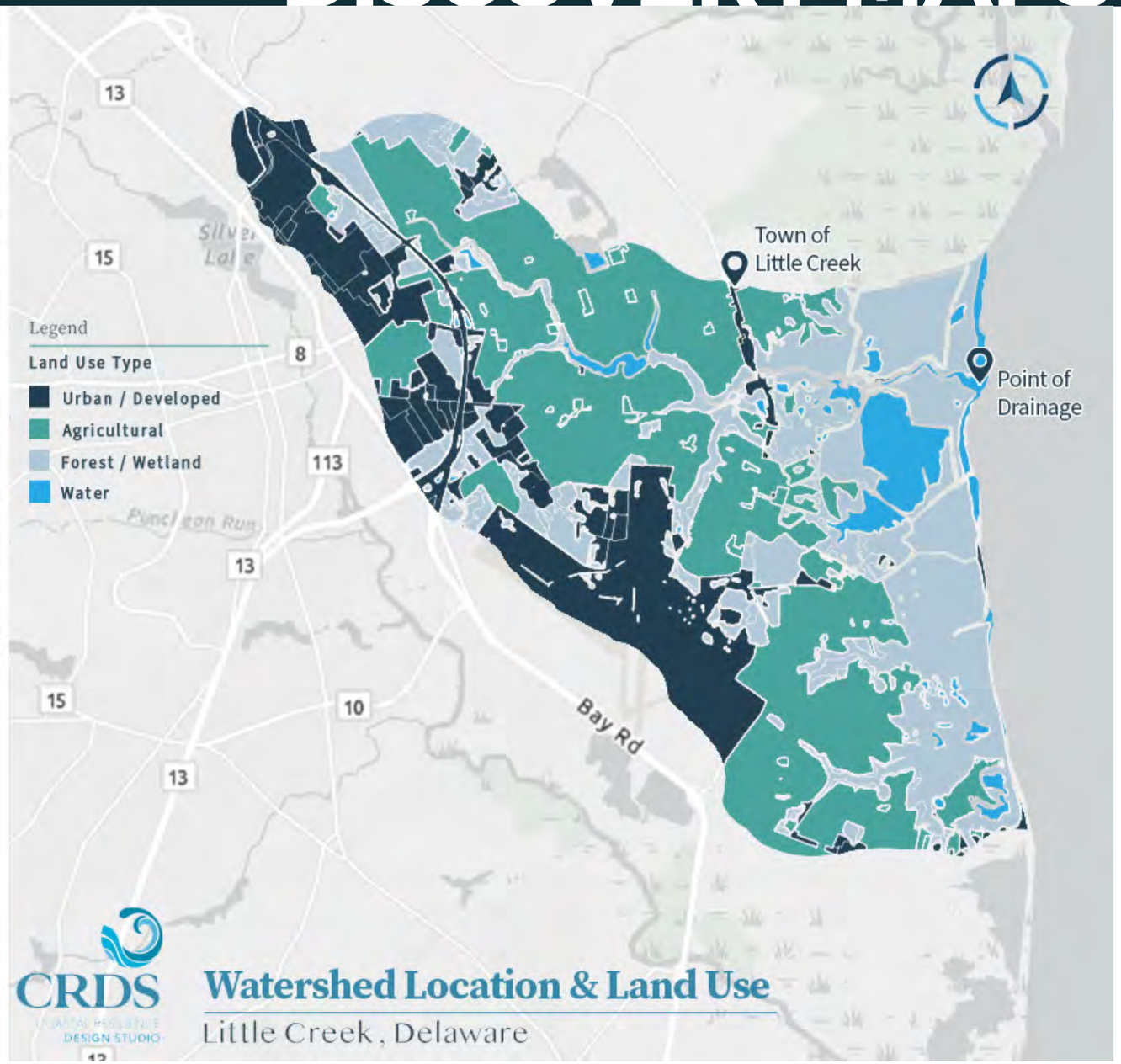
The community has identified sea level rise as a growing concern, as surveyed in the Comprehensive Plan. The Town Comprehensive Plan has outlined the following items to address sea level rise:

The creation of a new zoning district or hazard overlay zone
Expanding floodplain requirements and flood proofing measures
Wetland restoration
Riparian corridor enhancements, *(being mindful of horseshoe crab habitat)*
Monitoring drinking water wells
Explore FEMA programs
Provide homeowner / builder awareness and education

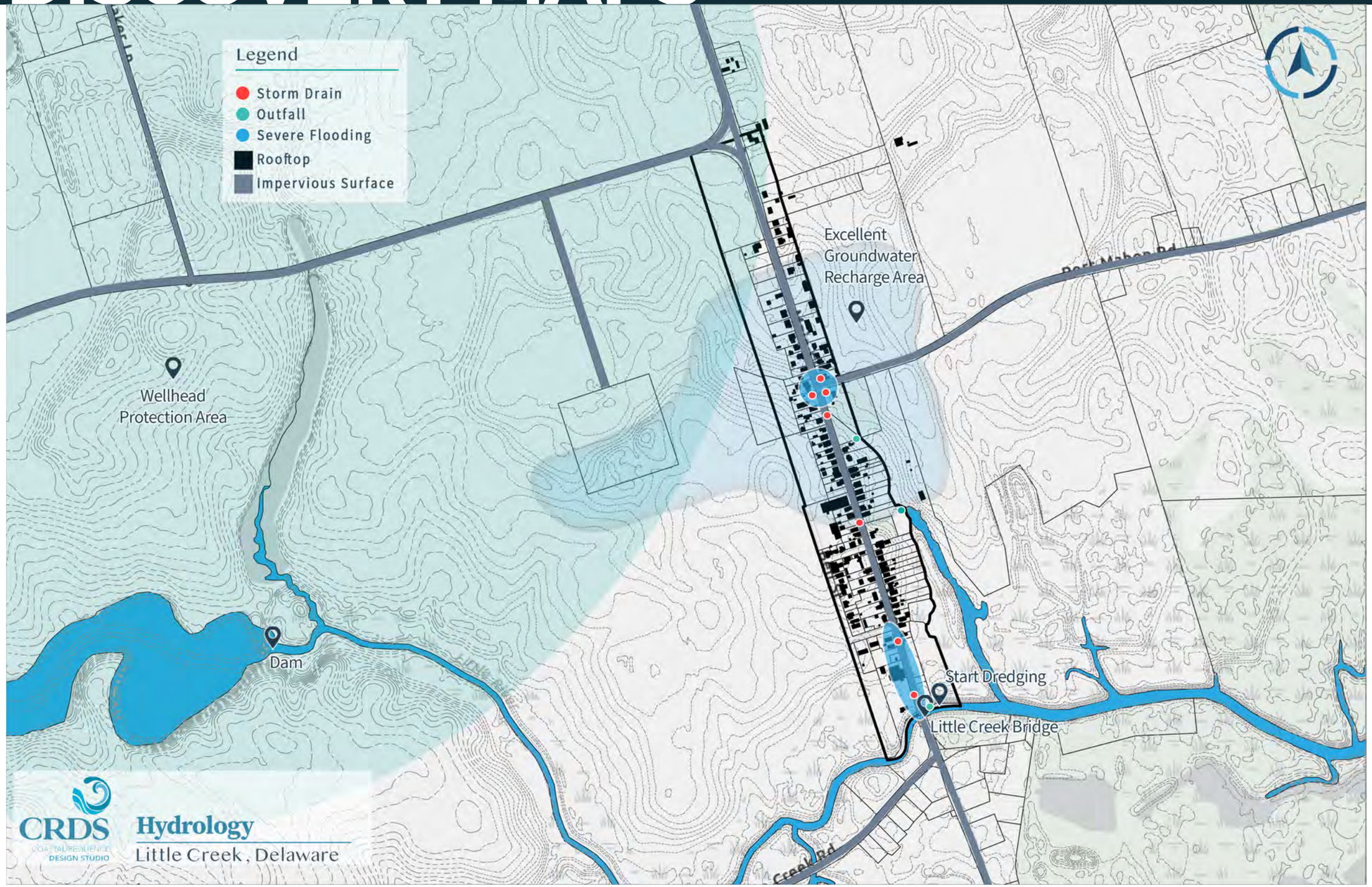
Hydrology: Flows, Uses & Pollutants

The greater watershed is known as the Little Creek Watershed, which drains approximately 23 square miles to the Delaware Bay via the Little River. The mainstem of Little River is five miles long and flows east through the town of Little Creek. The lower three miles of the Little River is characterized as saline wetland habitat (Delaware Watersheds, n.d.). In the 23-mile drainage area, the dominant land use is agricultural (40%); the remainder of land uses are characterized as forest and wetland (saltwater and fresh) (32%) and urban (19%) (USGS Streamstats, n.d.).

These waterways are impacted by nutrient and bacterial pollution, with 5.5 miles of the Upper Little River and 2.9 miles of the Lower Little River listed on the Federal Clean Water Act list of Impaired Waterways: 303(d). According to the total daily maximum loads (TMDLs) established for the Little Creek Watershed by DNREC, 40% reductions in both phosphorus and nitrogen, as well as a 75% reduction in enterococcus bacterial loads must be met to restore health to this disturbed waterway. Uses of the waterway include primary and secondary recreation, fishing, aquatic and wildlife habitat, industrial water supply and agricultural water supply in upstream freshwater lengths of the river (DNREC LC Watershed Proposed TDMLs, 2006). A greater watershed study including Little Creek showed historic wetland habitats have decreased by 21% due to the development of agriculture and open water access along the coast. The grade designation given to describe the health of the current environments is a C+, indicating a need to restore health to the wetland.



DISCOVERY MAPS



Upstream Existing Dam and Sedimentation

A small dam was built on private property in the 1980's approximately a quarter mile upstream of the town and has been identified by several town residents as a potential cause of sedimentation and increased flooding in town (WWI, 2016). Although there has been no hydrological assessment, dams are well known to cause drastic changes to the natural flow and sediment transport of streams (International Rivers). Without a thorough hydrological study, the impacts of dam removal on the downstream system are uncertain; however, a precedent study shows an example of dam removal to restore the natural flow regime to a stream that improved the health and habitat surrounding that system.

Recurring sedimentation of the Lower Little River inhibits navigation and prevents many of its uses. In the fall 2015, a costly $10 million dredging east of the Little Creek bridge to the Delaware Bay deepened the creek to 6 feet and widened it to 30 feet (WWI, 2016). The CRDS recommends dam removal as a strategy to restore the natural condition and functionality of the Little River to not only improve coastal wetland function and habitat, but to improve flows that prevent sedimentation and the backlog of stormwater outfalls in town. Construction of the dam took place before any permitting process was in place, and without landowner approval the barriers to removing the dam are holding.

STORMWATER

The surplus and contamination of stormwater in Little Creek is a critical issue. The CRDS recommends enhancing the current stormwater infrastructure to effectively collect, redirect, and improve excess stormwater.

Several nationally-recognized methods were used to assess the existing stormwater conditions in Little Creek. These methods utilize local conditions, like topography, soil type, and rainfall records to calculate runoff.

The National Stormwater Calculator (NSWC) method resulted in the following stormwater statistics:
Average Annual Rainfall (inches): 45.99
Average Annual Runoff (inches): 17.54
Maximum Amount of Rainfall Retained (inches): 1.42
Rainfall Depth During 10 Year Event (inches): 3.2
Runoff Depth During 10 Year Event (inches): 4.8

The Purdue University Long Term Hydrologic Impact Analysis (L-THIA) yielded the following results:
Average Annual Rainfall Depth (inches): 43.07
Average Annual Runoff Depth (inches): 9.24
Nonpoint Pollutant Nitrogen (lbs): 224
Nonpoint Pollutant Phosphorous (lbs): 65.123

The Town has identified the need for stormwater management to improvements. The CRDS recommends the use of green infrastructure to reduce stormwater quantity and boost quality. The cost saving benefits of bioretention and infiltration basins extend beyond stormwater capture for flood avoidance. Infiltration basin related savings include carbon sequestration, pollutant capture, heat island mitigation, and air quality, wildlife habitat, and community aesthetic improvement.

The American Rivers and Center for Neighborhood Technology Toolkit: The Value of Green Infrastructure: A Guide to Recognizing its Economic, Social and Environmental Benefits yielded the following results:
Runoff captured in a potential bioretention area annually (gallons): 718,295.04
Estimated avoidance of wastewater treatment costs annually: $359.15

Existing Stormwater Infrastructure

Little Creek, Delaware

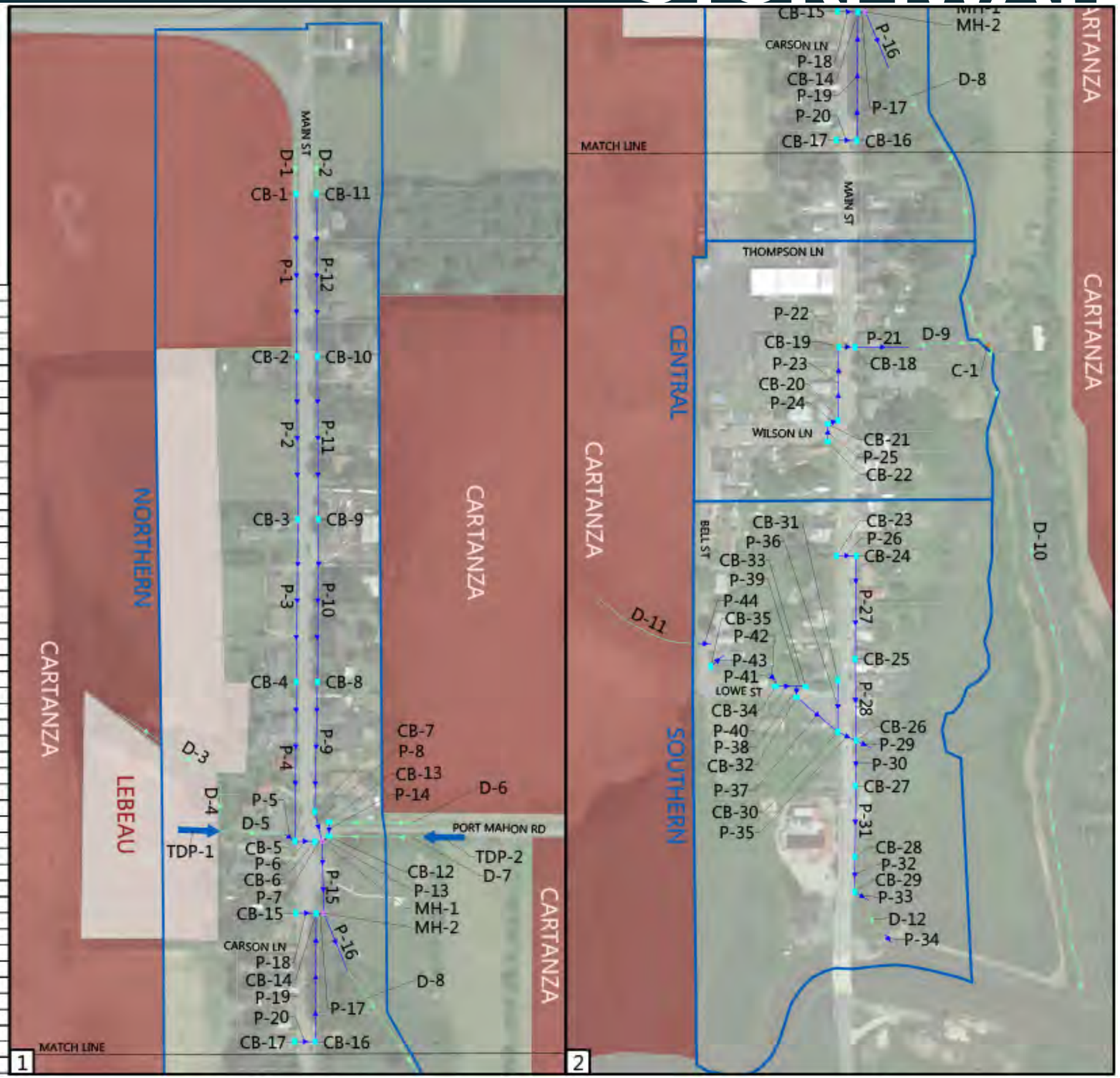
CRDS COASTAL RESILIENCE DESIGN STUDIO

0 180 360

Scale: 1" = 180'

Little Creek Stormwater Pipe Inventory

	Pipe	Diameter (in.)	Length (L.F.)	Type	Notes
Northern	P-1	-	~400	-	Assumed connections; Possibly inaccurate
	P-2	-	~400	-	Assumed connections; Possibly inaccurate
	P-3	-	~400	-	Assumed connections; Possibly inaccurate
	P-4	-	~395	-	Assumed connections; Possibly inaccurate
	P-5	~36	~32	CMP	Info from DelDOT Contract 65-10-011
	P-6	24	~30	RCP	Info from DelDOT Contract 65-10-011
	P-7	24	~5	RCP	Info from DelDOT Contract 65-10-011
	P-8	18	75	RCP	Info from DelDOT Contract 65-10-011
	P-9	-	~320	-	Assumed connections; Possibly inaccurate
	P-10	-	~400	-	Assumed connections; Possibly inaccurate
	P-11	-	~400	-	Assumed connections; Possibly inaccurate
	P-12	-	~400	-	Assumed connections; Possibly inaccurate
	P-13	18	32	RCP	Info from DelDOT Contract 65-10-011
	P-14	18	40	RCP	Info from DelDOT Contract 65-10-011
	P-15	30	~170	RCP	Info from DelDOT Contract 65-10-011
	P-16	30	150	RCP	Outlet ditch (D-8) silted-in
	P-17	-	12	ACCMP	Info from DelDOT Contract 65-10-011
	P-18	18	30	RCP	Info from DelDOT Contract 65-10-011
	P-19	22"x13"	307	ACCMP	Info from DelDOT Contract 65-10-011
	P-20	18	30	RCP	Info from DelDOT Contract 65-10-011
	TDP-1	~8	-	PVC	Tile Drainage Pipe (Cartanza); LeBeau lawsuit
	TDP-2	-	-	-	Tile Drainage Pipe (Unknown)
	C-1	18	25	ABBC-CMP	Culvert; Two pipes, same size; Partially Collapsed
Central	P-21	18	133	RCP	Info from DelDOT Contract 65-10-011
	P-22	18	~30	RCP	Info from DelDOT Contract 65-10-011
	P-23	15	186	RCP	Info from DelDOT Contract 65-10-011
	P-24	15	24	RCP	Info from DelDOT Contract 65-10-011
	P-25	15	34	RCP	Info from DelDOT Contract 65-10-011
Southern	P-26	15	30	RCP	KCD inspected; Joint Offset; Debris
	P-27	18	244	RCP	KCD inspected; Infiltration runner; Debris
	P-28	18	189	ABBC-CMP	KCD inspected; Significant corrosion
	P-29	18	20	ABBC-CMP	KCD inspection incomplete; Backflow from marsh
	P-30	18	~103	RCP	KCD inspected; Infiltration runner/ring broken
	P-31	18	~173	RCP	KCD inspected; Infiltration runner/dripper; Debris
	P-32	-	~100	-	-
	P-33	~18	~32	CMP	-
	P-34	~30	-	HDPE-DWCP	-
	P-35	18	~33	ABBC-CMP	KCD inspected; Lost BC
	P-36	18	~138	ABBC-CMP	KCD inspection incomplete
	P-37	12	~147	RCP	KCD inspection incomplete
	P-38	15	-	RCP	KCD inspected; Blind Junction w/ P-39, P-40
	P-39	-	-	-	KCD inspected; Blind Junction w/ P-38, P-40
	P-40	-	-	RCP	KCD inspected; Blind Junction w/ P-38, P-39
	P-41	15	-	RCP	KCD inspected
	P-42	15	-	RCP	KCD inspected; Unknown connection
	P-43	-	-	-	KCD inspected; Unknown connection
	P-44	12	-	RCP	Unknown connection; Possibly removed



Soils

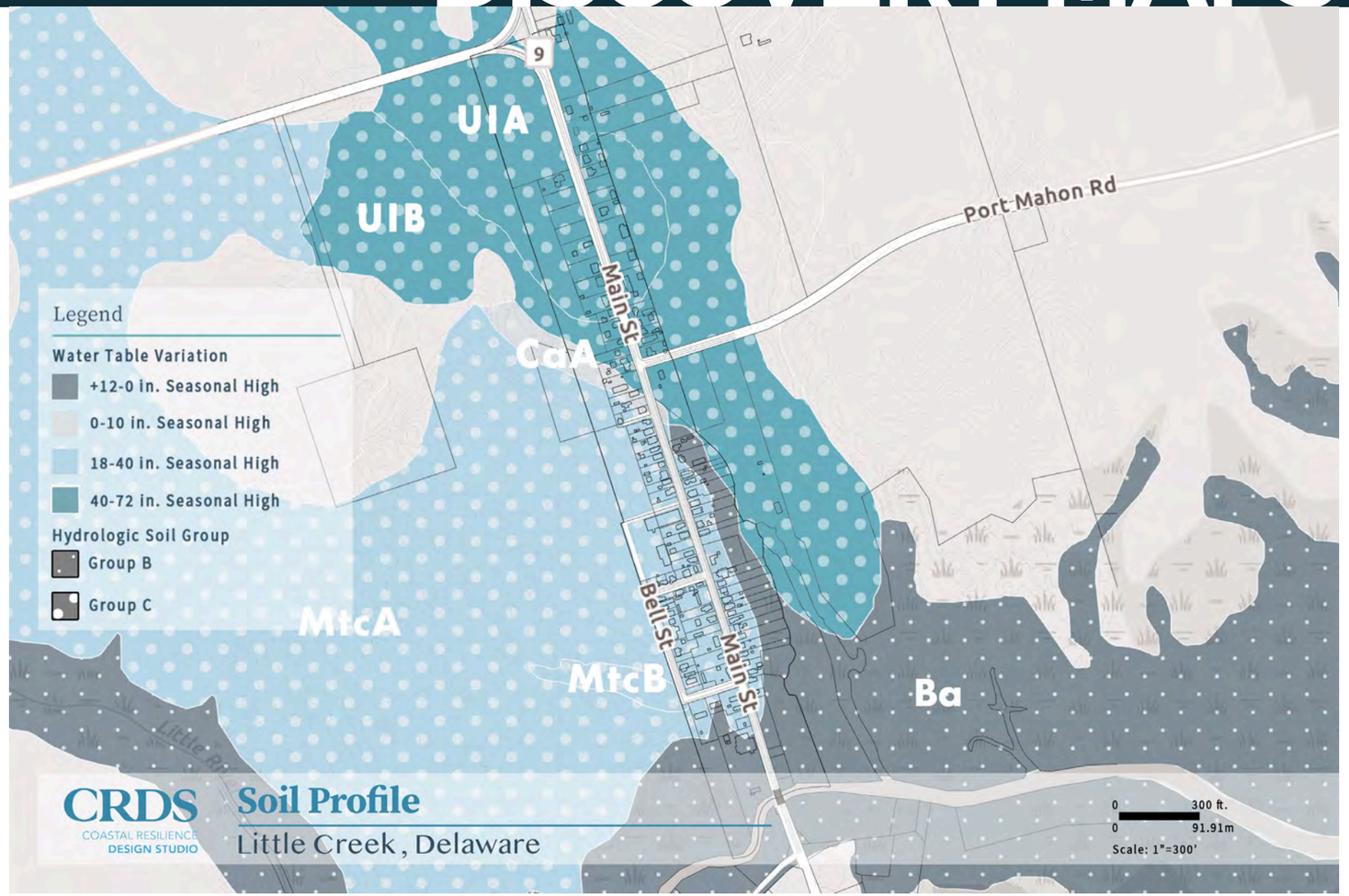
The soils underlying Little Creek include four loams listed below. These coastal soils have been formed by tidal deposition of sediment consistent with slow rising of sea levels, allowing for a natural conversion of habitat from forest to shrubland, and eventually marsh. This naturally occurring cycle of gradation has led to the development of the many rich soils prevalent in the region; however, increased rates of sea level rise prevent the natural deposition and are leading to erosion and lack of natural transition zones between habitat types.

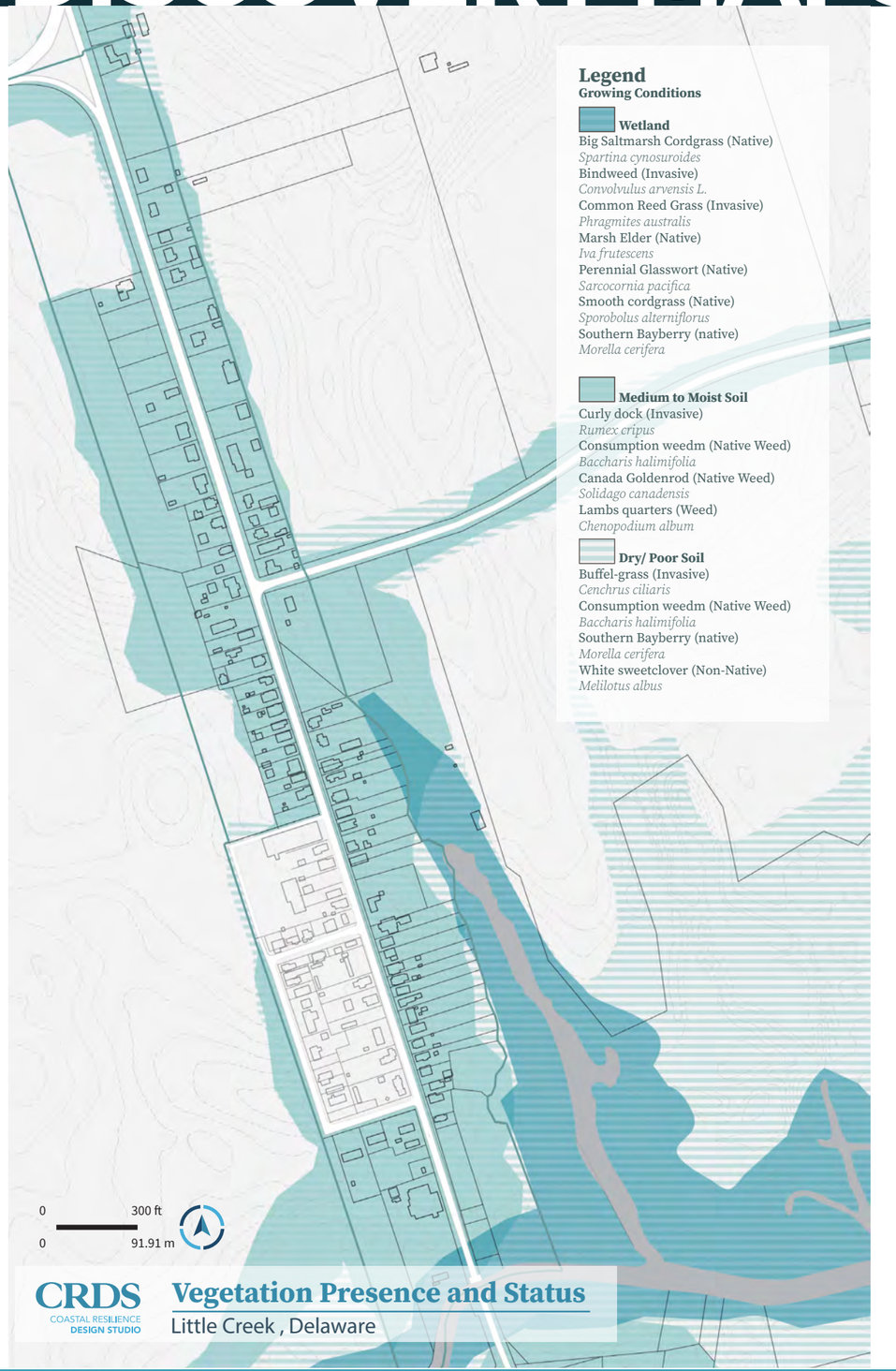
Ba Broadkill-Appoquinimink Complex
Very poorly drained
Not prime farmland
Landform: Estuarine tidal salt marshes--flooded twice daily by tides and occasionally by storm surges
Runoff class: Negligible
Frequency of flooding: Very frequently flooded
Available water storage: Very shallow, permanent
Depth to Seasonal high Water Table: +12 to 0 inches, January to December and continuously saturated with water and flooded twice daily by tides
Hydrologic soil group: D

Mt Mattapex silt loam A & B
0% to 5% slopes
Moderately well drained
Landform: Flat, depression, swale, marine terraces and uplands
Runoff class: Low to high
Frequency of flooding:
Available water storage: Moderately deep and common
Depth to Seasonal high water table: 46 to 102 cm (18 to 40 inches), January to April with wide seasonal fluctuation
Hydrologic soil group: C

UI Unicorn loam A & B
0% to 5% slopes
Well drained
Landform: Flats, coastal plain, knolls, terraces
Runoff class: Low
Frequency of flooding: None
Available water storage: Deep, common
Depth to Seasonal high water table: 102 to 183 centimeters (40 to 72 inches) from January to May
Hydrologic soil group: B

Ca Carmichael Loam A
0% to 2% slopes
Poorly drained
Landform: Flats and depressions
Runoff class: Low
Frequency of flooding: No flooding, occasional ponding
Available water storage: Very shallow, common (3 to 6 months)
Depth to Seasonal high water table: 0 to 25 centimeters (0 to 10 inches), January to May
Hydrologic soil group: C





Vegetation and Invasive Presence

Wetlands

Wetland habitats native to this region are composed mostly of brackish marsh species, Spartina alterniflora. The most common threats to the health of tidal wetland environments are forest harvesting, invasive plant species, excavation, filling, ditching, and the development of agriculture in and around these wetland habitats. It is important to understand the variety of plant species in a wetland and why native plants are important to support the marsh, and how invasives contribute to a decline in marsh health.

Just west of the Little Creek residential area, sits four brackish water marshes owned by the state of Delaware as an official wildlife area. The impoundments include the center marsh (146 acres), the north marsh (424 acres), the south marsh (472 acres), and the southwest marsh (155 acres), totalling in 1,197 acres of wetland in the Little Creek area.

Native plants are natural occurring plants found in a specific region. These uncultivated plants adapt to the surrounding environmental conditions, and therefore, favorably contribute to the region's ecosystem. Through time, as the plant adapts to an ecosystem and environment, the surrounding wildlife does the same. Insects adapt to specific natives for energy consumption and habitat. For example, native monarch butterflies (Danaus plexippus) are specialists when it comes to plant species. They rely on the nectar from the Common Milkweed plant (Asclepias syriaca) for nourishment.

An invasive plant on the other hand is a plant that is non-native or alien to the specific region. An invasive plant thrives in the region as it takes over and disrupts the ecosystem. With rapid growth and reproductive rates, invasive plants inhibit surrounding plants' growth. Unlike native plants, invasive plants do not provide the energy and habitat requirements for wildlife that have been adapting to the same region over time. An example is the Common Reed Grass (Phragmites australis). The plant is non-native, spreads fast, limits growth of other plants, and contributes little to the wildlife in the area.

Not all non-natives are invasive. As the name states, a non-native plant is an alien to a specific region. Invasives can thrive in the environment it was introduced in, while some introduced plants do not thrive well naturally in the introduced region. Many non-native plants cannot survive without the help of humans, and are often annuals in nature because they were found in different growing conditions. The Petunia is an example because the plant cannot survive itself during the winters on the East Coast.

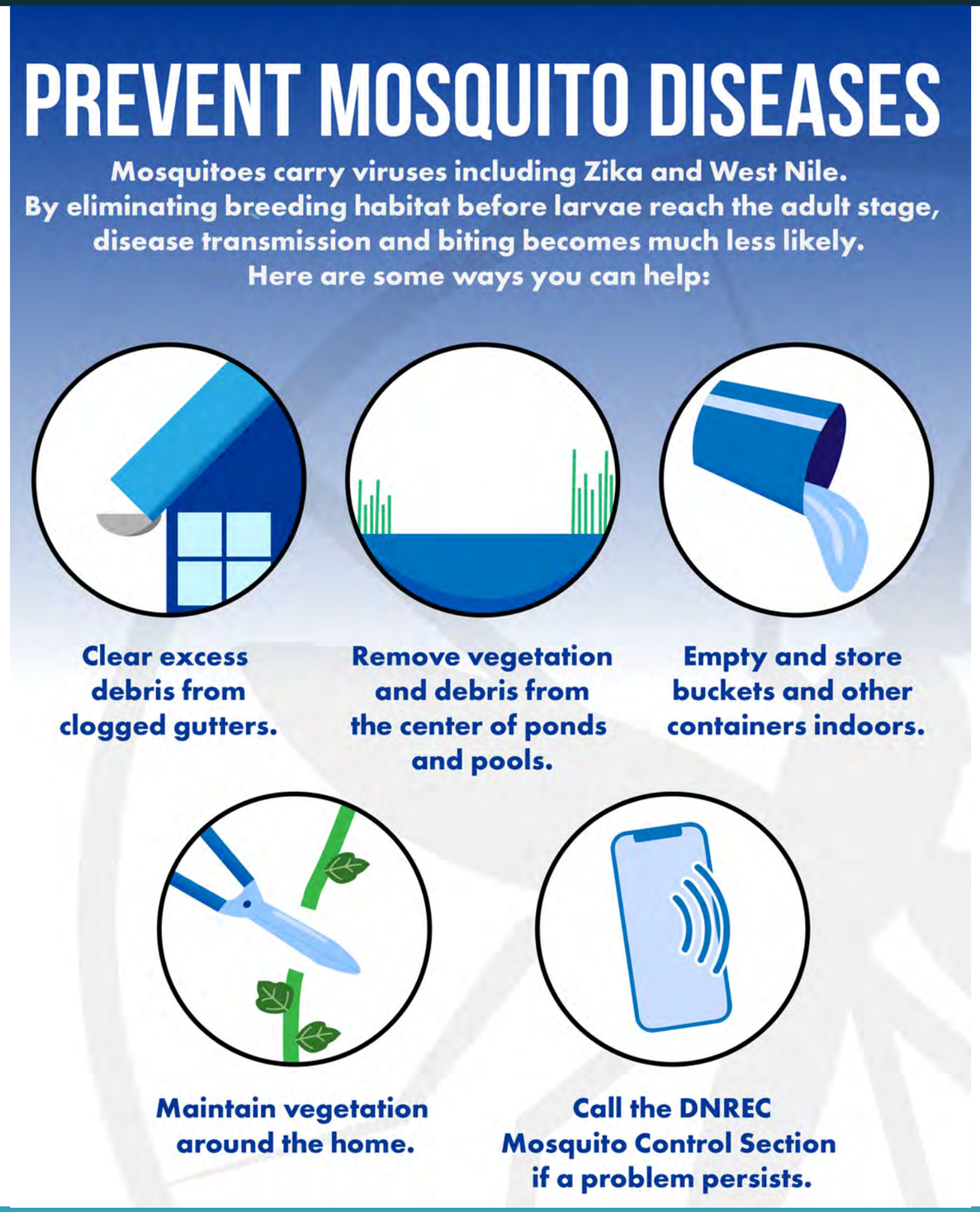
A weed on the other hand can be a native or non-native plant. A plant is considered a weed if it is not desired in the area focused on, and competes with other desired plants in a landscape. An example can be the native Oxalis. Oxalis will often show up in a landscape and compete with the other plants. Though the Oxalis is native, it is typically unwanted.

Hazard Overlay Zones

Hazard overlay zones are areas that enforce additional regulation on top of existing zoning. These regulations help to protect lives, property, and environments threatened by recurring issues, like wildfire and flooding. The Town of Little Creek is already subject to a hazard overlay zone. The Kent County Airport Environs Overlay Zone ensures that homes are insulated against air traffic noise in certain zones (Little Creek, Delaware Comprehensive Plan, 2016). These regulations secure the safety and comfort of residents.

In the Little Creek Comprehensive Plan, the town calls for a new hazard overlay zone to expand floodplain requirements and floodproofing actions (Little Creek, Delaware Comprehensive Plan, 2016). The Federal Emergency Management Agency (FEMA, n.d.) already has established Special Flood Hazard Areas in the town to protect areas that are subjected to periodic inundation (FEMA, n.d.). The town, in turn, has recommended the adoption of flood hazard areas in accordance with the FEMA hazard areas in the Floodplain Requirements Ordinance (Little Creek, Delaware Comprehensive Plan, 2016). A new hazard overlay zone would build upon these existing town codes to protect human lives and health, natural environments, properties, and commerce.

According to the current FEMA Special Flood Hazard Areas in Little Creek, Zone AE (the 100 year floodplain) contains 48 residential buildings, 4 commercial buildings, and 4 public structures (Little Creek, Delaware Comprehensive Plan, 2016). These properties have a 26% chance of being flooded during a typical 30-year mortgage period (Little Creek, Delaware Comprehensive Plan, 2016). Areas in Zone AE are at high risk of experiencing flooding. Zone X in Little Creek, or the 500 year floodplain, contains 34 residential buildings and 1 public structure (Little Creek, Delaware Comprehensive Plan, 2016). These properties are at a 6% risk of being flooded during a 30-year mortgage period (Little Creek, Delaware Comprehensive Plan, 2016). . Despite the implementation of FEMA and local flooding guidelines, the town still faces recurring inundation. Further hazard zoning, along with other items identified by the town like wetland restoration, would mitigate current floodings issues and projected SLR risks.



Mosquito Control

Like many coastal states, Delaware must continually monitor and control a persistent mosquito population. According to DNREC, there are 57 known species of mosquito present in Delaware, including 19 "bad actor" species. Of these "bad actors," there is a particular subset which presents problems to Little Creek. The Asian tiger mosquito (Aedes albopictus), common house mosquito (Culex pipiens), floodwater mosquito (Aedes vexans) and salt marsh mosquito (Aedes sollicitans) have the potential to act as vectors for several viral diseases including Zika, West Nile, and Eastern Equine Encephalitis (EEE) (DNREC). Little Creek may be at an elevated risk for annual mosquito population growth due to standing water present throughout the community. The increased risk presented by the landscape requires proper precaution taken to control and monitor mosquito populations when working with the land, and especially when altering or adding bodies of water, including retention ponds and detention basins.

MOSQUITO CONTROL STRATEGIES

Several strategies for mosquito control have been implemented in Delaware in the past, including dredging of wetlands in the mid-20th century and insecticide spraying, which continues today in cities including Bethany Beach (DNREC, 2019). Both of these strategies, however, are mostly ineffective in the long term (DNREC, 2013). Targeting mosquitoes in wetland areas does not address the vast majority of populations, which mostly thrive in non-wetland areas such as small ponds and containers created by humans (EPA, 20XX). According to DNREC, "Biological control provides more permanent mosquito control than chemical insecticides, resulting in a substantial reduction in insecticide applications and costs".

In retention ponds, a biological solution might involve several different approaches. Many biological solutions focus on controlling mosquitoes' larval stage due to the relative ease of managing these populations as compared to adult mosquitoes (EPA, 20XX). According to the EPA, "Aquatic stages of many mosquito species require 7-10 days in calm, standing water." However, some species only require 3-4 days. Several species also require vegetative growth on the surface of the water. Several steps to avoid the occurrence of these conditions are detailed below.

The first step must be to maintain adequate depth in the pond. Most mosquito larvae need just a few inches of water to survive, but can not survive when water depths surpass 3 feet (EPA, 20XX). Installing a fountain can also help discourage larvae establishment. Healthy pond systems have slight wave action at the surface, and a fountain can help simulate this (Clemson, n.d.). Skimming excess vegetative growth in the center of the pond creates less favorable conditions for some mosquito species which use this growth as cover (EPA, 20XX).

There are several other approaches to biological control to consider and implement concurrently with the primary strategies. First, introduce natural predators. According to Clemson University, fish including bluegill (Lepomus macrochirus) and largemouth bass (Micropterus salmoides) help decrease mosquito larva populations. DNREC sometimes recommends the stocking of mosquitofish (Gambusia) to reduce larval survival. It should be noted that retention ponds are not ideal habitat for fish, and stocked fish require maintenance such as general monitoring, and sometimes harvesting. The addition of a fountain is helpful in maintaining fish populations as it will aerate the water; however, rapid temperature and water level variation inherent in retention basins may lead to poor fish health, or even kill events.

Outside of the pond, other measures can decrease favorable conditions for larvae. For example, avoid regularly mowing around the pond as repeated mowing may lead to the formation of ruts in the ground, which may fill with water and become host sites. As an added precaution against pooling water on the edge of the pond, the surrounding ground should slope steeply into the pond if possible. Diverse plant communities can also be encouraged on the periphery of ponds in an attempt to support amphibians, and therefore, increasing predation on mosquitoes.

COMMUNITY OUTREACH STRATEGIES

In addition to designing a biological system conducive to mosquito control, community outreach is also an important step. There are many examples of good water sanitation practice that residents can take in their own yards. Storing buckets indoors and draining flower pots, unused tires, garbage cans and their lids, tarps, fire pits, and other objects present in the yard regularly can all reduce breeding sites and cover for mosquitoes. It is also important to monitor ornamental ponds, swimming pools and their covers, uncovered boats and other containers that regularly hold water for emergent mosquito populations. Where possible, homeowners can try adding fountains or fish to ponds, and should monitor vegetative growth on the surface of all water containers. If a mosquito problem persists after a resident has taken all of the precautionary steps, they should contact DNREC's Mosquito Control Section. Residents of Northern Delaware should contact the Glasgow office by calling 302.836.2555. Residents of Southern Delaware should contact the Milford office by calling 302.422.1512.

CONCLUSION

The mosquito population of Little Creek is not likely to be controlled through the management of standing water in broad land areas. While regulation of local stormwater retention ponds is necessary to help maintain numbers, the best thing the town can do is reach out to its residents for help. Residential properties are often prime mosquito breeding habitat due to the amount of opportunities for water to collect in objects like tires, bird baths, wheelbarrows, flower pots, discarded beverage containers, clogged rain gutters, buckets, trash cans and trash can lids, pools, ponds, and other containers which may be present in the yard. The improvement of mosquito control in Little Creek will mostly be dependent on managing these risks. Asking that residents move buckets, wheelbarrows and tires indoors or under cover, clear rain gutters, maintain proper depth and water movement where possible in pools and ponds, drain flower pots and bird baths regularly, cover trash cans, and maintain vegetation on their property is crucial. All of these steps will greatly reduce mosquito breeding habitat in town, and will ultimately be very effective in regulating larval populations before they reach the adult stage, which is the most difficult to control. If the town is able to implement a successful larval control strategy, there is a large potential for financial savings on the control of adult mosquitoes.

Asian tiger mosquito (Aedes albopictus)

common house mosquito (Culex pipiens)

floodwater mosquito (Aedes vexans)

salt marsh mosquito (Aedes sollicitans)

Wildlife of Delaware's Tidal Marshes

The Little Creek area offers a diverse and rich habitat for native wildlife. The areas 1,197 acres of brackish water tidal marsh provides home to waterfowl and aquatic life. Little River, a tributary to the Delaware Bay, enters through the south part of town. The river and bay offers a safe haven for aquatic wildlife that drift from the ocean to develop and feed as the tide comes in. The land should be protected to provide for local enjoyment and to enhance tourism opportunities to view wildlife.

Eastern oyster* *Crassostrea virginica*

Eastern oyster*

Crassostrea virginica

Eastern oysters are in the mollusca division that live along the East coast ranging from Canada to the Gulf of Mexico.

Horseshoe Crab

Limulus polyphemus

Horseshoe crabs are marine arthropods that live in brackish water environments. According to Shuster, horseshoe crabs can withstand extreme temperatures, salinity, pH, dissolved oxygen and anoxic sediments (Shuster 1982). They also require a sandy or muddy floor to bury themselves, and a sloped shoreline for reproduction. Horseshoe crabs typically move by crawling on the water body floor. If needed, horseshoe crabs can swim upside down for a short time.

Horseshoe Crab
Limulus polyphemus

North of Little Creek along Port Mahon Rd, the beach is covered in remains of concrete and brick structures, also known as riprap . There are hundreds of dead horseshoe crabs from when they reach the shore line during high tide, and are trapped in the crevices left behind when the tide goes back out. Riprap is a popular erosion control method along streams, river beds and coastal areas. Unfortunately, in this case, it replaces the shoreline habitat horseshoe crabs need to reproduce

Diamondback Terrapin

Malaclemys terrapin

Diamondback terrapins are aquatic turtles native to Delaware and the east coast of North America. They are found in brackish water like bays and tidal marshes. According to the U.S. Fish & Wildlife Service, diamondback terrapins require access to freshwater along with their brackish water habitat.

Diamondback Terrapin
Malaclemys terrapin

The population is decreasing and considered vulnerable. The main source of the population decline is habitat destruction, harvesting, and being hit by cars.

Although terrapins typically spend most of the day in water, the females leave the water for land to nest. A female ready to lay eggs will travel far on land to find a suitable nesting site. Females typically lay eggs in a sandy or shrubby area which results in them crossing roads. If disturbed, the female will abandon the nest for a long period of time and leave the eggs vulnerable.

Atlantic Marsh Fiddler Crab

Uca pugnax

Atlantic marsh fiddler crabs are arthropods in the ocypodidae family (same family as ghost crabs). These small crabs' carapace (main shell) grows to about 1.5" wide for males, and 1" for females (Vinton). They are recognized for their drastic difference in claw size, with one small claw and one large claw.

Atlantic marsh fiddler crabs are native to Delaware and the mid-atlantic coast area, and typically live in salt marshes. The crabs create burrows up to around 3" in the mud for mating, protection for predators and the surrounding environment, and hibernation. Depending on substrate type the burrows can range from 1 to 3' in depth; the more sand mixed in, the shallower the burrow. The fiddler crabs diet consists of waste matter and debris found in their habitat. Larger fish and even blue crabs prey on fiddler crabs.

Atlantic Marsh Fiddler Crab *Uca pugnax*

Summer Flounder
Paralichthys dentatus

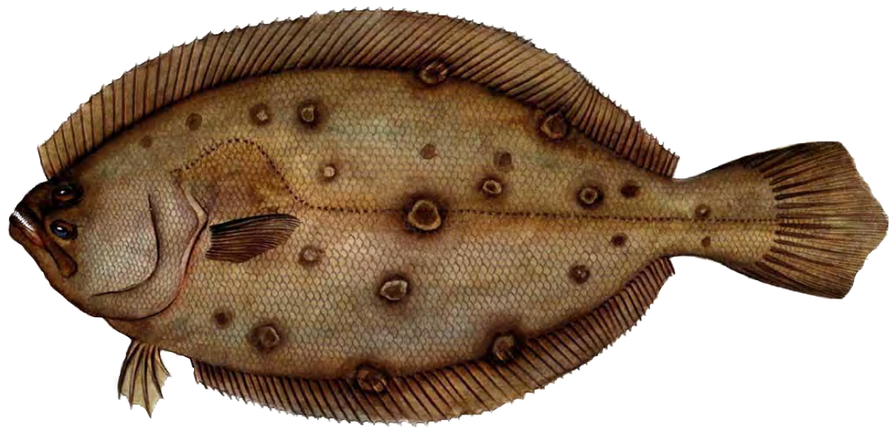
Summer flounders are fish found in the mid-Atlantic whose range extends from North Carolina to Massachusetts. They can grow anywhere between 10-20” in length, are flat with both eyes on the top side of the fish’s body and are brown with darker hued spots. Summer flounders typically feed on smaller fish and squid.

For spawning, the flounder typically require deeper depths from 100 - 600’. The larvae drift into bays (such as the Delaware Bay) and live there for the first year to grow up in size.

Summer flounders are a popular fish for fishing and are not at risk of being overfished.

Barnacles
Balanus glandula
This is a subspecies of the acorn barnacle. They are a type of shrimp that is covered in limestone. This crustacean is found on the west and east coast of North America, typically on rocks using a self made cement to attach themselves to the surface. They feed on cirri which includes plant particles and plankton.

White perch
Morone americana
White perch are small fish that live in freshwater and brackish water. They feed on smaller fish, insects and zooplankton. They are also preyed upon by larger fish such as bluefish and striped bass according to the Chesapeake Bay Program. White perch are very common but still an important part of the Delaware Bay’s food web and ecosystem.



Summer Flounder
Paralichthys dentatus

Barnacles
Balanus glandula

White perch
Morone americana

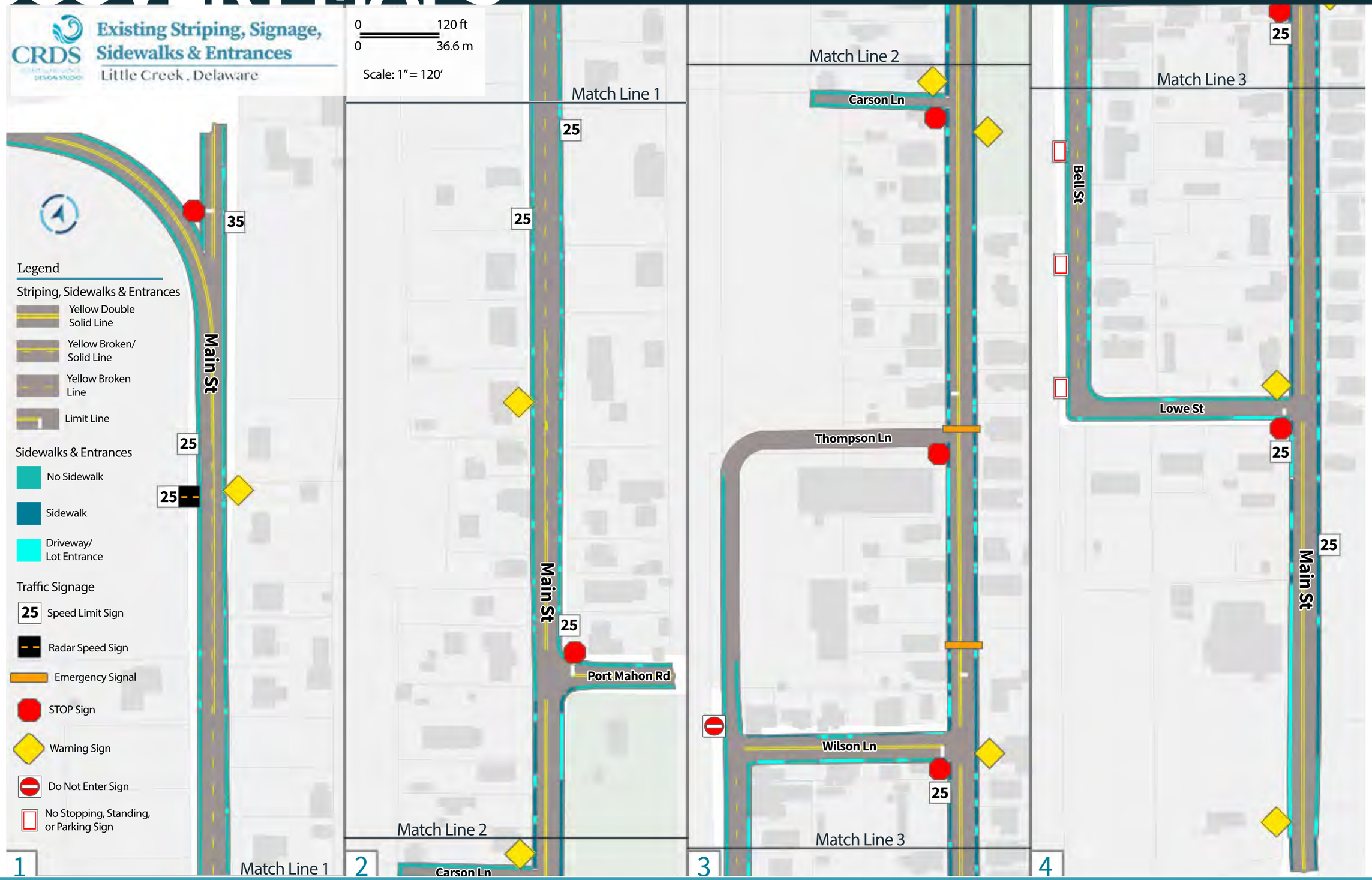
Conclusion

The bay, creek, and surrounding area provide a diverse environment for a variety of wildlife. The Little River provides a smaller yet still complex environment for a variety of common fish including white perch, summer flounder and minnows. Saltwater marine life, such as summer flounders, need the brackish Little Creek watershed to mature. Crustaceans also depend on the area: the Atlantic marsh fiddler crab population has developed a successful habitat near the Little Creek boat dock.

Along Port Mahon Rd, the riprap used for coastal erosion contributes to the demise of horseshoe crabs; the crabs are trapped within the riprap. Also on the decline is the diamondback terrapin due to over harvesting and habitat loss. Since the saltmarsh is near the bay, diamondback terrapins use the area for spawning. With slower traffic speed and innovative roadway enclosures, the area could be safer for the terrapins.

Other than issues with weedy and invasive plant species, Little Creek is a healthy environment for local wildlife.

DISCOVERY MAPS



Traffic Study

The Town of Little Creek's location along Route 9, a major collector according to DelDOT's functional classification map, means that regional traffic through the town is common (DelDOT Functional Classification, n.d.). Entering Little Creek, the road name changes from Bayside Drive to Main Street. DelDOT's published 2019 Vehicle Volume Counts reports that the average annual daily traffic (AADT) along Main Street is 1976 veh/d (Kent County Delaware Vehicle Volume Summary, 2019).

Main Street is a straight, two lane, two way road with an approximate width of 30 ft along its entire length. The majority of this traffic is traveling southbound and the road lanes were sized accordingly. The southbound lane is 12-ft along the entire length of Main Street. North of the Main Street and Port Mahon Road intersection, the northbound lane is not restricted by a shoulder lane. South of this intersection, the northbound lane is 10-ft wide and an 8-ft shoulder lane is striped for on-street parking. There is a hatched no-parking area within the shoulder across from the Little Creek Fire Station, which is situated between Thompson Lane and Wilson Lane. Presumably, this is to provide fire trucks space to back into the station.

There is a passing lane within town limits north of the Main Street and Port Mahon Road intersection (image on page 80). It should be noted that this image does not include the shoulder lane striping south of this intersection to maintain readability.

The posted speed limit along Main Street is 25 mph. The speed limit immediately north and south of the town is 35 mph. Traveling south on Route 9 into Little Creek, there is a STOP sign. There are also STOP signs at the intersections of all auxiliary roads along Main Street, including Port Mahon Road, Carson Lane, Thomson Lane, Wilson Lane, and Lowe Street. These and the remainder of the town's existing signage can be seen in Figure X. Much of this signage in town relates to the Little Creek Fire Company.

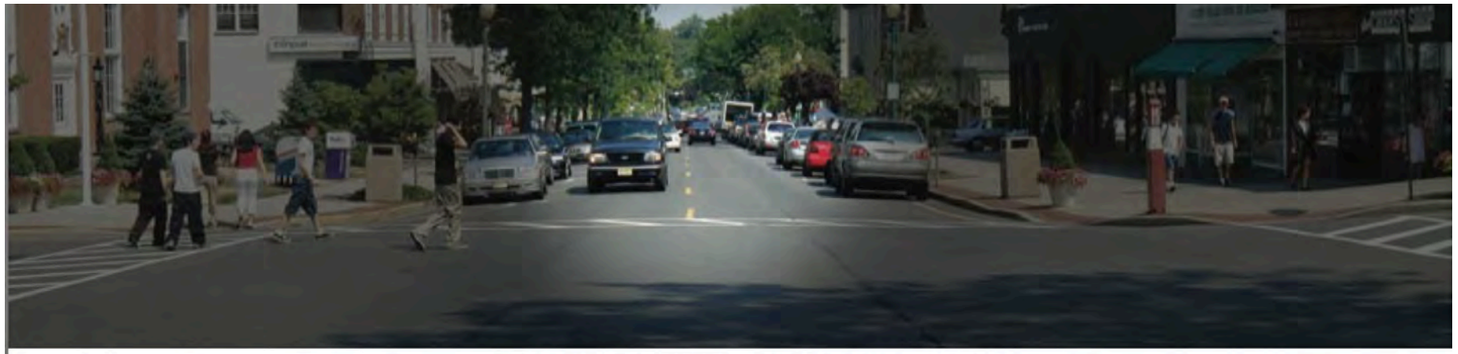
There is a radar speed sign along the southbound lane near the north entrance of the town. Currently, this is the only form of traffic-calming within Little Creek.

According to the Town of Little Creek's 2016 Comprehensive Plan, residents have expressed concerns about heavy truck traffic and vehicle speeds through the town (Comprehensive Plan, 2016). The close proximity of houses to Main Street, coupled with speeding vehicles, threatens residents' safety as well as the town's livability.

Truck traffic makes up approximately 14% of the overall through-traffic volume (Comprehensive Plan, 2016). It is assumed that most of these trucks are transporting fuel from the Delaware Storage Pipeline along Port Mahon Road to the Delaware Air Force Base (DAFB), located southwest of Little Creek. Consistent, high volumes of heavy truck traffic increase the frequency that road maintenance is required and inhibits the town's goal of becoming pedestrian-friendly. Additionally, emissions from truck traffic are directly tied to Little Creek residents' air quality concerns (Comprehensive Plan, 2016).

The issue of speeding vehicles through the town has been substantiated by a four month DelDOT traffic study from February to May 2020. Page 36 displays the collected data which includes the daily number of vehicles passing through the town and their speed. According to the data, an average of approximately 64% of vehicles were recorded traveling at a speed greater than 29 mph. Additionally, an average of 1.21% of vehicles per month were traveling at a speed greater than or equal to 50 mph.

It should be noted that during this traffic study, Delaware Governor John Carney issued a stay-at-home order for all non-essential business workers beginning on Tuesday, March 24, 2020 in response to the COVID-19 pandemic (Governor Carney Issues Stay-at-Home Order for Delawareans, 2020). While this resulted in a lower total number of vehicles during the months of April and May compared to February and March, the percentage of vehicles traveling at speeds greater than 29 mph remained consistent. This study confirms the town's anticipated need for traffic calming measures.



PERIPHERAL VISION AT 40+ MPH

Traffic Calming: Improved pedestrian and cyclist safety

PERIPHERAL VISION AT 20-25 MPH

Traffic-calming measures are necessary to address residents' concerns while maintaining existing access to residential and commercial entrances. Additionally, traffic-calming should promote Little Creek's commercial redevelopment through the creation of safe, accessible pedestrian walkways around town. According to DelDOT's American's with Disabilities Act (ADA) Inventory and Assessment Map, nearly all driveways, as well as some portions of the sidewalk, are not compliant with ADA standards (DelDOT ADA Inventory & Assessment, 2012).

Proposed traffic-calming measures should cause minimal interference with emergency vehicle response time and road maintenance vehicles such as snow plows. The majority of on-street parking spaces along Main Street should remain after implementation of traffic-calming measures. Under no circumstances should proposed traffic calming measures exacerbate flooding. Ideally, steps should be taken to ensure that any new infrastructure along Main Street improves drainage.

Possible traffic calming measures discussed during a community outreach event included medians, curb bump-outs and crosswalks at intersections of Port Mahon Road, Wilson Lane, and Lowe Street. Reducing road widths at intersections through re-striping was also discussed (Comprehensive Plan, 2016).

COMPLETE STREETS

ACTIVE SIDEWALKS

Sidewalks should be smooth, wide, feel safe, and have appropriate transitions to the street, making them easy to walk or use a wheelchair on

DEDICATED BIKE LANES

Simple pavement markings creating a dedicated bike lane make both motorist and bicycle movement more predictable, and therefore safer for both. They may increase the likelihood of casual riders using bicycles for transportation

ACTIVE ROADWAY

One lane of car traffic going in each direction with a two-way-left-turn-lane (TWLTL) in the center would reduce the amount of car crashes on Government Street by providing turning vehicles a refuge from through traffic, while keeping through traffic moving more efficiently

SAFE CROSSWALKS

Clearly marked crosswalks allow pedestrians and wheelchair users to cross streets safely, while making sure cars know where to expect them

PLANTING STRIP

Street trees and landscaping slow speeding traffic, improve the aesthetics of the roadway, provide shade, and create a buffer between cars and people, making a more inviting environment for pedestrians

GREEN SPACES

Parks and public green spaces create a destination, encouraging community interaction and providing a rest from the surrounding urban environment

COMPLETE STREETS

Complete Streets are streets for everyone.

They are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities.

Complete Streets make it easy to cross the street, walk to shops, and bicycle to work.

Creating Complete Streets means transportation agencies must change their approach to community roads.

Smart Growth America
Making Neighborhoods Great Together

DESIGN CONSIDERATIONS

Little Creek Watershed

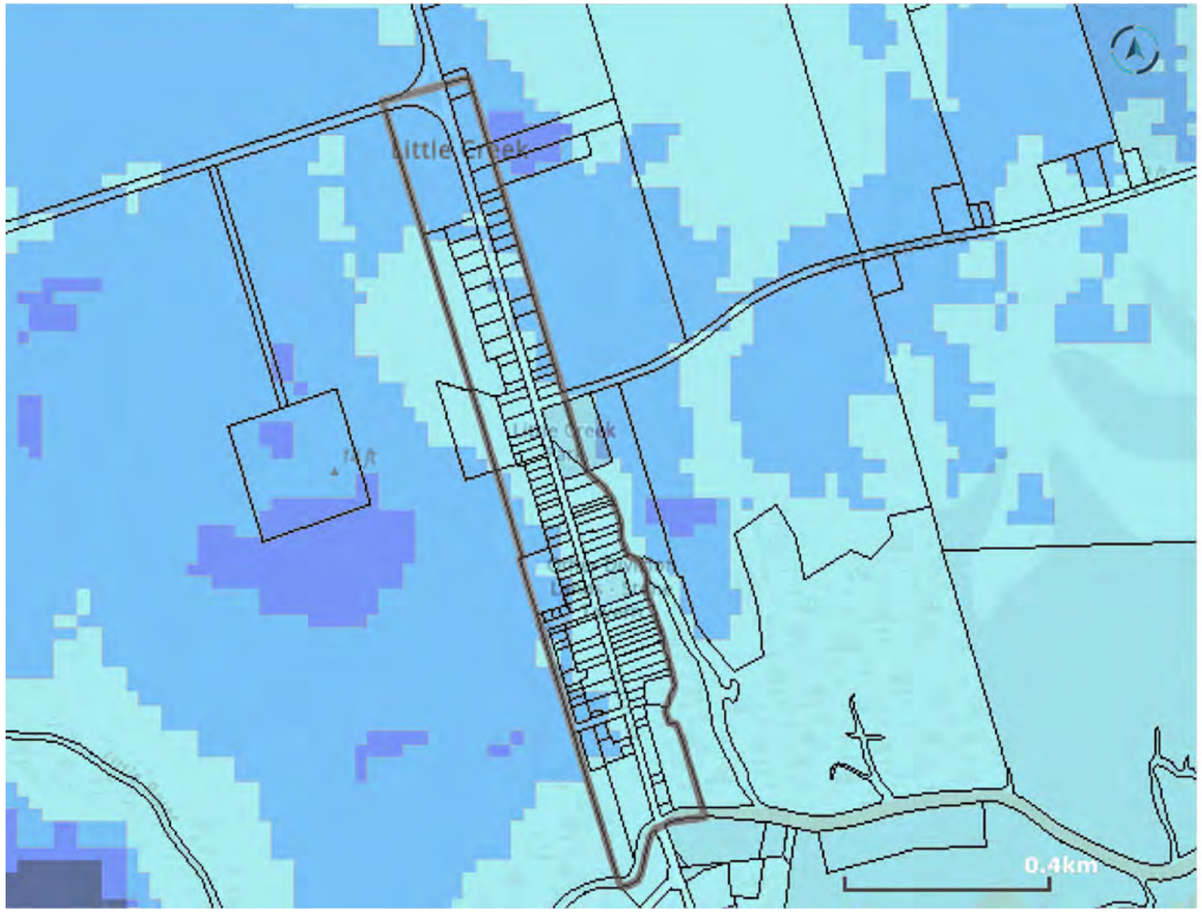
The Little River receives inputs from mostly nonpoint sources of pollution throughout the watershed. Nonpoint source pollution is contamination from diffuse sources, such as urban runoff. Nitrogen and phosphorus pollution stem from agricultural fertilizers and feedlots, while bacterial inputs are mainly from animal feedlots, domestic pet wastes and septic systems. There are two contaminant sites within the watershed that are currently under investigation or remediation including the Dover Air Force Base and the Wildcat Landfill, located along the watershed's southern border. Both sites pose risks of releasing potentially hazardous waste substances into the surrounding environment with substantial risk to ground and surface waters. Contaminants of concern include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls, and metals (Delaware Watersheds, n.d.).

Groundwater Recharge

Approximately 40% of the substrate in town limits has been designated as having 'excellent groundwater recharge', meaning that it is composed of high amounts of gravel and sand that allow water to infiltrate. Recharge areas are generally protected as a water resource, however, Little Creek does not have local source water protection regulations or limits to impervious cover in new development within these zones (Comprehensive Plan, 2016). Directing flows to these recharge areas and implementing green infrastructure will increase absorption of stormwater, reducing floods, improving water quality, and replenishing groundwater supply.

Impervious Surfaces

Impervious surfaces including roads, buildings, sidewalks, and parking lots cover ~8.9% of the land in the greater Little Creek Watershed and include portions of the Dover Air Force Base as well as residential developments in the city of Dover (USGS Streamstats, n.d.). Impervious surfaces have a direct impact on the town's water quality and quantity as they prevent infiltration of rain water to the groundwater aquifer and contribute to flooding.



Depth to Water Table

Little Creek, Delaware

Legend

Delaware Municipalities

Delaware Kent County Parcels

Delaware DGS Depth To Water - NORMAL

- 0 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 16 ft
- 16 - 20 ft
- > 20 ft

CRDS COASTAL RESILIENCE DESIGN STUDIO

Domestic Utilities

Residents of Little Creek use fresh water wells that draw from a surficial confined aquifer. There is no current public water supply, though ~28% of survey respondents felt there was a need for a public water system (Comprehensive Plan, 2016). According to the USGS, "Ground water in surficial aquifers is exchanged with surface water, maintains stream base flow, and supports sensitive wetland ecosystems;" therefore, the contamination and protection of the surficial aquifer is both a public health and environmental concern. In addition to contamination from agricultural and urban runoff, private wells are susceptible to intrusion of saltwater as sea levels rise (SLR). The comprehensive plan notes that the 'medium' and 'high' SLR scenarios pose the greatest risk to town residents (Comprehensive Plan, 2016). Implementation of a public water system is cost-prohibitive for the town, so short-term mitigation strategies for preventing saltwater intrusion into drinking water wells must help to maintain balance between recharge and use (Solonist, n.d.). Options for increasing recharge include conserving water, reducing impervious surfaces, and increasing vegetated space. According to The Delaware State website, the responsibility of evaluating water safety falls on private well owners, and "both the US EPA and the Centers for Disease Control And Prevention recommend annual sampling to ensure optimal water quality" (Delaware.gov, n.d.). Testing kits are available for $4 at the Thomas Collins building in Dover and test for chemical (including sodium) and bacterial contamination.

The town uses both private septic systems and a public sanitary sewer service to collect and treat sewage. The town has two pumping stations that lead to the Kent County Wastewater Treatment Plant in Dover. Removing septic systems will help reduce bacterial runoff and pollution of the Little Creek Watershed.

Sidewalks

After a thorough site and aerial photo analysis of the sidewalks in Little Creek, we determined there are several issues that need to be addressed.

1. missing sidewalks - throughout the Town, there are several segments of missing sidewalks that present hazards for pedestrians.

2. broken sidewalks in need of repair - throughout the Town, as seen in the photo, there are sidewalks that have large cracks, weeds growing between cracks, chips, and uneven pavement, all of which present hazards for pedestrians.

CRDS recommends applying for DelDOT Transportation Alternative Program. According to their website, “the Delaware Department of Transportation (DelDOT) supports and administers the TAP for all Delaware Projects. All potential TAP projects require a sponsor to be responsible for 20% of the project costs. The project sponsor also assumes the maintenance and legal liability for the duration of the project’s useful life.”

The Town is eligible to be a project sponsor and will have to consider where to find non-federal funds for the required match.

SIDEWALK INVENTORY

Case **Studies**

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

Lessons Learned

A robust trail system can strengthen community identity and attract private investment dollars.

Building street and trail improvements using funding from small grant awards means costs stay low.

Case Study: Small Town Complete Streets

WARSAW, MISSOURI

Warsaw, Missouri was awarded 'Best Complete Streets Initiatives of 2017' from Smart Growth America

In 2006, the city of Warsaw, Missouri developed a Trail Masterplan that outlined its vision for a comprehensive trail network with connections between Warsaw's downtown and its string of waterfront parks (Smart Growth America, 2017). The network also connects to regional recreation facilities as well as historic landmarks. Through collaboration with the Missouri Department of Transportation, Warsaw's trail network also integrates with on-street bicycle facilities and sidewalk improvements (Smart Growth America, 2017). Although they only formally adopted a Complete Streets policy in 2016, the city of Warsaw has been implementing multimodal transportation initiatives for nearly 14 years.

The trail network and connectivity to downtown has helped strengthen Warsaw's identity and attracted over $4.5 million in private investment (Smart Growth America, 2017). Small businesses now thrive downtown, and have created new jobs opportunities for the community. In addition to serving as a vital asset for recreation, Warsaw's trail network and Complete Streets improvements have become an economic engine for the small community (Smart Growth America, 2017).

> "We've created a sense of pride here for the community. When people come here, they're amazed with what we have."
>
> -Randy Pogue, Administrator & Planner
> Warsaw, Missouri

Despite its small size and limited budget, Warsaw successfully implemented its extensive trail network and kicked off a broader Complete Streets program by using a "three P's" approach: planning, partnerships, and personnel (Warsaw Riverfront Trails 2019). They also built their street and trail programs in small increments, going after smaller grant opportunities and building the system slowly, to keep the cost down.

Today, the waterfront trail network is a staple of community life in Warsaw. The town holds events and festivals along the trails that draw attendees from within and beyond the area (Warsaw Riverfront Trails 2019).

City of Warsaw

Missouri Bicycle & Pedestrian Federation

Warsaw Riverfront Trails. (2019, August 27). Retrieved July 14, 2020, from https:// welcometowarsaw.com/warsaw-riverfront-trails/

Smart Growth America. (2017). The Best Complete Streets Initiatives of 2017 (Rep.). Retrieved July 14, 2020, from https://smartgrowthamerica.org/app/uploads/2018/03/Best-Complete-Streets-Initiatives-of-2017.pdf

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

CASE STUDY

Case Study: The Anchorage Canal Drainage Area Stormwater Retrofit

BETHANY BEACH, DELAWARE

The coastal section of Delaware Route 1 from Lewes to Fenwick is highly developed and much of it covered by impervious surfaces. A significant amount of untreated runoff moves into the Delaware Bay. The Anchorage Canal is the northernmost canal in South Bethany and it connects to Little Assawoman Bay. The canal has a large drainage area of 125 acres, with over 50% of that space covered by impervious materials. High levels of nitrogen, hydrocarbons, and sediment enter the canal from the watershed which produces runoff even during light rains (Delaware Center for the Inland Bays).

Initial Planting- photos courtesy of Delaware Center for the Inland Bays

Excavation of one right of way bioretention area - photos courtesy of Delaware Center for the Inland Bays

In 2008, the Center for the Inland Bays partnered with the Town of South Bethany, the Town of Bethany Beach, Middlesex Beach, Sea Colony, the Delaware Department of Transportation, and the University of Delaware to develop a strategy, or master plan, to address polluted runoff flowing to the Anchorage Canal (Delaware Center for the Inland Bays). A total of 25 sites were identified for retrofit stormwater designs.

Implementation began in 2011 and started with a series of wet-swale bio-retention areas and several infiltration pits along South Pennsylvania Avenue. The green infrastructure treats 35 acres to remove 24 pounds of nitrogen and 3.4 pounds of phosphorus per year and is planted with native vegetation (Delaware Center for the Inland Bays).

The second phase of the project included 16 median bio-retention areas down the middle of DE Route 1 designed to treat and absorb stormwater. Dr. Susan Barton from the University of Delaware created the planting plan for several of these bioremediation areas. Each area is estimated to trap and filter 1.5 pounds of nitrogen and 0.15 pounds of phosphorus every year (Delaware Center for the Inland Bays).

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

Lessons Learned

Green infrastructure projects require deep municipal agency partnerships and not-for-profits for coordination.

Green infrastructure improvements have mulitple benefits including the additon of native plants and associated ecosystem services they provide.

Lessons Learned

In urbanized areas, the use of pervious pavers allows for increased infiltration and associated benefits.

Living shoreline retrofits can work in association with exisitng grey infrastructure such as rip-rap.

Case Study: Read Avenue Nature Based Stormwater Solutions

DEWEY BEACH, DELAWARE

In the fall of 2018, the town of Dewey Beach began a green infrastructure project at the northeast corner of DE Route 1 and Read Avenue in Dewey Beach, Delaware. This project added a bio-retention reservoir retrofit along Coastal Highway and a living shoreline and outfall retrofit at the bayside end of Read Avenue (Delaware Center for the Inland Bays, 2018).

Oyster Bags in Use
Photo: DelDOT

The bio-retention reservoir is covered by permeable pavers and plantings, allowing the water to seep into the reservoir while also reducing the impervious cover in the town. Biochar was added to the soil to help clean the water as it moves out into the Rehoboth Bay. This project was designed to improve drainage and treat a 2.7 acre area (Delaware Center for the Inland Bays, 2018).

At the bayside end of Read Avenue, a second project to stabilize the shoreline and reduce flooding during high tide events was designed to mitigate regular flooding events.

This project retrofit a living shoreline and upgraded a stormwater drain and outfall into the Rehoboth Bay. The living shoreline was created with a combination of oyster shell bags and realignment of existing riprap. Oyster shell bags encourage habitat and growth of oysters, which help to improve water quality through natural filtration. Coupled with existing riprap, the oyster bags will also provide protection against wave energies anticipated at the site. The existing volunteer marsh was preserved and expanded through sand nourishment and marsh plantings. The existing dune was enhanced and raised to an elevation of 3.5 feet (Coastal Green Infrastructure to Enhance Resilience of State Route 1, Delaware 2018).

The project also includes a footpath to encourage access to the bay at a single entrance so that the living shoreline components can succeed without human disruption (Coastal Green Infrastructure to Enhance Resilience of State Route 1, Delaware 2018).

This project was completed in July 2020.

Coastal Green Infrastructure to Enhance Resilience of State Route 1, Delaware. (2018, July 12). Retrieved July 13, 2020, from https://www.fhwa.dot.gov/ environment/sustainability/resilience/ ongoing_and_current_research/ green_infrastructure/delaware/ page04.cfm

Delaware Center for the Inland Bays. (2018). Dewey Beach Embraces Nature-Based Stormwater Solutions. Retrieved July 13, 2020, from https://www.inlandbays.org/ dewey-beach-embraces-nature-based-stormwater-solutions/

Bio-retention Reservoir
Photo: Delaware Center for the Inland Bays

Read Avenue Conceptual Design
Photo: DelDOT

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

Case Study: Evaluation of Gateway and Low Cost Traffic-Calming Treatments for Major Routes in Small, Rural Communities

Iowa

Rural communities are often challenged with balancing local vehicle access, on-street parking and pedestrian safety with through-traffic. In 2007, Iowa State University conducted a study to evaluate the effectiveness of several low-cost traffic calming measures once implemented into different rural communities.

Eighteen small (populations less than 5000),rural communities in Iowa were chosen as potential test sites based on the following criteria:

- Through, paved, major county or state highway
- No traffic calming currently in place or planned
- No construction, reconstruction, or significant maintenance activities planned along the route during the study period
- No access control
- No adverse geometry such as sharp horizontal curves or steep vertical curves where treatments would be placed

These eighteen sites were narrowed down to five using speed studies to determine which communities had the most significant speeding problems. The five communities were: Union, Roland, Slater, Gilbert and Dexter (Traffic Calming on Main Roads Through Rural Communities 2009).

Through funding from the Federal Highway Administration (FHWA), two of these five communities, Union and Roland, received full gateway traffic-calming treatments. Gateways are "a measure, or set of measures, strategically located as motorists enter a community, that announces to motorists that they are entering a community and are no longer on an open high-speed roadway." Encouragingly, many European studies have shown success using gateways to calm traffic in rural communities. The remaining three sites, Slater, Gilbert and Dexter, received single-measure, traffic-calming treatments funded by the Iowa Highway Research Board (IHRB) (Hallmark et al., 2007).

Researchers compiled an extensive list of traditional traffic-calming measures used in both urban areas and on major roads in small communities. Final treatment selection for the test sites was based on the following criteria:

- Low Cost
- Accommodation of farm vehicles and large trucks
- Compatibility with rural setting and driver expectations
  (Traffic Calming on Main Roads Through Rural Communities 2009)

The treatments for each community are summarized in Table 1.

City (population)	Treatment	Roadway	AADT (veh/day)	Cross section (all are two-lane)
Union (427)	Transverse pavement markings [1] with speed feedback sign	D-65 (west edge of City)	830	Asphalt (22.4 ft), unpaved shoulders
	Transverse pavement markings[1] with speed feedback sign Lane narrowing using painted center island and edge line markings	S-62/SH 215 (from intersection with D-65 to north city limit)	1680	Concrete (40.0 ft), curb and gutter
	Transverse pavement markings[1]	SH 215 (near south city limit)	1,000	Asphalt (22.4 ft), unpaved shoulders
Roland (1,324)	Converging chevrons[1] with "25 MPH" pavement legend	E-18 (near east and west city limits)	2,300	Asphalt (22.6 ft), unpaved shoulders
	Lane narrowing using shoulder widening & "25 MPH" pavement legend	E-18 (from intersection with R-77 to east city limit)	2,300	Concrete (36.0 ft), curb and gutter
	"25 MPH" pavement legend	E-18 (from intersection with R-77 to west city limit)	2,300	Asphalt (22.6 ft), unpaved shoulders
Gilbert (987)	Speed table	E-23 (center of community)	1,480	Asphalt (22.0 ft), no shoulders
Slater (1,306)	Lane narrowing with center island using tubular markers channelizing markers	R-38 (from intersection with SH 210 to south city limit)	2,060	Concrete (25.8 ft), curb and gutter
	Speed feedback sign	R-38 (near north city limit)	2,870	Asphalt (22.6 ft), unpaved shoulders
	"SLOW" pavement legend	SH 210 (west from intersection with R-38 to west city limit)	2,940	Asphalt (22.5 ft), unpaved shoulders
Dexter (689)	"35 MPH" pavement legend with red background[1]	F-65 (near east and west city limits as well as at curve before west city limit)	1,000	Asphalt (25.4 ft), unpaved shoulders

[1]A request for experimentation was submitted to and approved by FHWA for this treatment.

Table 1. Summary of traffic-calming treatments and existing conditions at each site (Traffic Calming on Main Roads Through Rural Communities 2009)

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

Opportunities & Constraints

CRDS
COASTAL RESILIENCE
DESIGN STUDIO

Opportunities

PLANTS AND WILDLIFE HABITAT

• Protect and restore wildlife habitat - specifically for horseshoe crabs and diamondback terrapins. Specifically, reduce or eliminate riprap to enhance horseshoe crab habitat and develop terrapin road enclosures to keep the endangered turtle safe from traffic.
• Increase knowledge and awareness of invasive and problematic species, like phragmites and mosquitoes.
• Create a native plant ordinance.
• Reduce mosquito population using biological control in areas less than 3 feet deep and create guidelines or mosquito ordinances for landscape and landscape maintenance of green infrastructure and on private property
• Increase the width of riparian corridors being mindful of horseshoe crab habitat.
• Increase wetland habitat by 20%.
• Increase overall vegetated space and tree canopy.
• Reduce heat island effect related to impervious surfaces.

ECONOMIC DEVELOPMENT

• Create an inviting commercial district for anglers in close proximity to the river
• Enhance ecotourism opportunities through additional town amenities and publicizing connectivity
• Promote opportunities within a 6 mile radius of Little Creek and along the Bayshore byway.

WATER QUANTITY AND QUALITY

• Develop a flood management strategy and reduce flooding along Main St, which serves as an evacuation route.
• Better manage stormwater from west neighboring farmland.
• Reduce pollutant runoff (N & P by 40% and bacterial loads by 75%) into Little River with green infrastructure plantings, enforcement of agricultural setbacks, dog waste stations, and septic removals.
• Increase groundwater recharge and reduce runoff, specifically locate and remove septic systems via DEMA grant funding opportunities, to reduce bacterial runoff.
• Protect the Little Creek from contamination sites along the southern border of the watershed.
• Direct water flow to recharge and propose a new code or regulation to protect recharge areas.
• Find funding for a grant to conduct a detailed hydrologic study.
• Find funding for a grant to conduct an engineering study of the gray infrastructure.
• Reduce reliance on gray stormwater infrastructure.
• Protect the aquifer by conserving water - consider a rain barrel program for private residence, reduce impervious surfaces, and increase vegetated spaces.

& Constraints

COMPLETE STREETS

• Little Creek's Main Street is part of the Delaware Bayshore Byway, which provides opportunities for grant funding to improve walkability and biking.
• Improve livability by reducing travel speeds along Main Street and consider ways to reroute trucks
• Increase the pedestrian experience.
• Add crosswalks for pedestrian safety and connectivity to the commercial district.
• Add planted bump-outs and planted medians that have the potential to collect stormwater while calming traffic.
• Reduce vehicle speeding with better road striping/signage.
• Add a designated bike lane or striped sharrow lane.
• Propose the reduction of utilities lights and signage and develop a plan to plant native street trees.

SEA LEVEL RISE / RESILIENCE

• Reduce costly FEMA flood insurance rates.
• Implement measures to develop public education and outreach on SLR and coastal restoration through signage and community outreach.
• Protect property and aquifer from salt water intrusion.
• Create a hazard overlay zone related to flooding
• Expand and specify floodplain requirements to include enhaced building standards with flood-proofing regulations.
• Work with community members who recognize the occurrence of sea level rise and are willing to adapt.

CULTURAL / RECREATIONAL

• Provide increased outdoor recreational amenities for town residents that overall benefits health and quality of life.
• Honor maritime history with design recommendations.
• Maintain the small-town character.
• Consider views of agricultural lands and access to open space during the design process.

CHALLENGES

• Access to private property and federal lands.
• Future sea level rise predictions and resulting damage to coastal resources and infrastructure.
• Invasive phragmites.
• Saltwater intrusion into groundwater wells and aquifers.
• Pollution of confined groundwater aquifer.
• Improbability of permissible dam removal from private property
• Maintenance and cost of repairing/ replacing traditional stormwater infrastructure.
• The 32'- 35' road width will require making some compromises on the number of designated lanes and limits bike lane potential.
• DelDOT constraints on state highways will need to be addressed through the roadway design process.
• Vertical traffic calming is prohibited due to snow removal and emergency vehicle access.
• Overhead power lines and DelDOT restrictions will limit the size and location of potential street trees.
• The high water table prohibits burying utilities.
• The high water table limits types of green infrastructure.
• Existing soils within town limits have moderately high runoff potential (Hydrologic Group C).
• The current land use and protected wetlands will limit the size and scale of any future design or development in Little Creek.
• FEMA flood zoning will limit development.
• Mosquito and fly populations may contribute to a less inviting outdoor streetscape.
• Maintenance of future infrastructure and connectivity installments.

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