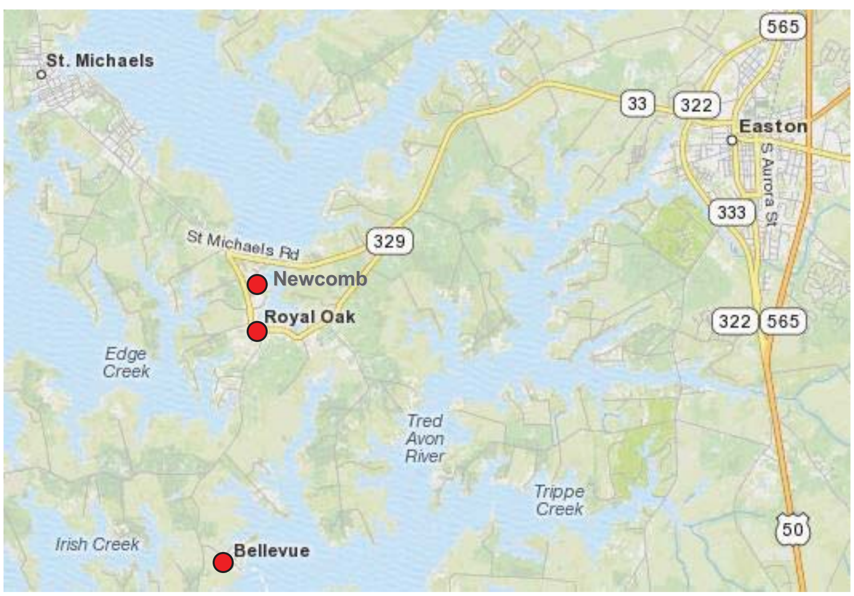
Coastal Management for Traditional Villages

Background

The area of land extending from the Town of Easton over 22 miles by road, to Tilghman Island is known as the Route 33 corridor. Apart from the Town of St Michaels, the area is predominantly rural in character and density. There are twelve rural, waterfront villages scattered among farms and forests that trace their histories back from 100 to 300 years. The villages supported ports, wharfs, railroad stations, canneries and mills. Homes were built primarily on small lots by watermen, laborers, merchants and tradesmen, or as vacation cottages and retreats. Over time most villages have evolved into single family residential communities.

Residents of these villages along Route 33 have expressed concerns about how runoff from roads is managed. Runoff from roads and drainage from individual properties has been managed by less than optimal systems, resulting in nuisance flooding and delivery of pollutants to local creeks and the Chesapeake Bay. Additionally, shoreline conditions have not been analyzed in a comprehensive manner. Individual property owners may have hardened sections of shoreline, but there has been no study devoted to how Talbot County communities have been or may be impacted by erosion, sedimentation, flooding or sea level rise.



To address these concerns, the Talbot County Office of Planning and Zoning undertook a pilot project of three waterfront communities along the Route 33 corridor to evaluate current conditions regarding water pollution, flooding concerns and threats from shoreline erosion. This pilot project focused on the villages of Royal Oak, Bellevue and Newcomb and involved two public meetings to gather input from residents and report back the findings, and a field evaluation of each village to identify proposed solutions. This brochure summarizes the recommendations and strategies for implementation.

Project Goal: To empower rural communities in Talbot County to better manage nonpoint source pollution from stormwater runoff and to develop mechanisms to address shoreline erosion and flooding hazards.

Prepared by: Center for Watershed Protection, Inc.
Prepared for: Talbot County Office and Planning and Zoning
Project partners: Maryland Sea Grant, BayLand Consultants and Designers, Inc., Andrews, Miller and Associate.
Funded by: Maryland Department of Natural Resources

Coastal Management fo

Major Coastal Concerns

Water pollution
The major source of water pollution in developed areas is stormwater runoff from impervious surfaces, such as roads, parking lots and rooftops. The increased volume and velocity of runoff contributes to erosion and delivers a slew of pollutants, such as nutrients, sediment, metals, bacteria, oil and grease, to nearby creeks and bays. In coastal areas, water pollution can limit recreational use of waterways due to health risks and also impacts fishing and shellfishing.

Flooding and drainage issues
Talbot County is located in the coastal plain, a very low-lying region with little elevation change. Some of the soils are poorly drained due to high clay content. During extended or intense periods of rain, these conditions can contribute to flooding. Where extensive impervious surfaces are present, the problem is exacerbated by the increase in stormwater runoff that is generated. These issues can be worsened by future sea level rise impacts expected in the area.

Shoreline erosion
Erosion of shoreline property is caused by removal of vegetation which previously provided stabilization, as well as increased stormwater runoff, wave action and storm surges, and can be more of a problem in areas with highly erodible soils. Talbot County's numerous tidal creeks, bays, and coves provide extensive shoreline, some of which are experiencing erosion, prompting landowners to install stabilization projects. Shoreline protection should consider future sea level rise and flood plain areas.

Proposed Solutions

The project team identified specific water pollution, flooding and shoreline erosion problem sites within the three villages and evaluated them for potential solutions. An important consideration was if and how these sites might be affected by sea level rise. Therefore, maps depicting future inundation under a 2 foot sea level rise scenario were used when considering solutions. To learn more about this project, go to: http://mdsg.umd.edu/climate/talbotvillages

County strategies

- Living shorelines & shoreline stabilization
- Stormwater retrofits such as bioretention
- Drainage system upgrades

Homeowner strategies

- Lawn and nutrient management
- Stormwater retrofits such as rain gardens, rain barrel, grass filter strip

- Road improvements and ditch maintenance
- Ditch maintenance with County coordination

Royal Oak

The Village of Royal Oak consists of large and small lot residential development bordered by agricultural fields and tidal creeks. Nearby creeks include Oak Creek, a tributary of the Miles River, to the north, Upper Edge Creek and Solitude Creek off of Broad Creek to the south west, and Plaindealing Creek off of the Tred Avon River to the southeast. The major impervious surfaces are the rural two lane highways and scattered residential rooftops.

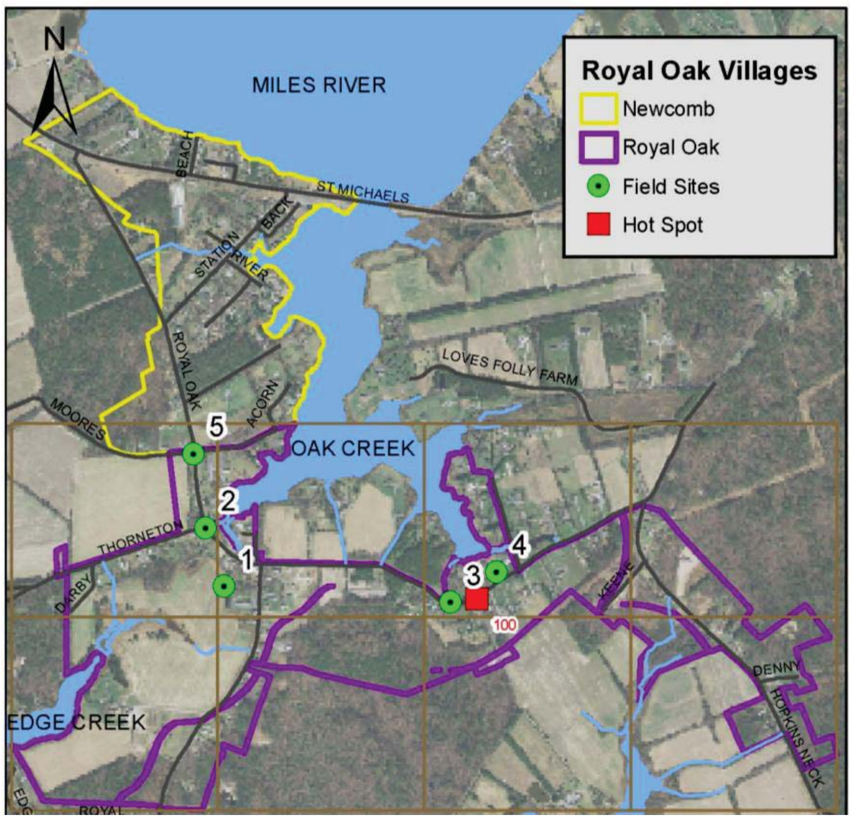
Problems

The major problem identified by Royal Oak residents was periodic or nuisance flooding in ditches and along roadways. Five specific sites were evaluated (see Map 1).

Water pollution: Estimated pollution impacts from village runoff are relatively low due to low impervious cover; the roadside drainage ditch system does not currently provide any pollutant removal; no existing stormwater management practices are present on lots; a potential sanitary sewer overflow was identified during the site visit; lawns, which cover an estimated 20% of residential lots in the village, may be a significant source of nutrient pollution.

Flooding: Road flooding is a problem during very large or intense storms due to the presence of low-lying open section roads throughout the village.

Shoreline erosion: A small number of properties are adjacent to the shore and erosion was not raised as an issue at the public meeting. Shoreline erosion is not considered a major issue in this village.



Map 1. Problem Sites Investigated in the Village of Royal Oak.

Sea level rise impacts: No existing residential structures are located within the 2-foot sea level rise inundation zone, although several structures, including outbuildings, are likely to be impacted. Of the proposed locations for drainage upgrades, at least one pipe outfall would probably be inundated during high tide and/or storm surge with a two foot sea level rise. A significant portion of the existing residential structures are well within the existing floodplain and are potentially impacted by a 100-year storm surge event at the current sea level and it should be expected that the risk of flooding will increase with any rise in sea level.

Royal Oak

Proposed Solutions

Drainage system upgrades (Sites 1, 2, 3, and 5)
The current roadside drainage system consists primarily of roadside ditches, culverts, and drainage channels, and to a lesser degree pipe systems. Reports and other evidence of flooding indicate that these systems likely perform as designed during the more frequent and small storm events, with the amount of nuisance flooding increasing as storm intensity and duration increase.

Drainage system upgrades are recommended at Sites 1, 2, 3 and 5. Upgrades include adding manhole structures or junction boxes at pipe connections as needed to increase flow capacity (Figure 1); installing headwall or end wall sections as needed to improve culvert hydraulics and capacity; and replacing old and broken sections of pipe. Because part of the system is underground, identifying and prioritizing the upgrades would include using video inspection equipment or other means of investigating the actual alignment and pipe system condition.

Figure 1. The culvert at Royal Oak Site 3 has been directly connected to another culvert without using a junction box, which impacts the drainage system by reducing flow capacity.

Ditch maintenance (Village wide)
The roads and ditch systems exist in a low lying area with low relief and soil characteristics that range from high clay to high sand content. This creates ditch conditions that are highly variable and in some cases difficult to maintain. Many of the ditches hold standing water (Figure 2). Some ditches were observed to have silted in up to one-half of the flow capacity.

Figure 2. The flat bottom and vertical side slopes of this ditch at Royal Oak Site 2 can contribute to flooding and reduced flow capacity but can be improved with changes to ditch maintenance.

Periodic maintenance of the system over the years to remove sediment has resulted in very rectangular ditch cross sections (Figure 2). This is generally considered unsafe when positioned within the roadway clear zone and, over time, will reduce flow capacity in the ditches and adjacent culverts, increasing the frequency of minor flooding over the roadway.

Where possible, future ditch maintenance should attempt to implement a more gradual ditch section with 2:1 or even 3:1 vegetated side slopes if the grade adjacent to the road is suitable and there is available right-of-way. This ditch geometry is much more stable and maintainable. Periodic maintenance focused on keeping the ditch inverts and culvert entrances clear of debris and woody vegetation will be more effective in reducing the frequency of minor road flooding while also reducing the export of sediment from the ditches that typically results from traditional ditch maintenance.

Royal Oak

Proposed Solutions

Stormwater retrofits (Sites 3 and 4)
The site investigation uncovered only limited opportunities to reduce water pollution by installing "stormwater retrofits," where practices are installed in the built landscape to capture and treat runoff from impervious surfaces. There are few retrofit opportunities because most of the village impervious cover is associated with roads but the ditches were not considered a viable retrofit option due to their geometry and proximity to the road. At Site 3, an area of channel that is experiencing erosion (Figure 3) may benefit from minor stabilization with biodegradable matting and vegetation, although it will be important to ensure that future development upstream does not impact this repair. At Site 4, the upper portion of a drainage channel could be retrofitted with a shallow bioretention area to help remove nutrients from upstream lawn runoff (Figure 4).

Figure 3. Minor channel erosion at Royal Oak Site 3.

Figure 4. Proposed bioretention site at Royal Oak Site 4.

Residential lawn management (Village wide)
Homeowner opportunities to reduce water pollution from impervious cover are also limited because most of the impervious cover is rooftops, which are already disconnected from the drainage system (e.g. rooftop drainage is directed to lawns). Homeowners may instead want to focus on reducing pollution from lawns, which comprise an estimated 20% of residential lots within Royal Oak. Rain gardens, which were identified as a desirable option at the public meeting, could be used to capture and treat lawn runoff (Figure 5). Other options for better lawn management include planting trees and native vegetation, reducing fertilizer and pesticide use, proper disposal of pet waste and water conservation.

Investigate possible sewer overflow (Hotspot Site)
A manhole located on the corner of Schoolhouse Lane and Royal Oak Road was found to be overflowing during the field investigation. The overflow was reported and the City of Saint Michael's waste water treatment staff investigated the problem within hours. The manhole was tested that afternoon and contained no evidence of sewage contamination. It was determined the manhole, which covers a sanitary sewer pump and force main, often fills with groundwater and overflows during wet weather, but is designed so that there is no contact between the sanitary sewer flow and groundwater.

Figure 5. Rain garden example.

Royal Oak

Action Strategy

Benefits	Costs	Possible Funding Sources	Lead Entity	Next Steps
Drainage system upgrades				
Addresses nuisance flooding and drainage issues	Unknown	MDE 319	County or state	Determine where easements or additional natural resource protection elements exist along roadways and identify funding source
Ditch maintenance				
Addresses nuisance flooding and drainage issues, helps maintain the integrity of the pavement surface, improves safety	Minimal, changes to maintenance practices	MDE 319	County – public land Homeowner – private land	Find and transfer the state highway stormwater infrastructure, if applicable
Stormwater retrofits				
Reduces water pollution	$3,300 for bioretention, ~$1,000 for stabilization	NFWF, CBT	Consultant(s)	Apply for funds to design and implement
Residential lawn management				
Reduces water pollution, saves money, improves aesthetics	Minimal, mostly involves changes in lawn care practices	N/A	Royal Oak residents	Education and outreach to the community by a designated group (e.g., Sea Grant extension)
List of Acronyms: CBT (Chesapeake Bay Trust), N/A (Not applicable), MDE (Maryland Department of the Environment), NFWF (National Fish and Wildlife Foundation)				

Summary: The priority recommendations (based on cost/environmental benefit) are the drainage system upgrades and ditch maintenance as well as the residential lawn management.

Bellevue

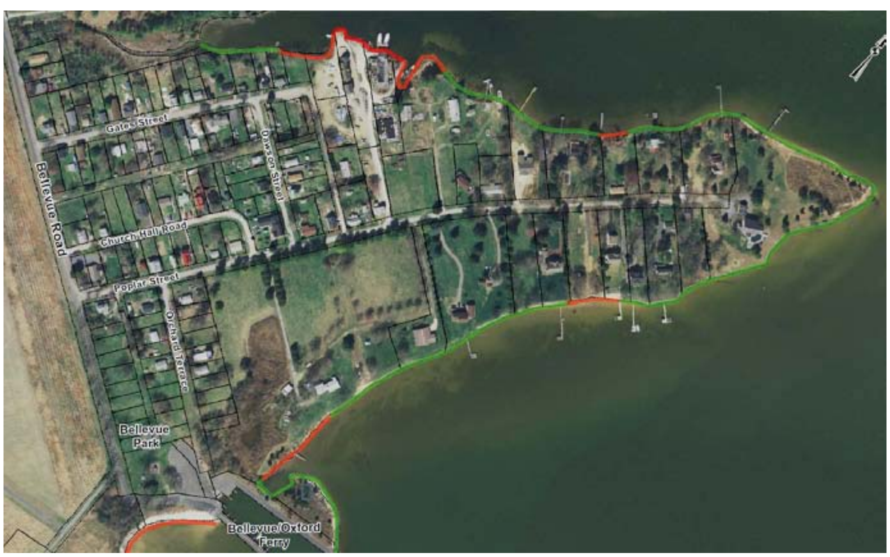
Bellevue is a 57.9 acre community that has morphed from a village supported by a local canning operation to a single lot residential community. Bellevue is also home to the Oxford-Bellevue Ferry, which is believed to be the oldest privately operated ferry service, running continuously since 1836. This village contains extensive shoreline along the Tred Avon River and Tar Creek.

Problems

Since most of the properties in Bellevue include shoreline, field investigations included surveying the entire shoreline. The major concern expressed by Bellevue residents was nuisance flooding at road intersections.

Water pollution: Pollution impacts from village runoff are estimated to be 21.7 lbs/yr of total phosphorus, 166.7 lbs/yr of total nitrogen and 4,531.9 lbs/yr of total suspended solids. No existing stormwater management practices are present on residential lots and the roadside drainage ditch system does not provide any pollutant removal. Runoff from the recently constructed ferry launch parking also does not receive any type of stormwater management.

Flooding: The stormwater conveyance system for the road network in Bellevue was determined to be inadequate, nonexistent or nonfunctioning. The roadside drainage swales were observed with a significant amount of standing water and did not appear to drain properly. Residents report that, at almost every intersection, runoff backs up and ponds for extended periods of time. This has contributed to accelerated deterioration of road surfaces.



Map 2. Village of Bellevue. Bay Land Consultants & Designs, Inc. determined that there were 4,285 linear feet stable shoreline (shown in green) and 1,875 linear feet unstable shoreline (shown in red).

Shoreline erosion: The shoreline is mostly protected with bulkhead or revetment armoring. Around 30% of the shoreline is considered unstable (shown in red in Map 2), with the most significant erosion in the northwest of the peninsula where Tar Creek empties into the Tred Avon River. Several landowners here have experienced failure of the stabilization system.

Sea level rise impacts: A 2-foot sea level rise would adversely affect the northwest tip of the Bellevue peninsula where no bulkhead or stone revetment has been constructed. The Bellevue-Oxford ferry commercial operation may require mitigation or infrastructure upgrades to avoid any potential adverse impacts. No existing residential structures would be impacted from a 2 foot sea level rise. A significant majority of the existing residential structures and the Oxford- Bellevue Ferry are well within the existing floodplain and would be significantly impacted by a 100-year storm surge

Bellevue

event at the current sea level and the risk of flooding be increased with any rise in sea level. The 2 foot inundation and 100 year flood inundation lines are provided in Map 3.

Map 3. Two foot inundation is shown in light blue and 100 year floodplain is shown in dark blue for Bellevue.

Proposed Solutions

Resurfacing interior roads

The interior roads of the Bellevue Village are either deteriorated asphalt or gravel surfaces. The road edge often becomes the collection point for concentrated stormwater flows (see Figure 6), resulting in gully erosion and high sediment loads. The recommendation is to resurface the roads so that water drains properly and prevents accelerated deterioration and erosion of the driving surface. Additionally, it would be beneficial for individual property owners to maintain their driveways in a manner that reduces the amount of water ponding at the edge of the driveway and road surface.

Figure 6. Interior Bellevue Village road.

Bellevue

Proposed Solutions

Bioswales
A bioswale is a vegetated open channel management practice designed specifically to slow stormwater runoff and remove pollutants using vegetation and soils. Because of their linear nature, they are ideal for conveying and treating runoff from roads. Bioswales are recommended at three sites in Bellevue: 1) along either and/or both sides of Orchard Terrace; 2) along the East side on Poplar Street; and 3) between Bellevue Park and the Bellevue-Oxford Ferry parking lot. See Figure 7 for example.

Constructed wetlands
Constructed wetlands are systems that capture, temporarily store, and treat stormwater runoff before releasing it downstream. They are designed to mimic natural wetlands and incorporate certain features, such as variable water depths and wetland vegetation, which promote multiple pollutant removal processes. Two constructed wetland projects are recommended in Bellevue. The first project involves conversion of an old 1.8 acre overgrown phragmites marsh into a shallow wetland with multiple permanent pools and landscaped with native vegetation along Bellevue Road, just west of Gatest Street. The second project is construction of a small shallow wetland at the culvert underneath Bellevue Road.

Rain gardens
Rain gardens are planting areas installed in shallow basins into which rooftop runoff is directed for removal of pollutant by plant and soil media. Property owners of the larger lots situated to the north/northeast of Bellevue community may wish to install rain gardens to provide water quality for their rooftop and adjacent impervious surfaces. Rain gardens would not be ideal for individual property owners on smaller lots located in the more urbanized part of the community due to the limited lawn area available.

Figure 7. A bioswale example. On the left shows a suitable area selected and on the right shows an design proposed. This example is from the Center for Watershed Protection's Arlington, Virginia work (2011) using NOAA's CanVIS program.

Bellevue

Proposed Solutions

Figure 8. Living shoreline example in London Town Publik House and Garden, Anne Arundel County, MD. Source: David Burke.

Living shorelines

Living shorelines are a combination of structures, practices and vegetative measures, including beach nourishment, wetlands and dune plantings that are positioned along a shore to deflect and dissipate the force of waves in order to protect the shoreline. A living shoreline example is provided in Figure 8. Living shorelines are typically recommended for coastal environments experiencing low to medium energy. Living shorelines can help shorelines withstand wave impact, retain the protected earth on the bank, trap sand, and, in general, may very effectively prevent erosion at the site of protection. Four living shoreline projects are recommended:

- Construction of a 350 foot long living shoreline project on a property located on the southeast side of the peninsula below the Oxford-Bellevue Ferry.
- Construction of a 300 foot long living shoreline project on a property located on the southeast side of the peninsula, north of the inlet where the Oxford-Bellevue Ferry is located.
- Repair of 50 feet of existing living shoreline on a property located on the northwest side of the peninsula.
- Construction of a 250 foot long living shoreline project on a property located on the southwest side of the peninsula, north the point where Tar Creek empties into the Tred Avon River.

Shoreline structural stabilization

Shoreline structural stabilization uses rigid, barrier-type structures that result in a "hardening" of the shoreline to protect against the action of waves, currents, tides, wind driven water, runoff from storms, and/or groundwater seepage that erodes shorelines. Such structural measures include: riprap, revetments, bulkheads, jetties, and seawalls. One structures shoreline stabilization project was identified and would consist of replacing 550 feet of a previously failed bulkhead on a commercially utilized shoreline access spanning several property owners. This site is located at the shoreline where Poplar Street and an unnamed road to the NE of Dawson Street come together.

Hydrodynamic structures

Hydrodynamic structures are devices designed to improve quality of stormwater runoff using features such as grit chambers, oil barriers, baffles, and absorbent pads that are designed to remove sediments, nutrients, metals, organic chemicals, or oil and grease. It is recommended that an online hydrodynamic separator be installed to treat runoff from the Bellevue-Oxford Ferry parking lot and boat ramp that currently flows directly to tidal waters. This option is likely cost prohibitive for implementation.

Bellevue

Action Strategy

Benefits	Costs	Possible Funding Sources	Lead Entity	Next Steps
Resurfacing of interior roads				
Reduces nuisance flooding, reduces erosion, helps maintain integrity of pavement surface	$94,000	MDE 319	County, Homeowners (for driveway drainage maintenance)	Apply for grant, determine appropriate funding mechanism and partnerships
Bioswales (that are 1100 ft long and 2 to 4 ft wide and 200 ft long and 4 to 8 ft long)				
Reduces water pollution	$144,000	CBT, NFWF	County, consultant(s)	Prioritize, seek funding for design and implementation
Hydrodynamic structures				
Reduces water pollution	$50,000	CBT, NFWF	County, consultant(s)	Ranked low in the report. Pursue this option with caution.
Constructed wetlands				
Reduces water pollution	> $180,000	CBT, NFWF	County, consultant(s)	Prioritize, seek funding for design and implementation
Rain gardens				
Reduces water pollution, improves aesthetics	$3,000 per project	CBT, NFWF	Homeowners	Partner with groups that can help fund, build, guide and educate (e.g., Master Gardeners, CBT, CBP, DNR, etc)
Living shorelines (for 3 sites over 600 ft)				
Reduces erosion, protects property, improves aesthetics	$235,000	CBT, DNR, NFWF	County, consultant(s)	Prioritize, seek funding for design and implementation
Shoreline structural stabilization (for 550 ft)				
Reduces erosion, protects property	$275,000	USACOE	County, consultant(s)	Discuss with homeowners
List of Acronyms: CBT (Chesapeake Bay Trust), DNR (Department of Natural Resources), MDE (Maryland Department of the Environment), NFWF (National Fish and Wildlife Foundation), USACOE (US Army Corps of Engineers)				

Summary: Based on cost of project per pollutant load removed, the priority projects that ranked the highest were the following: 1) shoreline protection (living shorelines prioritized over structure where the erosion level is low), 2) structural stabilization; and 3) rain gardens.

Newcomb

The Village of Newcomb is a 160 acre community that consists of large and small lot residential development bordered by agricultural fields and tidal creeks. Newcomb has about 180 residents and is comprised of single family homes where lots range from ¼ acre to over 5 acres. Newcomb is bordered by Royal Oak Road to the west, the Miles River to the north, Oak Creek to the east, and Acorn Road to the south. The major impervious surfaces are the rural two lane highways, driveways, parking lots, and rooftops that amount to 14% of the land cover. Newcomb's elevation is from 0 to 8 feet with 0 to 2% with 0 to 2% slopes. There are numerous properties adjacent to the water with docks and water access. An estimated 31 boat docks exist in Newcomb and at least one slip hold multiple boats. Also, existing hardened shorelines exist and evidence of eroding shorelines was observed.

Map 4. Newcomb Village is shown in the yellow outline.

Problems

The major problem identified by Newcomb residents was periodic or nuisance flooding in ditches and along roadways. The field investigation found that a majority of driveway and cross culverts were clogged with sediment from 50 to 75% of capacity. Four specific sites were identified for potential projects (see Map 4).

Drainage issues: During small and large storms road flooding and standing water in ditches are problems in Newcomb. Culverts are largely inadequate for proper drainage in the area.

Shoreline erosion: Newcomb's shoreline is about 1.7 miles long where 7,580 ft are stable to moderately stable which is about 88% of the shoreline. This largely reflects the hardened shoreline that makes up 7,245 feet or about 84% of the shoreline. On the Miles River, shoreline erosion has been a problem over the years.

Water pollution: Pollution impacts from village runoff are estimated to be 157 lbs/yr of total phosphorus, 130 lbs/yr of total nitrogen and 3.3×10^4 lbs/yr of total suspended solids. No existing stormwater management practices are present on residential lots and the roadside drainage ditch system does not provide any pollutant removal.

Failing infrastructure: In addition to aging roadways and ditches, existing shoreline hardened structures such as bulkheads, culverts, and drainage network are failing in areas and in need of either repair or replacement.

Sea level rise impacts: Future sea level rise impacts could impact the homes and homeowners that are adjacent to the Oak Creek and Miles River. The Miles River shoreline near Route 33 bridge over Oak Creek is the most vulnerable area to sea level rise impacts of 0 to 2 feet. Zero to 2 feet sea level rises could impact stormwater sites Oak3, Oak 4, Oak 5 and shoreline projects Section 7, Section 9, and Section 11. Also, large storm events and storm surge will impact these areas with flooding events. Flooding events can impact infrastructure, crops, and reduce or impact property values.

Newcomb

Proposed Solutions

Stormwater retrofit projects were recommended based on rankings that included community input, drainage area, peak flow rate, soils, groundwater elevation, pollutant removal, and feasibility. A shoreline survey was conducted by boat of the 8,635 feet of shoreline and was recorded in sections and several sites for living shorelines or repair were recommended.

Submerged Gravel Wetlands (SGWs) were recommended for areas with high groundwater tables and poorly drained soils, which are both common in Newcomb.

Stormwater site Oak 5 was ranked #1 in Newcomb and is highly recommended for implementation (Figure 9). This site has available space in a 50 foot county right-of-way (ROW). A new drainage pipe that directs stormwater to the 80 foot SGW that is inline with the existing roadside ditch is proposed. The stormwater would discharge into a plunge pool that is part of a living shoreline project at this site (shoreline Section 7). This site is located at River Road near Woodside Road intersection. The drainage area is 7.5 acres.

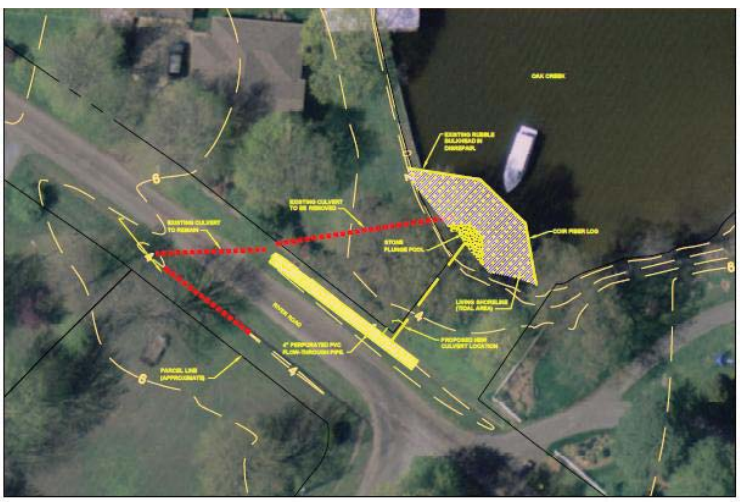


Figure 9. Site Oak 5 is an example where a Submerged Gravel Wetland and living shoreline was recommended.

Stormwater site Oak 4 was ranked #3 in Newcomb and directs stormwater runoff for 45% of the Newcomb area drainage to a 170 foot gravel wetland that has check dams that dissipate large storm event velocity and retain runoff for small storms to improve the water quality treatment. A living shoreline project is also proposed (shoreline Section 9). This site is located northeast of St. Michaels Road & Royal Oak Road (Figure 10). The drainage area is 105 acres. This property is located on public land managed by the County Department of Parks and Recreation.

Stormwater site Miles 3 in Newcomb and should improve the drainage ditch where the outfall exists and a 100 foot long stormwater gravel wetland. Also, ten feet of an existing bulkhead should be repaired. This site is located behind eastern properties of Beach Road. The drainage area is 12 acres.

Stormwater site Oak 3 in Newcomb and is a SGW and living shoreline project (shoreline Section 11). This site is located at the intersection of Back Street and Station Road. The drainage area is 5.4 acres.

Stormwater site Oak 9 in Newcomb and recommends placing a SGW where no ditch existed, but erosion is evident between two properties. This site is located at the end of Acorn Road. The drainage area is 4.3 acres.

Newcomb

Proposed Solutions

Figure 10. Shoreline erosion can be alleviated by living shorelines. Oak 4 and Section 9 site where a stormwater gravel wetland and living shoreline was recommended.

Linear Wetland
Stormwater site Miles 1 was ranked #2 in Newcomb and recommends expanding the existing ditch into a buffer strip. The expansion area should be excavated to a lower elevation than the existing ditch invert. A linear wetland is proposed that is 500 feet long. This site is located northeast of Route 33 and Solitude Road intersection. The drainage area is 33 acres.

Drainage Improvements
Stormwater site Miles 2 was in Newcomb and is a site for maintaining the swale flow path, riprap, and native wetland plants. This site is located on 4 properties northeast of Route 33 and Royal Oak Road intersection (Figure 11). The drainage area is 17 acres. Also, general roadside ditch and culvert maintenance is needed and this effort could be County led with citizen volunteers. Flooding at Royal Oak Road and Station Road intersection during storms was a citizen concern where new culverts are needed immediately for the property owner.

Figure 11. Miles 2 where a proposed swale and native plants could be placed.

Linear Shoreline Projects
Shoreline field inspection site Section 9 was the best opportunity for a living shoreline (also stormwater site Oak 4). A combination of low profile stone sills and coir logs could be installed around the peninsula. The living shoreline could easily be designed to vary between upland and wetland. This living shoreline would also provide protection to the historical cemetery located directly upland of the peninsula. Shoreline field inspection site Section 11 (also stormwater site Oak 3) was an area where a living shoreline can stabilize and improve the eroding shoreline. At shoreline field inspection site Section 7 (also stormwater site Oak 5) a 30 feet of concrete revetment should be removed and a living shoreline was proposed. A coir fiber log is recommended to protect the tidal wetlands planted.

Bulkhead Repairs and Replacements
Three shoreline field inspection sites indicate areas in disrepair and structural updates are needed with the County's guidance. These shoreline field inspection sites are: 1) Section 8 shows signs of degradation that indicate the bulkhead has reached the end of its service life; 2) Section 10 bulkhead is nearing failure; and 3) Section 16 indicates a 165 foot bulkhead near Beach Avenue is in disrepair.

Newcomb

Action Strategies

Benefits	Costs	Possible Funding Sources	Lead Entity	Next Steps
Submerged Gravel Wetlands (Sites Oak 3, Oak 4, Oak 5, Oak 9, and Miles 3)				
Reduces stormwater runoff volume and provides water quality	$154,700	CBT, NFWF, DNR	County	Oak 3 & Oak 4 ranked high; scope for feasibility and community support
Linear Shoreline Projects				
Reduces erosion, protects property, improves aesthetics	Costs included in SGW for Oak 3, Oak 4, Oak 5, & Oak 9	CBT, NFWF, DNR	County, consultant(s)	Discuss with citizens where shoreline stabilization was failing; scope living shoreline project Section 9 with Oak 4
Drainage Improvements				
Addresses nuisance flooding and drainage issues, helps maintain the integrity of the pavement surface, improves safety	$3,000 per project	CBT, NFWF, SHA, MDE 319	SHA	Upgrade homeowner culvert at Royal Oak Road & Station Road intersection; Plan for short and long term maintenance and updating for roadside ditches & culverts
Linear Wetland				
Reduces water pollution, stabilizes ditches, alleviates shoreline erosion and culvert degradation	$39,200	CBT, NFWF, SHA	County, consultant(s)	Miles 1 ranked high; scope for feasibility and community support
List of Acronyms: CBT (Chesapeake Bay Trust), DNR (Department of Natural Resources), MDE (Maryland Department of the Environment), NFWF (National Fish and Wildlife Foundation), SHA (State Highway Authority), USACOE (US Army Corps of Engineers)				

Summary: The priority recommendations based on best professional judgment considering feasibility for project implementation and costs/environmental benefit are at sites Oak 5 (Shoreline Section 7) for a 50 ft. SGW and 30 ft. living shoreline, Miles 1 for a 500 ft. linear wetland, and Oak 4 (Shoreline Section 9) for a 170 ft. SGW and living shoreline.

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June 2011

COASTAL MANAGEMENT FOR TRADITIONAL VILLAGES: ROYAL OAK ASSESSMENT

Prepared by the Center for Watershed Protection, Inc.

CENTER FOR WATERSHED PROTECTION

Prepared for Talbot County Office of Planning and Zoning

THE GREAT SEAL OF TALBOT COUNTY MARYLAND
TEMPUS PRAETERITUM ET FUTURUM

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Project Overview

Talbot County has over 600 miles of coastal shoreline that supports a diverse community and economy focusing on agriculture, recreation, manufacturing, and professional services. Talbot County's population is over 37,000 with Easton serving as the county seat (MD DBEC, 2011). Talbot County is a low-lying coastal area where local flooding is a concern. In addition, Talbot County has been identified as vulnerable to future sea level rise and/or coastal hazards (Titus (1998), IPCC (2007), Johnson (2000). In western Talbot County twelve communities in the "Bay Hundred" area were identified that require assistance to better manage non point source pollution from stormwater runoff. These twelve rural, waterfront Villages have similar topography and population. Established 100 to 300 years ago the Villages generally have single family residential homes that have little to no stormwater management and are served by wells and septic systems (CCI, 2010). The three villages identified as representative areas for study are Royal Oak, Newcomb, and Bellevue. The major concerns for these areas are stormwater management and shoreline erosion and three consulting agencies were tasked to characterize their respective Village and make recommendations for improvements that can be applied to all 12 Villages in the Bay Hundred area. Finally, future efforts to improve stormwater management and control shoreline erosion such as project implementation, management options, community outreach and education, and/or securing funding mechanisms are outcomes for this work.

Introduction

Center for Watershed Protection, Inc. (Center) worked with Talbot County Office of Planning and Zoning on the, "Coastal Management for Traditional Villages," project funded by the Coastal Communities Initiative (CCI). This CCI project focused on stormwater management and community coastal erosion concerns. As part of this CCI project, Center's objective was to characterize stormwater management in the Village of Royal Oak (Figure 1) and provide recommendations for stormwater management improvements. To incorporate future potential sea level rise impacts into field work and resulting recommendations, 0-2 foot inundation maps were used. Therefore, the sea level rise was a component of these recommendations, where appropriate.

The Village of Royal Oaks consists of large and small lot residential development bordering agricultural fields and tidal creeks: Oak Creek a tributary of the Miles River to the north, Upper Edge Creek and Solitude Creek off of Broad Creek to the south west, and Plaindealing Creek off of the Tred Avon River to the southeast. The major impervious surfaces are the rural two lane highways and scattered residential rooftops.

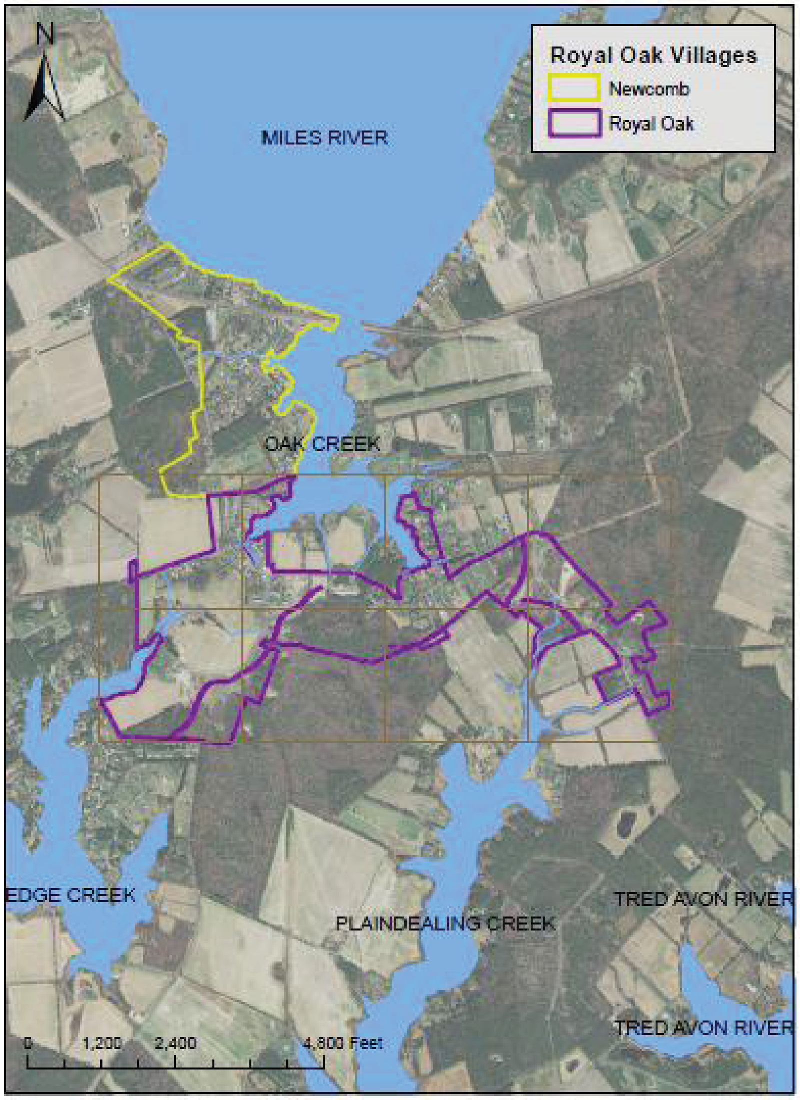


Figure 1. Village of Royal Oak map.

All the roads through the Village are low lying open section with roadside ditches, numerous culverts, and man-made channels draining to the adjacent creeks noted.

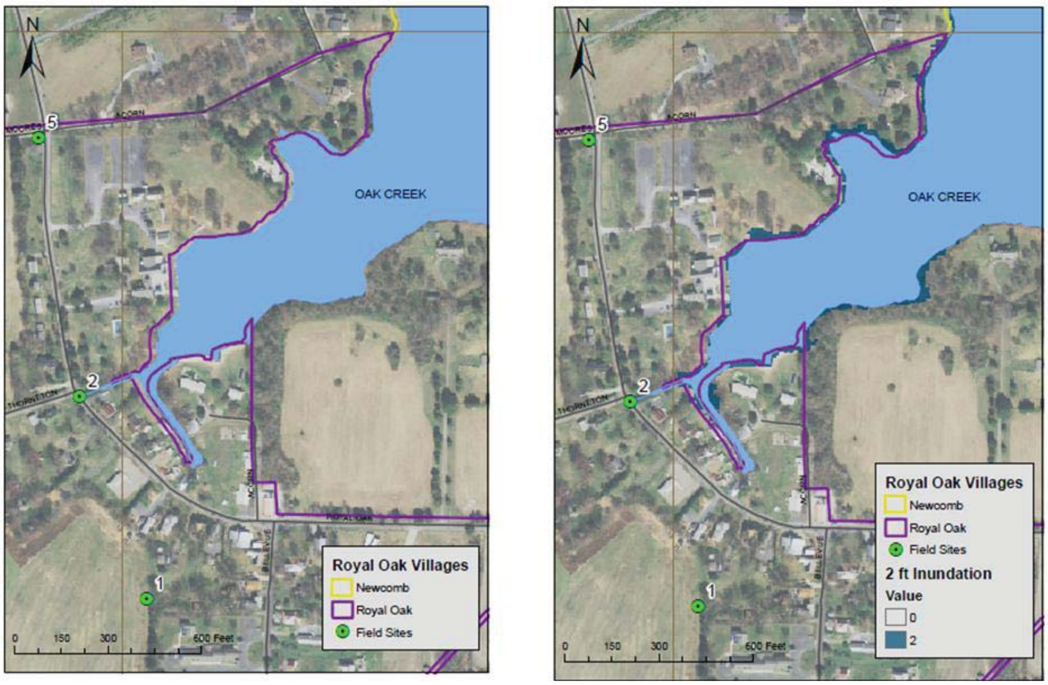
Methods

Community input and cooperation was the driving force for this project. The Center attended the team strategy meeting entitled, "Coastal Management for Traditional Villages," on November 18, 2010, to outline project objectives, goals, and timelines. The Center attended the first of two community meetings targeted for the three study area Villages entitled, "Talbot County Village Stormwater, Shoreline, and Sea Level Study Kickoff." At this meeting the community heard the project overview and provided feedback. The Center met with Royal Oak community members to discuss stormwater management issues in the area, target sites to investigate during field assessments, and assemble community members interested in participating in the field assessment. The outcome was a Royal Oak map with eight to ten sites identified for investigation and community member contact information for project participation (e.g., Frank Cavanaugh who is the Chairman of the 12 Village's Board, Stephen Luethy who is the Royal Oak representative, and Allen Fox, IV from Royal Oak). Field work was conducted on March 2, 2010, by two Center staff (Senior Stormwater Engineer & Watershed Planner), the community members identified above plus Steve (last name unknown), Vicky Carrasco with MD Sea Grant Consortium, and Martin Sokolich ,Project Manager for the Talbot County Office of Planning and Zoning's Long Range Planner.

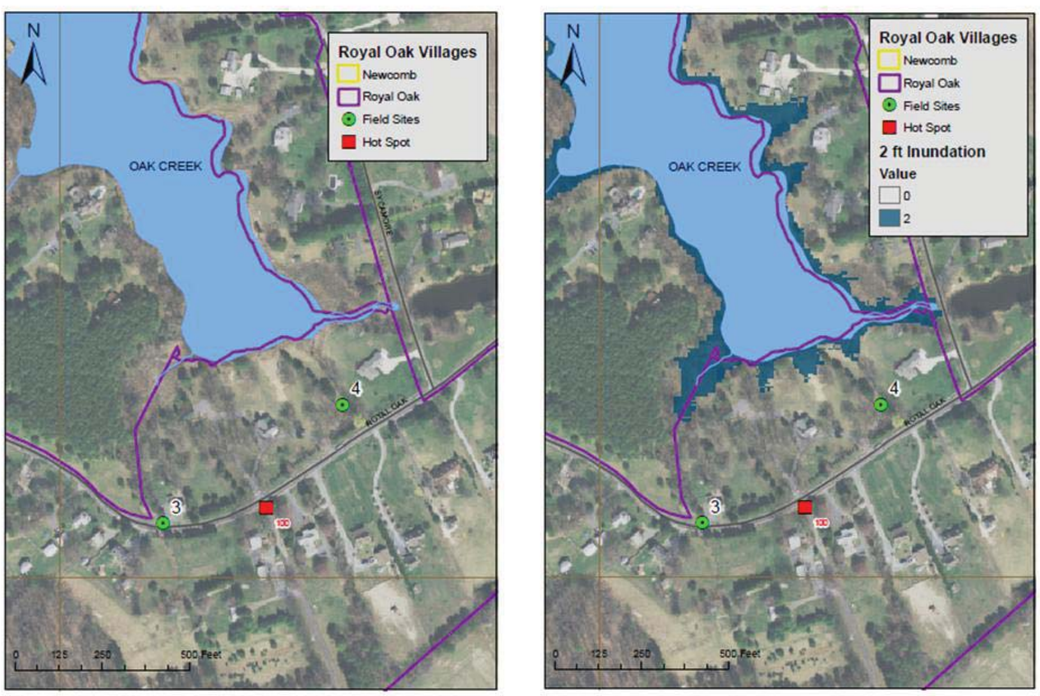
Before going into the field, Talbot County provided Geographical Information (GIS) that included typical site data (e.g., aerial imagery, contour lines, infrastructure, waterbodies, etc.). Prior to the field investigation, the Center compiled this GIS data and obtained the two foot inundation sea level rise data layer from the Maryland Department of Natural Resources (DNR) web mapping site "Merlin." This website is available online at: http://www.mdmerlin.net/mapper.html and includes parcels, historical shorelines, oyster bars, floodplains, sea level rise vulnerability, wetlands, and additional information. Desktop analysis was performed to identify potential areas for investigation, field maps were made and printed, and coordinate field work with the Village of Royal Oak stakeholders.

The Center used the Retrofit Reconnaissance Investigation (RRI) for stormwater management field investigations. The RRI identifies potential treatment practices designed to address stormwater quantity or quality where no practice previously existed. These treatment practices, also known as retrofits, are designed to store, infiltrate, and/or treat stormwater runoff from as much development as possible. Stormwater retrofits differ from "regular" treatment practices mainly in terms of when they are installed – they are installed well after development is complete, rather than during or even before construction. For this reason, stormwater retrofitting can sometimes be difficult. Finding the space available to install stormwater treatment practices without negatively impacting existing uses of the land is not always possible. For additional information about the RRI, refer the Schueler et al., 2007. In addition to the RRI, the Center field staff assessed the Village of Royal Oak for neighborhood investigations using the Neighborhood Site Assessment (NSA), looked for any "Hot Spots" using the Hot Spot Investigation (HSI). However, the major findings were based on the RRI assessment since only one Hot Spot was identified and the NSA findings are incorporated in the RRI results for this one neighborhood (or town). The overall objective for the RRI is to reduce stormwater runoff volumes and pollutants to the maximum extent practicable across the Village of Royal Oak drainage area given the rural and low development within the watershed. Additionally, photos were taken and logged.

The residential properties and drainage issues identified by the residents include cases of periodic or nuisance flooding. A site visit was conducted on Wednesday, March 2, 2011. Center staff, accompanied by the team members investigated each of the sites identified by the community to evaluate the public and private stormwater conveyance systems, and determine potential water quality and/or stormwater flooding retrofit opportunities. The area had experienced a moderate to light rainfall event the previous weekend and there was evidence of stormwater in several ditches, which is common in the winter and early spring. The Center utilized Village of Royal Oak Geographic Information System (GIS) maps that contained typical site information and land cover, as well as sea level rise data to identify retrofit areas and determine how sea level rise may impact project design. Two foot inundation sea level rise data was chosen since this represents the 50 year inundation scenario that is most relevant for stormwater infrastructure lifespan. See Figure 2 for an example of the sea level rise information at the sites.



(a)



(b)

Figure 2. Two foot inundation sea level rise maps were used in the field to inform future management options explored. In (a) the map on the left shows Sites 1, 2, and 5 with no sea level rise information and the map on the right identifies Sites 1, 2, and 5 with the two foot inundation information (shown in darker blue). In (b) the map on the left shows Sites 4 and 5 with no sea level rise information and the map on the right identifies Sites 4 and 5 with the two foot inundation information (shown in darker blue).

Village of Royal Oak Land Cover Summary

Using the GIS data provided by Talbot County, the following summary statistics were determined for the Village of Royal Oak (Table 1). The study area is rural with low impervious cover (<5%) consisting of primarily low density residential single family homes (residential parcels comprising approximately 50% of the land cover) and roads. This overall low level of impervious cover is generally considered to be within the accepted tolerance of stream hydrologic function and aquatic diversity. (Schueler, Fraley-McNeal, and Cappiella, 2009) Further, the low density of the impervious cover (that is, widely distributed in relatively small areas of rooftops, driveways, and roads) means that meaningful stormwater retrofits are unlikely (as confirmed by the field visit). However, several programmatic (non-structural) strategies, such as public education on general land and runoff management could be implemented to achieve significant pollutant load reductions on a watershed scale.

Table 1. Land cover analysis.

Feature	Area[1]	Percent of Total Land Cover
Village of Royal Oak (Total Area)	339 acres	
Residential Plots	172 acres	51%
Impervious Cover within Residential Plots[2]	8 acres	2%[3]
Forest Cover within Residential Plots	90 acres	27%[3]
Managed Turf within Residential Plots	74 acres	22%[3]
Roads	8 acres	2%
Other (open space, meadow, forest, unmanaged turf)	159 acres	47%

[1]Based on the resolution of the data up to 10% error is estimated.
[2] Impervious cover breakdown – driveways: 3 acres, Rooftops: 5 acres.
[3] Percentage of total area.

General Observations and Stormwater Quality Retrofits

The primary road through the Village of Royal Oak is Royal Oak Road (Route 329) which along with it's system of culverts and ditches are the central drainage features of the area. All five of the sites visited during this evaluation included Royal Oak Road and its associated drainage infrastructure. Each of the identified sites consists of, in part, relatively small roadway drainage systems (e.g., roadside ditches, cross culverts, drainage channels, and to a lesser degree pipe systems) that serve small suburban developed areas within relatively large rural agricultural and forested drainage areas. The sites visited were a result of the community meetings where residents identified areas of concern such as periodic road flooding and because they are highly visible areas adjacent to residences along the primary travel route through the Village of Royal Oak. In addition to the pre-identified sites the Center field team and volunteers assessed the Village of Royal Oak using a "windshield survey" (aka from vehicle).

The site visits included interviews with the property owners, where possible, to capture the historic anecdotal evidence of the drainage or water quality issues. In most cases, there was evidence of standing water or indicators of out of bank flow (e.g., leaf litter patterns, flattened grass, etc.), and the eye witness accounts provided confirmation of the conditions and assisted the investigating team's retrofit assessment. A common theme at all the sites was the frequency and duration of the observed flooding summarized as follows:

1. The reported flooding occurred during extremely large or intense storms and
2. The duration of the out of channel flow or nuisance flooding was limited to a few hours after the storm event.

This evidence indicates that these systems likely perform as designed during the more frequent and small storm events, with the amount of nuisance flooding increasing as storm intensity and duration increase.

The field sites visited and one Hot Spot identified are indicated on the map in Figure 3. A detailed assessment for all sites is in the Village of Royal Oak Stormwater Retrofit Assessments section.

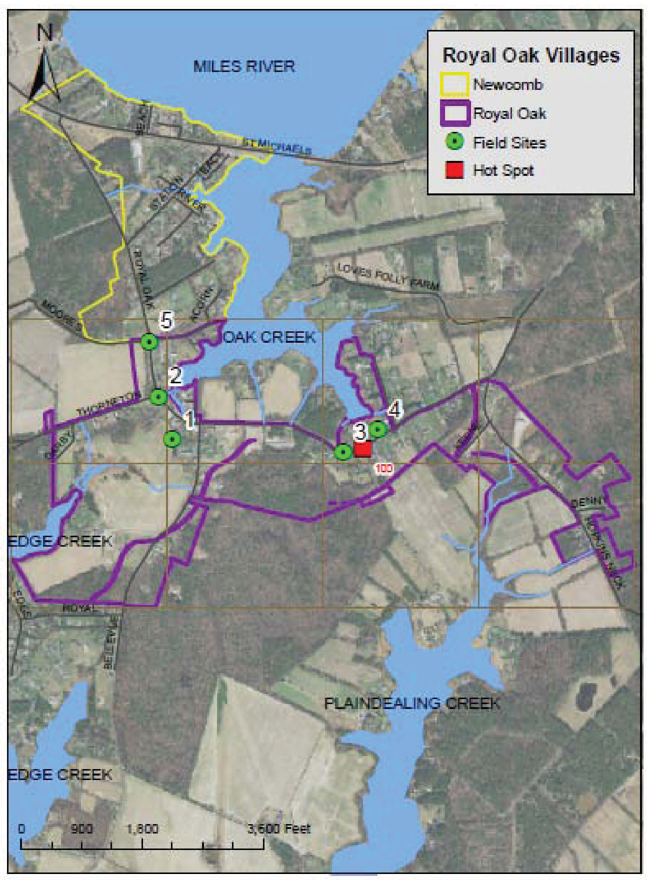


Figure 3. Field sites 1, 2, 3, 4, 5 and one Hot Spot (#100) are identified.

The field site visits also indicated that there are few structural retrofit opportunities to reduce stormwater runoff volume or pollutant load. The impervious cover is almost exclusively roadway, and isolated driveways and rooftops in this agricultural and recreational focused village. While the opportunities for small scale retrofits such as rain barrels and rain gardens at individual residences are available, they would serve primarily as educational tools for the community and not a significant source of water quality and/or quantity improvement.

The Village of Royal Oak retrofit opportunities are categorized as the following: 1) drainage system upgrades; 2) drainage and ditch system maintenance; 3) structural water quality retrofit improvements; 4) non-structural water quality retrofits; and/or 5) a combination of 1 through 4. These stormwater retrofit opportunities are described here:

Drainage System Upgrades: The drainage system described in Site 1 represents the most extensive system observed: multiple inlets and underground pipe alignments connecting private and public (County and State road) drainage systems, including possible field connections. Similarly, the system described in Site 2, while much simpler, was also difficult to accurately assess. The observed alignment of what appeared to be single run pipes or culverts did not continue to the expected terminus inlet (no pipe outlet or connection located in the field), indicating a possible underground horizontal bend or field connection.

Note:

A *horizontal bend* consists of gradually changing the alignment of the pipe by beveling the pipe alignment at each joint. There is a maximum bevel for different pipe materials and joint configurations, beyond which water can escape the pipe, and/or soil or pipe bedding material can enter the pipe – potentially undermining the grade above the pipe. In addition, the hydraulic design of storm drain systems rarely consider the hydraulic losses of horizontal bends, thereby inadvertently under sizing the system for the design flow.

A *field connection* consists of a smaller pipe connected to a larger pipe by cutting directly into the diameter of the larger pipe without a manhole or junction box. This technique is used often when new pipe systems are added in older developed areas. Field connections will significantly impact the drainage system by: 1) reducing the flow capacity of the larger system creating hydraulic losses within the pipe; 2) potentially adding flow beyond the design flow capacity; and 3) creating a condition that will snag debris such as branches, leaf litter, and/or trash in an inaccessible location further reducing the flow capacity of the system.

In addition, several culverts were in disrepair at the entrance due to the impact of vehicles that partially run off the road or large trucks that cut the intersection corners and run their tires into the ditch.

Drainage system upgrades would include a prioritized list of system components identified at Sites 1, 2, 3 and 5. Upgrades include eliminating field connections and horizontal bends by adding manhole structures or junction boxes, the installation of headwall or end wall sections as needed to improve culvert entrance hydraulics and capacity, and the replacement of old and broken pipe (or sections of pipe). Identifying and prioritizing the upgrades would include using video inspection equipment or other means of investigating the actual alignment and pipe system condition.

Unfortunately, the upgrades to the drainage system do not necessarily translate to measured water quality benefits. While flooding conditions may add to overall water quality impairments by destabilizing soil, killing vegetation, or washing debris and trash into the adjacent creeks, there were no specific improvements associated with drainage upgrades that related to water quality noted at the five sites investigated. In fact, only one "Hot Spot" was identified and consisted of a potential sewer manhole overflow. This Hot Spot was located at Schoolhouse Lane and Royal Oak Road (see Figure 3).

Drainage and Ditch System Maintenance: The roads and ditch systems exist in a low lying area with low relief (0 to 8 feet above sea level) throughout Royal Oak. Soil characteristics that range from high clay to high sand content (or a soil complex with varying combinations of the two) create ditch conditions that are highly variable and in some cases difficult to maintain. Many of the ditches (Site 3 & Site 5) hold standing water. Additional ditches were observed to have silted in up to one-half of the flow capacity.

It is evident that periodic maintenance of the system over the years to remove sediment and restore the ditch invert down to the elevation of the culvert has resulted in very rectangular ditch cross sections: a flat bottom invert with vertical side slopes. This is generally considered unsafe when positioned within the roadway clear zone; i. e.,: adjacent to the travel lane without any shoulder or guardrail, as noted by caution signs within the Village of Royal Oak that warn motorists of the drop off immediately adjacent to the road surface. Over time, these vertical ditch sides will slough into the channel creating a "vee" ditch geometry with less flow capacity and a new raised invert elevation (typically above the culvert invert). Gradually the sediment level will equalize in the adjacent culverts further reducing the hydraulic capacity and increasing the frequency of minor flooding over the roadway.

Other sections along Royal Oak Road have been graded to provide a more gradual ditch section with 2:1 or even 3:1 vegetated side slopes. This ditch geometry is much more stable and maintainable. Where possible, future ditch maintenance should attempt to implement this broader ditch section if the grade adjacent to the road is suitable and there is available right-of-way.

The traditional methods and equipment for roadside ditch maintenance can often create more water quality issues by clearing vegetation and mobilizing sediment. Instead, periodic maintenance focused on keeping the ditch inverts and culvert entrances clear of debris and woody vegetation will be more effective in reducing the frequency of minor road flooding while also reducing the export of sediment from the ditches that typically results from traditional ditch maintenance. While periodic traditional ditch maintenance is critical to maintaining the integrity of the pavement surface and providing a means to keep the roadway surface dry, there is generally minimal water quality benefit.

Structural Stormwater Quality Retrofits: There are limited opportunities for structural stormwater retrofits due primarily to the limited amount of impervious cover within the sites investigated. Most of the drainage areas consist of scattered impervious cover with rooftops providing the most likely opportunity through the use of rain barrels and rain gardens at the downspouts. These small scale stormwater retrofits will serve as an excellent public education campaign, however, the drainage problems at the five sites as identified by the citizens are not caused by these impervious areas. Flooding was likely due to the large drainage areas, the relatively small drainage systems (small ditch cross sections and the undersized or partially clogged culverts), and large and intense storm events. These intense storms are likely to increase in duration and frequency along coastal communities (IPCC, 2007).

Another potential structural retrofit option is the roadside ditches. However, due to the geometry of the ditches and the proximity to the road, the sites investigated did not represent a viable retrofit option.

Site 3 and Site 4 include potential structural retrofits that include the following:

- Channel stabilization of the small area of the channel on Site 3, along with strict implementation of Environmental Site Design (ESD) with any new development upstream; and
- Soil amendments and landscaping in the upper drainage areas of Site 5.

As noted above, however, the amount of impervious cover to these locations is minimal, and the current conditions do not reflect water quality impacts. It should also be noted that a non-structural stormwater retrofit using the application of an urban nutrient management plan at Site 5 (and community wide) for managed turf areas would be more cost effective and establish more readily measureable nutrient reductions. This is discussed further in the non-structural retrofit section below.

Non-Structural Water Quality Retrofits: Non-Structural water quality retrofits can include a variety of programs or policies that are directed towards reducing the pollutant load to the drainage system and creeks in the Village of Royal Oak. The establishment of an incentive program to install rain barrels and/or rain gardens represents a non-structural approach (incentives) to implementing small scale structural practices (rain barrels). Also, creating a public education and incentive program to implement urban nutrient management throughout the Village of Royal Oak is recommended. This could include components targeting professional landscape and lawn service contractors, residential "do-it-yourself" homeowners, pet waste management, and water conservation measures.

For example, programs that promote smaller discrete stormwater management options such as rain gardens and/or rain barrels installed by individual property owners could yield significant stormwater management benefits as the program expands over time to more residents of Royal Oak. Likewise, programs that promote better landscape and turf management practices can influence the potential stormwater pollutant load from a much greater drainage area than any structural practices can manage. Utilizing a focused outreach effort at a community wide scale can reduce pollutants entering receiving waters in the Village of Royal Oak.

Village of Royal Oak Stormwater Retrofit Assessments

Five sites were visited during field evaluations and are detailed here including a site introduction, drainage description, recommendations, and water quality benefit (if applicable).

Site 1

<u>Introduction</u>
Site 1 is located approximately south of 25913 Royal Oak Road (38 ° 44' 30.47 N, 76° 10' 44.89 W). Site 1 has a combination of nuisance flooding issues and a potential water quality retrofit. Field photos are included in Table 2. This area represents a typical drainage situation that occurs when what appears to be a minor change in the watershed can have significant consequences. In this case, the farm field in the southwest quadrant of the Site 1 Picture Index in Figure 4 was previously managed through conventional tilling. Over the past 5 years (approximate), the farming practice transitioned to "no-till" and a vegetated buffer was added. According to Steve (last name unknown) (owner of Property A shown in the Picture Index in Figure 4) and Allan "Jay" Fox (owner of Property B shown in the Picture Index in Figure 4) whose residences front the south side of Royal Oak Road near 25913 Royal Oak Road, this has resulted in an increase in nuisance flooding during relatively large rainstorms.

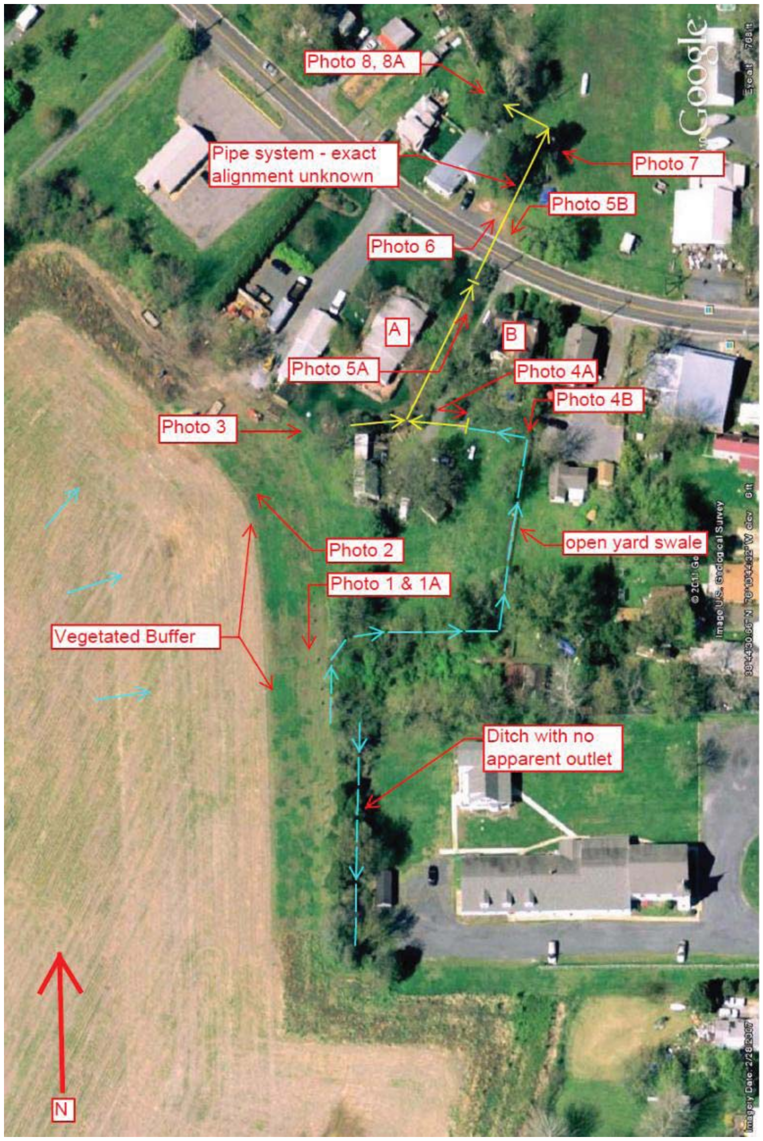


Figure 4. Site 1 picture index.

Table 2. Site 1 field photos.

Table 2. Site 1 field photos.	
 Site 1 - Photo 2	 Site 1 - Photo 3
 Site 1 - Photo 4A	 Site 1 - Photo 4B
 Site 1 - Photo 5A	 Site 1 - Photo 5B

Table 2. Site 1 field photos.

Drainage Description

The natural drainage divide between Oak Creek to the north and Upper Edge Creek to the south in the area of Site 1 is located somewhere in the vicinity of the rear of the properties along Royal Oak Road. The local high point of the sub-drainage shed is approximately in the center of the field and the drainage area that appears to drain to the north is approximated by the area shown in the Site 1 (Table 2 & Figure 4). The previous tilling operations provided a release for this runoff to the south along the eastern edge of the field (before the buffer was installed) where it continued to follow a small ditch system into two small ponds in series before draining into Upper Edge Creek. Upon the introduction of the "no-till" practice and the vegetated buffer (Photos 1 and 2), the residents indicate that the sub-drainage shed of the farm field is now draining through their properties towards Oak Creek to the north.

The drainage pattern to Oak Creek is complicated by the introduction of a rather complex drainage system. The flow from the farm field enters the residential properties through at least two independent paths:

1. The first starts with field runoff conveyed in a shallow depression (Photo 1A) that feeds a small ditch that runs the perimeter of the Fox property (Photo 4B) before entering a pipe system (Photo 4A).
2. The second collects the runoff from the field in small ditches immediately adjacent to the downstream side of the vegetated buffer and conveys runoff to a small pipe system (12" plastic pipe in background of Photo 3).

There are no as-built stormwater drawings to verify the configuration of the pipe system below this point. Figure 5 provides a best estimate of the system including drainage inlets serving Royal Oak Road. It is important to note the following:

- The pipe systems indicated in Photo 3 and 4A connect at 180 degrees with no maintenance access;
- The area circled in Photo 5A: this is a pipe connection of what was previously an open ditch; this area is a low point between the driveways and Royal Oak Road that routinely ponds water and the surface condition indicates that water enters the pipe system through the ground, likely carrying a significant volume of sediment into the pipe;
- Inlets on Royal Oak Road (one in each direction – east and west) field connect into this system at an undetermined location without any maintenance access;
- The pipe system continues across Royal Oak Road and makes at least two 90 degree bends (vicinity of Photo 7) without any maintenance access, before discharging into Oak Creek. (Construction of a sewer connection from the house on the north side of Royal Oak Road indicated no conflict with, or evidence of, the drainage system; and
- The outfall of this system is shown in Photo 8 & 8A, and is in disrepair. The last pipe section has separated and fallen into Oak Creek. Rip rap and other construction debris was periodically placed around the outfall to stabilize the bank and outfall pipe.

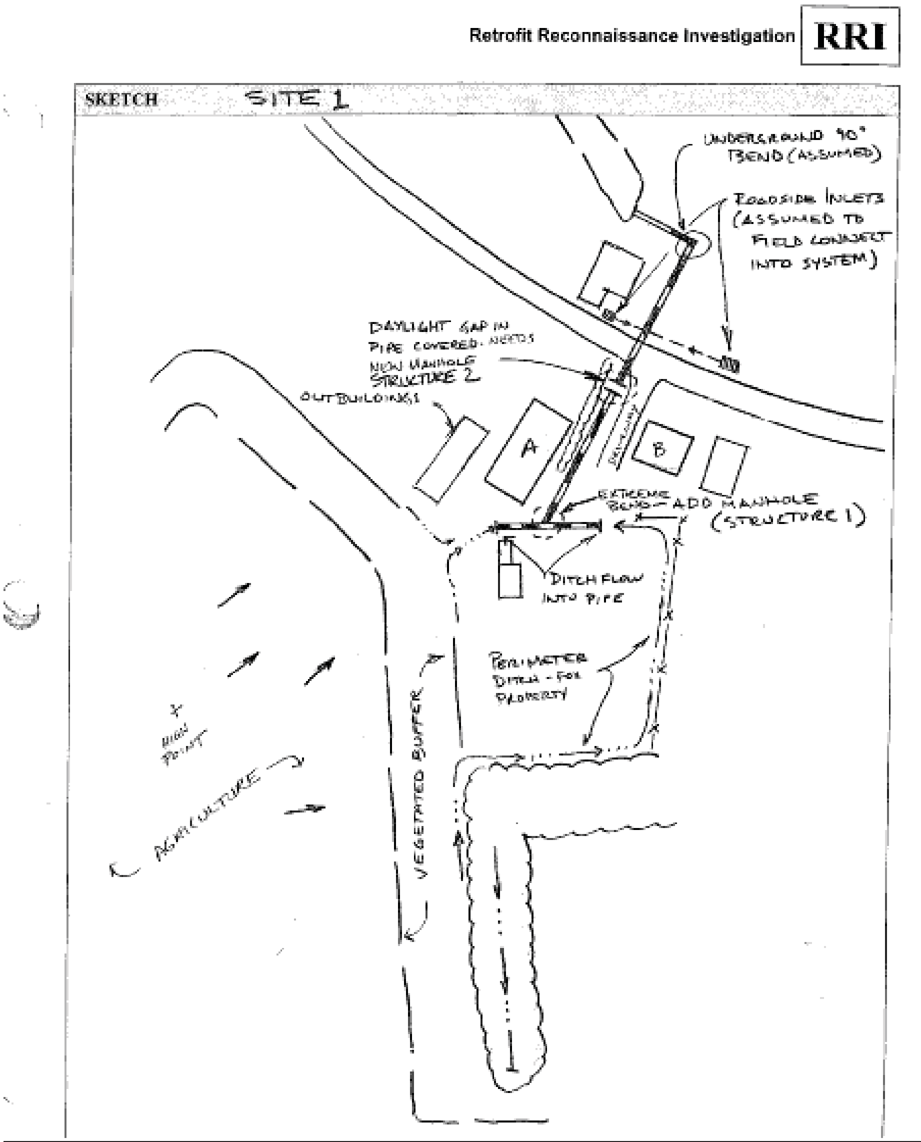


Figure 5. Site 1 system was sketched from field work and includes drainage inlets serving Royal Oak Road.

<u>Recommendations</u>

Recommendations to alleviate flooding include:

1. Install a manhole, inlet, or access structure at the 180 degree connection (structure 1 in Figure 5. Since this is a small system on private property, it is likely a homeowner installation.
2. Install inlet structure at location identified in Photo 5A (Structure 2 in Figure 5). Investigate the condition of pipe in both directions. Possible video of pipe under Royal Oak Road will help identify potential drainage problems associated with the State highway (or county) system in Royal Oak Road, and possibly locate the alignment of the system on the north side of Royal Oak Road. The owner of Property A indicated that he would install this junction since he had previously made the connection.
3. Install maintenance access (or cleanout) at the 90 degree bends in the system on the north side of Royal Oak Road.
4. Repair outlet of pipe system at Oak Creek.

Anecdotal evidence indicates that the periodic nuisance flooding in the residential area recedes in a reasonable period of time after the rain event. Therefore, it is expected that the drainage system under Royal Oak Road, when properly maintained, will be adequate for the drainage area (including the farm field). This can be verified once the system alignment and grades are identified.

If the system is not adequate, the drainage from the farm field can be redirected to its historic drainage pattern by leveling the low areas on the back side of the buffer that currently allow runoff to enter the residential properties. The flow should then be directed on the back side of the buffer towards the south (reversing the direction of the flow in Photo 1A) by re-establishing a short section of ditch through the field to reconnect with the main ditch system leading to the small ponds on the southern edge of the field. It is important to then establish (or re-establish) a buffer for this ditch to help maintain the efficacy of the small ponds (by filtering sediment and nutrients prior to entering the ponds).

Finally, sea level rise mapping did not indicate additional retrofits at this site. However, higher water levels at the outfall pipe should be considered when restabalizing this shoreline area.

Water Quality Benefit

Repairing the outfall of the pipe system and protecting the adjacent banks in the immediate area will be a load reduction practice similar to *stream restoration* or *structural* or *non-structural shoreline stabilization* (USEPA, In prep). The extent of the stabilization at the outfall will determine the extent of the load reduction credit. In addition, repairing the pipe system at the outfall and at the junction referenced in Photo 5A will eliminate the conveyance of soil fines from the pipe bedding and bank material and therefore represents an additional potential water quality benefit (although very difficult to numerically quantify).

The farm drainage is currently filtered through an *Agricultural Grass Buffer*; additional plantings currently in place may qualify the buffer for additional water quality performance (to that of a *Forested Buffer*). Therefore, the recommendation to redirect the farm field runoff to Upper Edge Creek must redirect the runoff after it has passed through the buffer in order to maintain the existing water quality benefits. Secondly, any additional ditching through the field in order to connect this drainage to the existing ditch system should be similarly buffered in order to maintain the water quality benefit. (The *Agricultural Grass Buffer* efficiency credit is 46% total nitrogen (TN); 42% total phosphorus (TP); and 56% total suspended solids (TSS)).

Site 2

<u>Introduction</u>
Site 2 consists of nuisance flooding at the intersection of Thorneton Road and Royal Oak Road (38 ° 44' 36.98" N, 76° 10' 47.73" W). The information from citizens indicates that the flooding occurs only during large or intense storm events. Field photos are included in Table 3 and Figure 6 gives the picture index.

Figure 6. Site 2 picture index.

Table 3. Site 2 field photos.	
	

Table 3. Site 2 field photos.

 Site 2 - Photo 3	 Site 2 - Photo 4
 Site 2 - Photo 5	 Site 2 – Photo 6
 Site 2 - Photo 6A	

<u>Drainage Description</u>
The drainage system serving the intersection is anchored by a large culvert that crosses under Royal Oak Road and discharges directly into a long channel (Photo 6 and 6A) that connects to the adjacent upper finger of Oak Creek as the drainage the outfall from Site 1. A series of inlets serving Royal Oak and Thorneton Road connect at some point and discharge to the single outlet.

Similar to Site 1, there are limited manholes, junction boxes, or access points to verify the alignment and/or condition of the pipe system.

Photos 2, 3, 4 and 5 show inlet pipes that connect to a large grate inlet (Photo 1), however, since only 3 incoming pipes were observed, there is likely an alternate alignment. Also, along the alignment of the pipe depicted in Photo 3 is a connection of another 15 inch diameter pipe and since no junction box is evident, it is assumed that this is a field connection. A more thorough investigation of these systems in required in order to evaluate if there is any drainage system upgrade or reconstruction required. It should also be noted that the entrance of the 18 inch CMP pipe on Thorneton Road is crushed (Photo 5).

Finally, the invert of the primary culvert under Royal Oak Road, a 32 inch by 48 inch (approximate) horizontally elliptical corrugated metal pipe (HECMP), is rusted out at the outlet and may begin to undermine the outlet and the road embankment if not repaired. The outfall channel appears to be stable and is held on one side by a bulkhead.

Recommendations

The nuisance flooding of the intersection is likely caused by a combination of increased volumes of runoff associated with land conversions and decreased conveyance capacity caused by clogging and poor hydraulics of the drainage system. As noted above, the exact alignment of the drainage system is not known; therefore the first recommendation is to verify the location, alignment, and condition of the pipes. Additional recommendations are the following:

1. Verify the location, alignment, and condition of the pipe system serving the intersection of Thorneton and Royal Oak Road;
2. Identify any pipe junctions that are without an access manhole or junction box; and
3. Clean out the entrance of the culverts and verify the working condition of the pipes.

Finally, sea level rise mapping did not indicate additional retrofits at this site.

Water Quality Benefit

Typical nuisance flooding problems do not usually contribute to water quality problems unless the flood waters cause excessive erosion or other impacts to upland areas that normally are not subject to periodic inundation. There was no evidence of erosion or other impacts in the vicinity of Site 2.

Site 3

<u>Introduction</u>
Site 3 represents a typical roadway cross-culvert condition where the flow velocity during storm events serves to keep the culvert clear of sediment. This site is located to the west of the Schoolhouse Lane and Royal Oak Road intersection on Royal Oak (38 ° 44' 28.28" N, 76° 10' 12.85" W). However, the condition of the downstream channel shows the beginning signs of scour where the channel makes a slight bend within a confined section adjacent to the road. The citizen interest in this as a retrofit project was due to the potential for continuing erosion under current conditions, as well as possible accelerated erosion into the future (in conjunction with a currently proposed development in the upper reaches of this sub-watershed). Resident(s) report losing a tree and potential to loose land due to increased erosion. Field photos are included in Table 4 and Figure 7 gives the picture index.

Figure 7. Site 3 picture index.

Table 4. Site 3 field photos.


Site 3 - Photo 1


Site 3 - Photo 2


Site 3 - Photo 3


Site 3 - Photo 4

<u>Drainage Description</u>
The upper portion of the contributing drainage shed to the cross culvert consists of forested wetlands. Closer to the road, the area is clear with a small the drainage consisting of a small shallow channel with thick vegetation (Photo 1). The area where the flow enters the roadway culvert is well maintained (clear of woody vegetation) and the culvert itself is in good condition (Photo 2).

The roadway culvert includes a field connection. The driveway on the east side of the culvert outlet (Photo 3) has a small culvert that connects directly into the roadway culvert approximately three feet upstream of the outlet. This driveway culvert connects one of the four roadside ditches that connect to this channel – two on the upstream side and two on the downstream side. The reports of periodic flooding over the roadway may be the result of the hydraulics caused by the field connection as well as the hydraulics of the contributing ditches; although the issue of potential channel erosion below the culvert (Photo 3 & 4) is more of a concern than flooding.

Recommendations
There are no obvious retrofit opportunities or fixes to this system of ditches and the cross culvert. The ongoing management practice of maintaining this area as a close-cropped lawn is contributing to the erosion. The area of channel now currently experiencing erosion may benefit from minor stabilization with biodegradable mating and vegetation. The plantings appropriate for this area should be relatively strong rooted ground cover rather than a bushy or thick shrub that would restrict the flow in the channel.

The timing of the proposed development upstream of this location will determine the stormwater management requirements. Ideally, the project should be required to comply with the Maryland Environmental Site Design requirements as adopted in Talbot County. This represents the best strategy for controlling any increases in runoff volume and peak flow rate.

Finally, sea level rise mapping did not indicate additional retrofits at this site.

Water Quality Benefit
No retrofit proposed.

Site 4

<u>Introduction</u>

Site 4 is located between Schoolhouse Lane and Sycamore Lane on Royal Oak Road's northern side (38 ° 44' 30.85" N, 76° 10' 06.12" W). Site 4 is a heavily landscaped and maintained section of a channel that collects runoff from upstream roadside ditches as well as relatively new single-family large lot developments that is conveyed through a roadway cross-culvert. There is no evidence of flooding or channel erosion. However, there were reports of periodic flooding over the road. Field photos are included in Table 5 and Figure 8 gives the picture index.

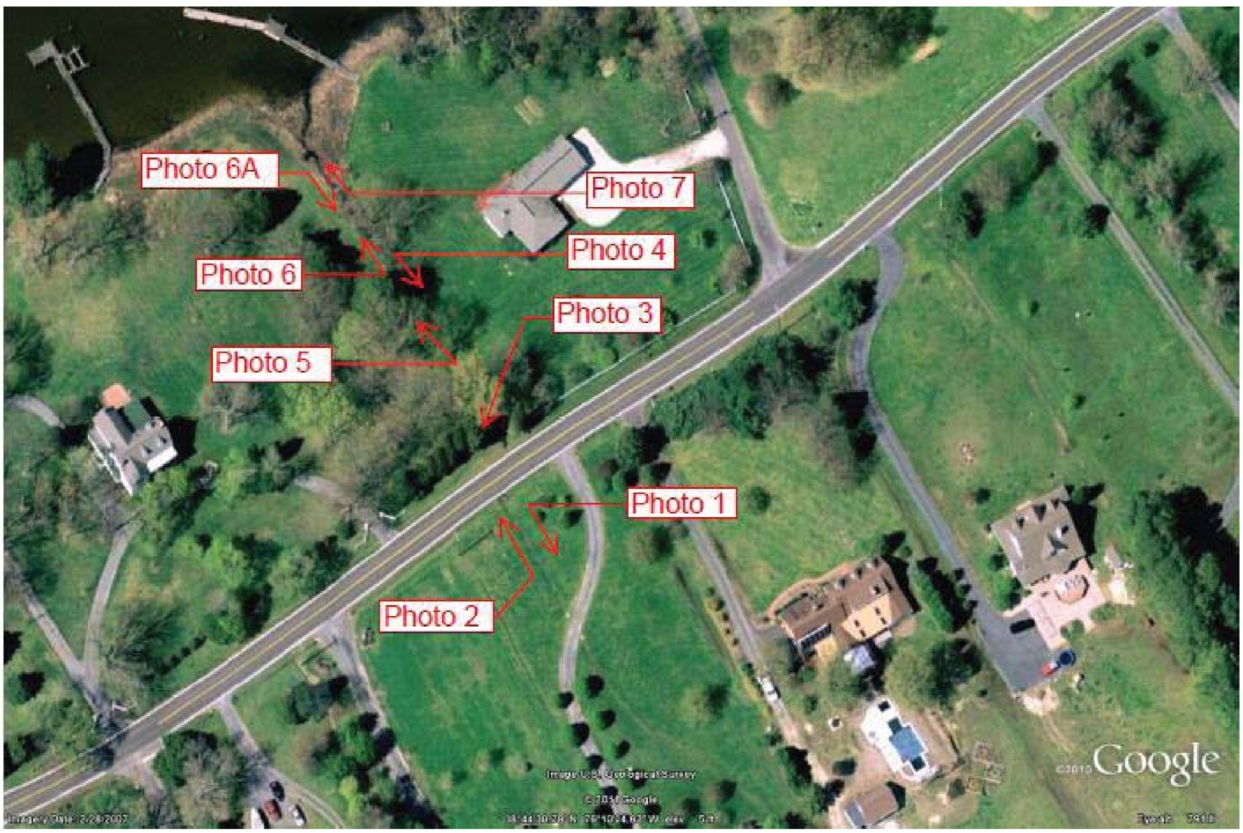


Figure 8. Site 4 picture index.

Table 5. Site 4 field photos.	
 Site 4 - Photo 1	 Site 4 - Photo 2
 Site 4 - Photo 3	 Site 4 - Photo 4
 Site 4 - Photo 5	 Site 4 - Photo 6

Table 5. Site 4 field photos.	
	

Drainage Description
The upper drainage area to the roadway cross-culvert consists of managed lawn. A broad flat swale gradually becomes more defined as it approaches the culvert (Photo 1 & 2). Typical for roadway culverts in the area, there is very little headwater depth available for the roadway cross-culvert to carry large storm flows. Therefore, the water is likely to back up during large storms and overtop the road. Also, this could occur in smaller storms (e.g., < 1 inch rainfall) if the culvert becomes clogged with leaves or debris (Photo 3).

This drainage channel has been incorporated into the private property landscaping (Photo 4), including a decorative bridge (Photo 5) and a landscape pond (Photo 6 & 6A). The landscape pond has a thick layer of organic material (leaves and bud shatter) on the pond bottom. The channel continues until below the landscape pond and then discharges to the upper finger of Oak Creek (Photo 7).

Recommendations
There were no apparent retrofit needs for this drainage area. The small pond traps a significant amount of leaf litter and additional organic debris moving through the channel. The outlet structure and the flat grade combine to maintain a stable channel all the way to the receiving waters of Oak Creek.

The upper portion of the channel (upgrade) – south of Royal Oak Road (Photo 1), could be retrofit with a shallow bioretention area to help reduce nutrient loads associated with managed turf in the upper drainage area, thereby improving the aesthetic conditions of the existing landscape pond. The proposed shallow bioretention area could consist of a heavy planting of herbaceous, local vegetation and include a six inch ponding area with a permeable berm. The permeable berm is proposed in lieu of an underdrain since there is no option to "daylight" an underdrain due to the flat grades.

Finally, sea level rise mapping did not indicate additional retrofits at this site.

Cost Estimate
Approximate Drainage Area: 0.48 acres
Approximate Impervious Cover: 0.1 acres
Typical Bioretention Surface Area (SA) = 5% of impervious cover; SA = 220 ft^2
Approximate Cost = \$15/ft^2 of surface area = \$3,300.

Water Quality Benefit
Bioretention is credited with 50% TP reduction as per the MD Critical Areas Guidance, and generally accepted removal efficiencies for TN and TSS of 60% and 80% respectively.
As noted in the recommendations, however, given the relatively small drainage area and correspondingly high cost per pound effectiveness, a well formulated urban nutrient management plan would potentially have a much greater water quality benefit in terms of the total area covered or "treatment area" and cost. A general urban nutrient management plan is detailed in the "Maryland Nutrient Management Law/Urban Nutrient Management" section that follows.

Site 5

<u>Introduction</u>
Site 5 consists of the intersection of Royal Oak Road with Acorn Road to the east and Moores Road to the west (38° 44’ 44.56” N, 76° 10’ 49.36” W). The Site description should also include the drainage ditches along the alignment of both sides of Royal Oak Road (north and southbound lanes, on both sides of the intersection). The drainage ditches are in relatively good shape; however they also contain what appears to be standing water. Similar to the other sites investigated, sites, these ditches appear to be operating at less than full capacity due to siltation and standing water. Field photos are included in Table 6.

Table 6. Site 5 field photos.	
 Site 5 - Photo 1	 Site 5 - Photo 2
 Site 5 - Photo 3	 Site 5 - Photo 3A

Table 6. Site 5 field photos.	
	

<u>Drainage Description</u>
The grade along Royal Oak Road is extremely flat, such that it is very difficult to determine the direction of the flow without a very accurate level. The drainage ditches at the site were all holding water. The roadside ditches appeared to contain sediment and/or organic material.

<u>Recommendations</u>
There is no retrofit recommendation for this site. However, if flooding is a major concern and/or observed often at the site, delineating the drainage area is recommended and should be based on survey data. Roadside ditches should then be assessed to determine if they are functioning as designed. The survey data can help guide improvements if it is determined that the ditches are inadequate for the road conditions.

Finally, sea level rise mapping did not indicate additional retrofits.

<u>Water Quality Benefit</u>
No retrofit proposed.

Hot Spot Investigation

A manhole that covers the pump station overflow was found in the field. This Hot Spot (Site Number 100) was located on the corner of Schoolhouse Lane and Royal Oak Road (38° 44' 28.23" N, 76° 10' 9.09" W). The site is indicated in Figure 3 with a red box. The overflow was documented (Table 7) and phoned into Talbot County Planning and Zoning Division. The City of Saint Michael's waste water treatment staff investigated this within hours of the original identification. Groundwater infiltrates the well, rises, and comes out of the manhole. It was tested that afternoon and contained no evidence of sewage contamination. This site often overflows according to the Royal Oak residents.

Table 7. Hot Spot investigation field photos.	
	

Summary

The Village of Royal Oak is a low lying coastal community containing a system of culverts and ditches that represent the central drainage features of the area, and is a representative area in the Traditional Villages located in Talbot County, Maryland. This study was carried out to analyze and describe existing conditions and develop management and implementation strategies where possible. In addition, management and implementation strategies incorporated the two foot sea level rise predictions. The Center performed field work in coordination with local stakeholders and project partners, assessed the area, and compiled this information to provide potential stormwater management options (i.e., retrofits) for the Village of Royal Oak.

The Center gathered background information through the internal kick off meeting and first community meeting. The information gathered included areas in the Village of Royal Oak where flooding or other problems existed, volunteers to participate in field work, flooding pictures, and additional study area information. The Center's analysis of the Village of Royal Oak resulted in the selection of five sites for management options. Each of the identified sites consists of, in part, relatively small roadway drainage systems (e.g., roadside ditches, cross culverts, drainage channels, and to a lesser degree pipe systems) that serve small suburban developed areas within relatively large rural agricultural and forested drainage areas. For each site the drainage area was assessed, potential stormwater retrofits were recommended, additional non-structural recommendations reported, and/or the water quality benefit was determined. In addition, sea level maps for the area were consulted in the field so that any potential retrofit's impact by two foot sea level rise inundation could be determined. There were no instances where this potential sea level rise impacted the retrofit design or recommendation. However, using sea level projections for coastal areas is important and this data should be incorporated into each planning, stormwater, and/or watershed planning effort for Talbot County.

Improving current drainage systems was recommended for Site 1 and 2 and included: 1) determining what infrastructure exists; 2) providing the infrastructure location; 3) gaining access to the system(s); and 4) performing system inspection and maintenance, if needed. For the Village of Royal Oak, drainage system upgrades, drainage and ditch system maintenance, structural stormwater quality retrofits, and non-structural water quality retrofits were recommended and discussed. Additional, recommendations for the Village of Royal Oak include: 1) a need to find and transfer the state highway stormwater infrastructure; 2) determine where easements or additional natural resource protection elements exist, especially along roadways; 4) use non-structural stormwater management and watershed planning since the study area contained low impervious cover and represented a rural landscape. Examples of non-structural stormwater management practices include urban nutrient management, pet waste education and outreach, and an incentive program to promote rainwater harvesting and other small scale management options.

Typical Royal Oak Management Strategies

Typical engineered stormwater retrofits (e.g., bioretention, grass swales, etc.) were not identified in the Village of Royal Oak. Royal Oak has very low impervious cover and low relief (0 to 8 feet). Existing impervious cover in the form of rooftops are disconnected to turf areas. Remaining impervious cover in Royal Oak are roads. The areas where road retrofits (e.g., swales) would be built are narrow and ownership rights and easement acquisition could prove costly compared to the water quality benefit. The lack of existing stormwater infrastructure makes typical urban retrofitting more difficult.

Generally, the prioritization ranking of nutrient reduction projects routinely places urban retrofits as the most costly (and therefore least cost effective in terms of dollars per pound of reduction). Other source sectors, such as agriculture, shoreline erosion, and septic likely contribute a far greater load in this particular watershed and therefore have more potential for cost effective reductions. However, based on the large percentage of land cover in residential use, it makes sense that the urban sector should be explored to the maximum extent practicable. Programs such as rooftop disconnection, rain barrels, and rain gardens can serve as a public outreach mechanism though most impervious cover is already disconnected. Rain gardens appear to be the most useful retrofit option which was identified at the community meeting as a desirable option. These efforts will likely have little measureable effect in terms of computed project specific nutrient reductions; however, the effect could be significant if they serve to educate the citizens of Royal Oak on more environmental land and runoff management strategies.

Typical Rain Gardens

Rain gardens are a stormwater management practice that can offer water quality benefit to receiving waters, localized flood control, and serve as an educational tool in the community. Several lots were identified (Figure 9) to serve as a typical rain garden retrofit. *Micro-Bioretention* are also known as *Rain Gardens* are small, distributed practices designed to treat runoff from small areas, such as individual rooftops, driveways and other on-lot features in single-family detached residential developments. Inflow is typically sheet flow or can be concentrated flow with energy dissipation, when located at downspouts.

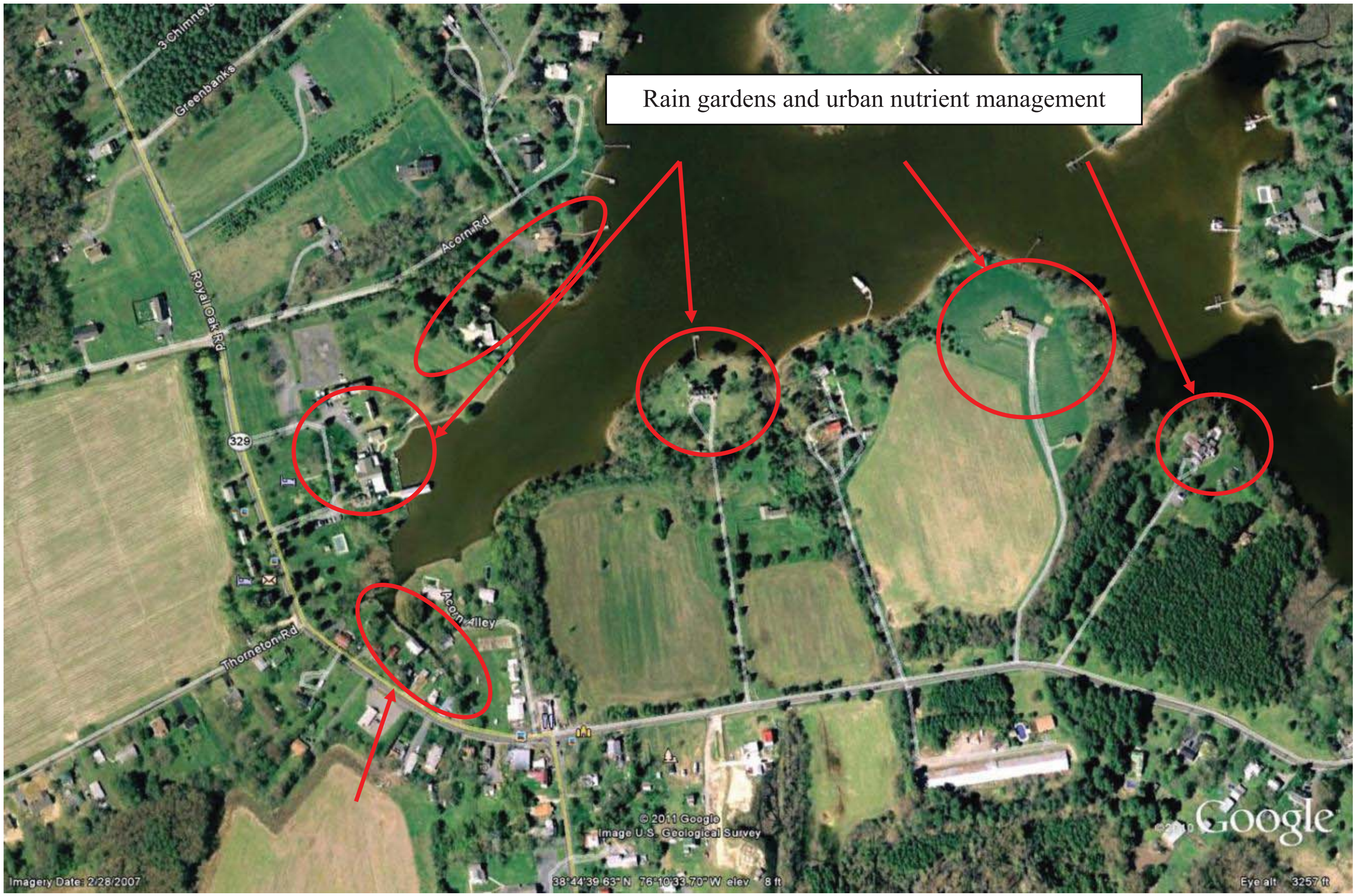


Figure 9. Typical rain garden retrofits near Royal Oak Road and Acorn Road.

Maryland Nutrient Management Law/Urban Nutrient Management

In an effort to reduce nutrient loading from urban and suburban turf areas the state of Maryland passed the Lawn Fertilizer Bill (SB 487 & HB 573). The bill amends the Maryland Commercial Fertilizer law under the Agriculture Article. The law only pertains to fertilizer applied for turf care, fertilizer used in agricultural production is not covered. The bill affects both the content of fertilizer and behavior at the residential and commercial scale. The bill applies to do-it-yourself (DIY), golf course, and commercial applicators.

Fertilizer Contents- The bill requires that turf fertilizer contain no more than 0.7 pounds of water soluble N and no more than 0.9 lbs if total N per 1,000 square feet, and at least 20% of the N shall be slow release. It also requires that lawn fertilizer contain no P except when specifically labeled for establishing vegetation, repairing turf to as determined by a soil test.

Use Restrictions- The law prohibits applying fertilizer to frozen ground and impervious surfaces, DIY, and commercial application before March 1st or after November 15th. Additionally the law prohibits fertilizer application within 15 feet of a water body (10 ft if using a drop spreader). It requires that professional applicators must be certified by Maryland Department of Agriculture (MDA), trained by a certification program approved by MDA or be working under the direct supervision of a certified professional fertilizer applicator.

Load Reduction- The legislation and its enforcement is estimated to reduce phosphorus runoff from urban loads by 15%. This represents 20% of the phosphorus reduction MD needs to achieve statewide as part of the Chesapeake Bay Total Maximum Daily Load (TMDL).

Talbot Septic Systems

Talbot County has already implemented one of the most significant strategies to reduce nutrient loads from suburban and rural communities by connecting households with traditional septic systems to a wastewater treatment plant (WWTP), which has a lower nitrogen load than traditional septic systems. An alternative to hooking up to the WWTP is to convert the traditional septic system to a best available technology (BAT) septic system.

Maryland Department of the Environment (MDE) outlined guidance from the Chesapeake Bay Program to determine nitrogen loadings from septic systems in "2006 TMDL Implementation Guidance for Local Governments." While there are many variables that affect the nitrogen loading from a given septic system, the guidelines assume that on average, 9.5 pounds of nitrogen per person per year will be delivered to a septic drain field and, in the critical area (within 1000-ft of a tidal body of water), 80% of the nitrogen will be delivered to the nearest body of water. These assumptions, combined with 2010 Census data of 2.20 people/household for Talbot County, lead to an average annual septic system loading rate of 16.72 pounds TN per household.

9.5 lbs TN x (0.8) x 2.20 people/household = 16.72 lbs (pounds) TN / household

Depending on the technology implemented at the WWTP this total N load per household could be reduced by approximately 90% by taking the household off septic and onto the WWTP.

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BELLEVUE COASTAL COMMUNITY

Comprehensive Analysis of Stormwater Management and Shoreline Erosion Control

April 2011

Prepared by

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BACKGROUND

The Shoreline community of Bellevue in western Talbot County was selected by Talbot County Government as part of the pilot program under the Maryland's Chesapeake & Coastal Program Coastal Communities Initiative (CCI). The pilot program seeks to assess the existing conditions of stormwater management (SWM) and shoreline erosion control; and establish stormwater management and shoreline erosion control priorities for retrofits, improvements and enhancement.

Bellevue is a 57.9 acre community that has morphed from a village supported by a local canning operation to a single lot residential community. Bellevue is also home to the Oxford-Bellevue Ferry, which is believed to be the oldest privately operated ferry service, running continuously since 1836.

Figure 1: Bellevue Coastal Community Study Area

CURRENT STORMWATER MANAGEMENT AND CONVEYANCE

Field reconnaissance could not identify any onsite existing stormwater management best management practices (BMPs) for either the roads or other impervious surfaces of the coastal community of Bellevue. Recently constructed homes, as identified from aerial images, where not observed to have implemented any single lot stormwater management BMPs. Especially prominent was the lack of any BMPs for what appeared to be the recently redeveloped and well maintained community park and ferry launch parking, both of which discharge directly to tidal waters.

The current condition of the stormwater conveyance for all the interior roads of the coastal community of Bellevue were identified as either inadequate, nonexistent or nonfunctioning. Bellevue Road is well maintained and crowned so that stormwater runoff collects in the roadside drainage swales. But, the roadside drainage swales were observed with a significant amount of standing water and did not appeared to drain properly. The ferry parking and access were observed to drain properly to tidal waters, but the runoff, in a high use paved area, does not receive any type of stormwater management. As highlighted by concerns from Bellevue residents, and verified by field observations, at almost every intersection stormwater runoff backs up and ponds for extended periods of time. Particular areas of standing water were at either end of Dawson Street, midway down Gate Street and the entrance to Church Street. The state of the current stormwater conveyance has resulted in the roadways with standing water after storm events, potholes and accelerated deterioration of driving surfaces.

CURRENT SHORELINE EROSION

Field reconnaissance of the entire 6,160 LF of shoreline revealed that a significant majority of the coast has been protected by individual property owners. Appendix 1 details the stability of the shoreline for the entire coastline of the Bellevue coastal community, where approximately 1,875 feet or about 30% of the shoreline appeared to be in an unstable condition. The majority of the protection on the southeast side of the peninsula is either bulkhead or revetment armoring. Along the north and northwest the protection is stabilized with revetment or a combination of revetment and living shorelines stabilized with native vegetation. The area that was found to have significant erosion is the northwest of the peninsula where Tar Creek empties into the Chesapeake Bay. Several land owners in this vicinity have experienced failure of the existing structural stabilization, with the major failure being that of an existing bulkhead in a little cove with several abandoned wooden boats. Several landowners in this vicinity are currently experiencing high degree of shoreline erosion from lack of any type of stabilization. The closer to Tar Creek the more naturally stable the shoreline becomes. The individual property owner’s ability to prevent erosion of their waterfront property varies greatly. Generally, the larger lots with newer homes have protected their shoreline, while the smaller lots with older homes have not. Fortunately, from a shoreline erosion perspective, the majority of the homes along the shoreline are newer homes on larger lots that have protected their shoreline.

FUTURE FLOODING HAZARDS

Future flooding hazards, due to rising sea levels, impacts on the Bellevue coastal community were assessed with The Maryland Department of Natural Resources – Sea Level Rise Inundation Vulnerability dataset. The 2 Foot Sea Level Rise Inundation dataset is a derivative of high-resolution topographic data (LiDAR). The State of Maryland, through a National Oceanic and Atmospheric Administration, Coastal Zone Management Grant, created the 2 Foot Sea Level Rise Inundation dataset to assist the Maryland Commission on Climate Change develop a strategy for reducing Maryland's vulnerability to climate change-induced sea level rise.

The existing topographic information, when compared to the 2 foot sea level rise dataset, revealed that the coastal community of Bellevue would be adversely affected in the northwest tip of the peninsula where no bulkhead or stone revetment has been constructed. This area is where the shoreline is very stable from previous shoreline stabilization efforts with native vegetation. The Bellevue-Oxford ferry commercial operation may require mitigation or infrastructure upgrades to avoid any potential adverse impacts due to 2 foot sea level rise. No existing residential structures would be impacted from a 2 foot sea level rise.

The exiting aerial imagery was overlaid with the exiting FEMA 100-year floodplain (storm surge) dataset to determine the current flooding hazards. The analysis revealed that a significant majority of the existing residential structures and the Oxford-Bellevue Ferry are well within the existing floodplain and would be significantly impacted by a 100-year storm surge event at the current sea level and the risk of flooding be increased with any rise in sea level. Appendix 2 shows the extent of shoreline vulnerability to rising sea levels and current 100yr storm surges.

ESTIMATE OF CURRENT STORMWATER POLLUTION LOADING

An estimate of current pollutant loadings can be determined with the Simple Method, developed by Schueler (1987). The Simple Method provides a realistic level of accuracy for estimating pollutant loading for stormwater runoff in urban areas. It requires several input parameters such as drainage area, amount of impervious coverage, annual precipitation, and pollutant concentrations to estimate the pollutant loading. The input concentrations can either be specific to the type of land use within the drainage area, or utilize more generalized pollutant concentrations for urban runoff. General urban pollutant loadings for stormwater runoff were utilized for this estimate. Equation 1 list the Simple method of calculating annual pollutant loads (lbs/yr) and Table 1 lists the input parameters utilized in the simple method to develop the annual pre-project annual pollutant loads.

Equation 1: $L = [(P) (Pj) (Rv) / 12] (C) (A) (2.72)$, where $Rv = [0.05 + (0.9 Ia)]$

Table 1 – Simple Method Annual Pollutant Loading Model Input Parameters		
Parameter	**Symbol**	**Input Value**
Annul Precipitation (in/yr)	P	43.2
Fraction of Runoff Producing Events	Pj	0.9
Runoff Coefficient	Rv	0.149
Area (Acres)	A	60
Impervious Area (%)	Ia	11.0
Mean Concentration of Total Phosphorous (mg/L)	C – TP	0.26
Mean Concentration of Total Nitrogen (mg/L)	C – TN	2.00
Mean Concentration of Total Suspended Solids (mg/L)	C – TSS	54.50

Using the Simple Method Equation and the above input parameters, current annual stormwater pollutant loading was estimated. The results are listed in Table 2.

Table 2 – Current Annual Stormwater Pollutant Loading						
Project ID	**Description**	**DA**	**Imp. Area**	**Annual Pre-project Pollutant Loads**		
				TP	**TN**	**TSS**
		Acres	**%**	**lbs/yr**	**lbs/yr**	**lbs/yr**
BV	Bellevue Coastal Community	60	11	21.7	166.7	4,541.9

ESTIMATE OF CURRENT POLLUTANT LOADS FROM SHORELINE EROSION

An analysis of the historic shoreline erosion rates shows an estimated historical shoreline loss of 6 inches to 1 foot per year for unprotected areas. Shoreline without structural or non-structural shoreline erosion controls in Maryland can be attributed a sediment loading rate of 2.917 kg/day/ft, based on Maryland Department of Natural Resources data. This loading rate closely matched our estimates of shoreline erosion based on an analysis of the topography and historical shoreline. The amount of phosphorus and nitrogen attached to sediment was calculated using information collected by USDA Agriculture Research Service. The estimate starts with an overall phosphorus concentration of 0.0005 lbs per lb of soil and a nitrogen concentration of 0.001 lbs per lb of soil. Soil texture is determined and a correction factor is used to better estimate nutrient holding capacity of the soil, because sandy soil has a lower nutrient-holding capacity than a clay soil. Silt is the dominant soil texture for the study area, so a correction factor was not necessary. Table 3 list the estimated annual pollutant loads attributed to shoreline erosion while appendix 3 shows the historical shoreline for Bellevue coastal community.

Table 3 – Estimate of Current Pollutant Loads from Shoreline Erosion				
Shoreline Classification	Shoreline Length	Annual Pollutant Loading Rate		
		TSS	TP	TN
	LF	lbs/yr	lbs/yr	lbs/yr
Unstable	1,875	4,391,908	2,195	4,391

POTENTIAL STORMWATER AND SHORELINE EROSION CONTROL BMPs

A strategic assessment of potential stormwater and shoreline erosion control BMPs was conducted in order to identify opportunities for potential retrofit BMPs to control stormwater runoff, shoreline erosion and reduce pollutant loading of the Chesapeake Bay. The BMP assessment utilized information gathered from a comprehensive field assessment and a review of Talbot County GIS data. From the assessment, comprehensive stormwater management and shoreline erosion control plan was developed that identifies and prioritizes BMP concept opportunities that would most effectively benefit the coastal community of Bellevue.

The BMP concepts are group by methodology, with each concept implementation being briefly described. The potential impervious area to be treated or shoreline to be protected is also quantified and a reasonable cost analysis is presented for each concept based on our experiences with previous projects of a similar nature. Cost shown are for comparison purposes and do not include contingencies, engineering, permitting, etc…Appendix 4 shows a location map of each of the identified stormwater management or shoreline erosion control concepts.

BMP – Maintenance of Interior Roads (Concept 1)

Description

The interior roads of the Bellevue Coastal Community are either deteriorated asphalt or gravel surfaces. They do not have stormwater management controls, nor were they built to minimize erosion impacts during severe rainfall events. The road edge often becomes the collection point for concentrated stormwater flows resulting in gully erosion and high sediment loads. The concept is to maintain and fix the driving surface so that water drains properly and prevents sediment loading from accelerated deterioration of the driving surface.

Concept

<u>Concept 1</u> – Resurface the existing 2.9 acres of the Bellevue coastal community interior roads with a minimum of 1 ½ inch bituminous surface course that to form a properly crowned residential road that will facilitate the drainage of water from the roadway surface to the pervious adjacent surfaces and prevent the accelerated deterioration of the driving surface. Additionally it would be advantageous to also encourage individual property owners to maintain their driveways in a manner that reduces the amount of

water ponding at the edge of the driveway and road surface. This will reduce the pollutant loading associated with stormwater runoff from the deterioration of the driving surface. The cost of implementing the maintenance of the interior roads by applying a 1 ½ inch surface course of bituminous concrete would be approximately $20 per square yard or approximately $94,000 for this concept.

BMP – Bio-swales (Concepts 2 through 4)

Description

A bio-swale is a series of vegetated open channel management practices designed specifically to treat and attenuate stormwater runoff for a specified water quality volume. It is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. All roadway bio-swales (concepts 2 through 4) are recommended to be implemented with concept 1 to provide positive drainage to the BMP from the roadway surface. Bio-swales are appropriate for the site because they will capture and treat runoff from adjacent impervious surfaces while being a linear BMP that does not require a vast amount of area to implement.

Concepts

<u>Concept 2</u> – Install 300 feet of 2'-4' wide bio-swales along either and/or both sides of Orchard Terrace. The design of the bio-swales should include the use of an underdrain. This concept could provide water quality treatment for approximately 0.16 acres of impervious roadway and up to 0.8 acres of the 1/8 acre residential lots located on Orchard Terrace. The cost to construct the bio-swales would be approximately $120 per foot or $36,000 for this concept.

<u>Concept 3</u> – Install up to 800 feet of 2'-4' wide bio-swale along the East side on Poplar Street. This concept could provide water quality treatment for approximately 0.52 acres of impervious roadway. The installation of several driveway culverts and an outfall easement across an adjacent landowner would be required for this concept. There is the possibility for an additional 500 foot bio-swale to be extended where the ideal outfall is located- an old road bed from a previous water access. The additional bio-swale would capture a limited amount of impervious area and is not recommended unless the roadway swale cannot be sized large enough to effectively treat the entire roadway stormwater runoff. The cost to construct the bio-swale would be approximately $90 per foot or $72,000 for this concept.

<u>Concept 4</u> – Install 200 feet of 4'-8' wide bio-swale on the between Bellevue Park and the Bellevue-Oxford Ferry parking lot. The bio-swale would drain into a yard inlet that would discharge underneath Bellevue Road directly to tidal waters. This concept could also utilize a trenchdrain installed across the parking lot to capture and treat more of the stormwater runoff. The concept could capture and treat runoff from approximately 0.25 acres of the impervious parking area. The cost to construct the bio-swale would be

approximately $180 per foot $36,000 for this concept, inclusive of the installation of the outfall and trenchdrain.

BMP – Hydrodynamic Structures (Concept 5)

Description

Hydrodynamic structures are devices designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads that are designed to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff. They also may be effective in removing contaminants that are not removed by less highly-engineered systems. However, they may also require greater maintenance than other BMPs and may not be economical for large runoff volumes.

Concept

Concept 5 – Install one or multiple basins (trenchdrains or inlets) and an online hydrodynamic separator to capture and treat stormwater runoff from the Bellevue-Oxford Ferry parking lot and boat ramp that currently sheet flows to tidal waters with no treatment. This device would also be ideal to capture other pollutants such as oil or gas that accumulate on the pavement from the high access of vehicular traffic and from the used oil/grease disposal site located in the parking lot.

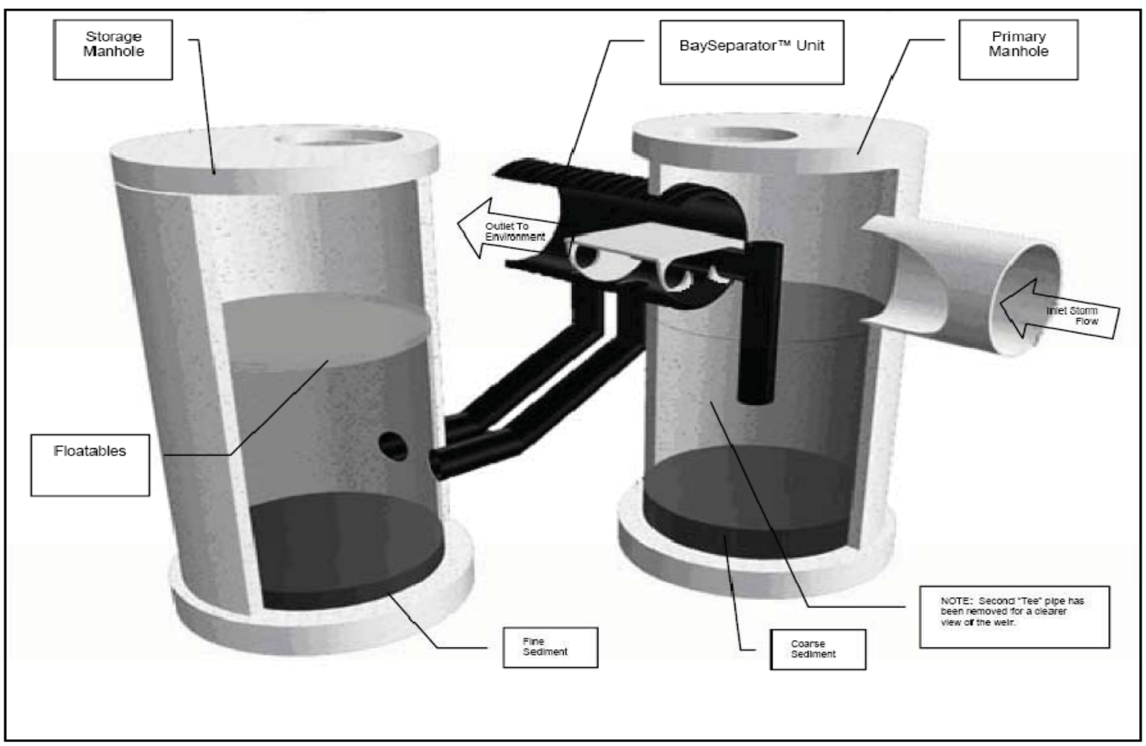

Figure 2: Example of a hydrodynamic separator.

The concept could capture and treat runoff from up to 0.35 acres of the impervious parking area and ferry access. Figure 2 shows an example of a hydrodynamic separator.

The cost to install the hydrodynamic separator can vary depending on the configuration/type of the capture and conveyance and the proprietary system selected. A standard hydrodynamic separator configuration for this concept would cost approximately $50,000.

BMP – Constructed Wetland (Concepts 6 and 7)

Description

Constructed wetlands are systems that perform a series of pollutant removal mechanisms including sedimentation, filtration, absorption, microbial decomposition and vegetative uptake to remove sediment, nutrients, oil and grease, bacteria and metals. Wetland systems reduce runoff velocity thereby promoting settling of solids. Plant uptake accounts for removal of dissolved constituents. In addition, plant material can serve as an effective filter medium, and effectively remove nitrogen.

Concept

Concept 6 – Convert an old 1.8 acre overgrown phragmites marsh that may have been previously used as a dredge material placement site into a shallow wetland with multiple permanent pools and landscaped with native vegetation. This concept could capture runoff from approximately 11.5 acres, of which 7.3 would be 1/8 acre residential lots. This option would also provide for habitat enhancement in addition to the pollutant removal benefits. Figure 3 shows an example of a site that was converted from a phragmites marsh into a constructed wetland.

Figure 3: Example of a constructed wetland before and after.

The concept would require a permanent easement or purchase of the land from a private land owner. If this concept was implemented, then concept 2 and part of concept 3 would not be necessary. The cost to construct a constructed wetland would be approximately $180,000.

Concept 7 – Construct a small shallow wetland at the culvert underneath Bellevue Road. The constructed wetland would need an easement or property purchase from a private landowner, who is not part of the Bellevue coastal community. The facility would capture runoff from the remainder of the land, which the current use is cultivation. The cost of the wetland would be dependent on the size of the parcel of land acquired and is directly linked to the potential pollutant removal benefits.

BMP – Rain Gardens (Concept 8)

Description

Rain Gardens are bio-retention basins primarily utilized for treating single lot runoff. They are planting areas installed in shallow basins in which the stormwater runoff is treated by filtering through the bed components, biological and biochemical reactions within the soil matrix and around the root zones of the plants and infiltration into the underlying soil strata. The majority of soils in the Bellevue coastal community are classified with a hydraulic conductivity of B and C, therefore each individual lot would require a separate infiltration test to determine whether or not an underdrain would be required.

Concept

Concept 8 - The concept is to promote individual property owners on the larger lots situated to the north/northeast of Bellevue community to install rain gardens or infiltration practices to provide water quality for their rooftop and adjacent impervious surfaces. This BMP would not be ideal for individual property owners on smaller lots located in the more urbanized part of the community. The design of the rain gardens will be lot dependant with each rain garden sized to 2% of the contributing drainage area, with an average contributing drainage area of 5,000 square feet. The cost for each individual project would be approximately $180 per square yard for a rain garden, or about $3,000 per project. The pollutant removal benefit is based on an uptake of 50%, or 10 individual private lot owners who own the larger lots installing rain gardens.

BMP - Living Shorelines (Concepts 9 through 12)

Description

Living shorelines are a combination of structures, practices and vegetative measures, including beach nourishment, wetlands and dune plantings that are positioned along a shore to deflect and dissipate the force of waves in order to protect the shoreline. Living shorelines are typically recommended for coastal environments experiencing low to medium energy. Living shorelines can help shorelines withstand wave impact, retain the protected earth on the bank, trap sand, and, in general, may very effectively prevent erosion at the site of protection. Figure 4 and 5 show some examples of a living shoreline.

Figure 4: Example of a completed living shoreline project.

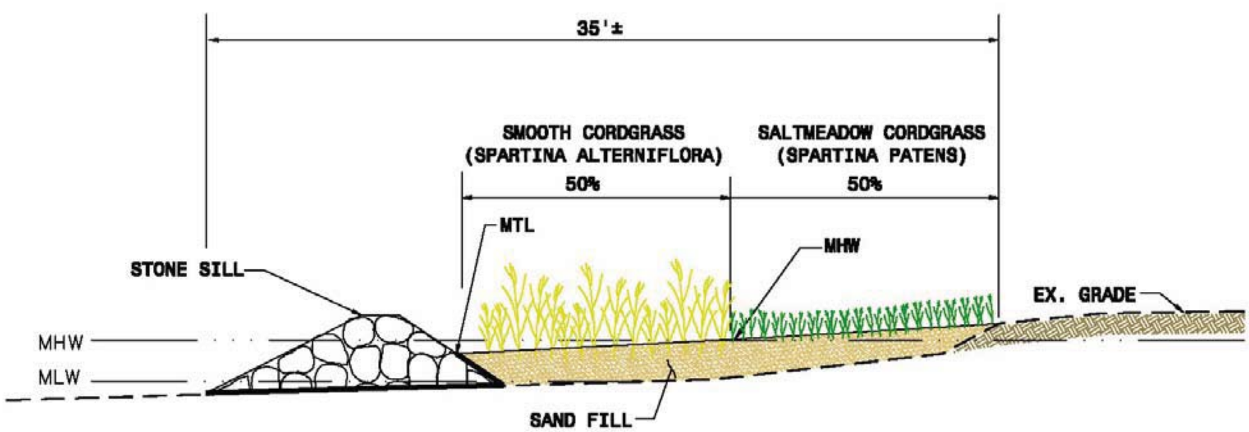

Figure 5: Cross-section of a typical living shoreline project.

<u>Concept 9</u> – Construct a 350 foot long living shoreline project on an individual lot owner's parcel for a currently unstable shoreline. The project is located on the southeast side of the peninsula below the Oxford-Bellevue Ferry. The project will protect the shoreline from further erosion and provide aquatic habitat for native wetland vegetation and sea life. A portion of the project is not within the coastal community of Bellevue, but the degree of shoreline erosion suggests that this would be a worthwhile project. The cost to construct a living shoreline would be approximately $250 per foot or $87,500.

Concept 10 – Construct a 300 foot long living shoreline project on an individual lot owner's parcel for a currently unstable shoreline. The project is located on the southeast side of the peninsula, north of the inlet where the Oxford-Bellevue Ferry is located. The project will protect the shoreline from further erosion and provide aquatic habitat for native wetland vegetation and sea life. The cost to construct a living shoreline would be approximately $250 per foot or $75,000.

Concept 11 – Repair and improve 50 foot of existing living shoreline on an individual lot owner's parcel. The project is located on the northwest side of the peninsula. The project will protect the shoreline from further erosion and improve the aquatic habitat for native wetland vegetation and sea life. The cost to construct a living shoreline would be approximately $200 per foot or $10,000.

Concept 12 – Construct a 250 foot long living shoreline project on an individual lot owner's parcel for a currently unstable shoreline. The project is located on the southwest side of the peninsula, north the point where Tar Creek empties into the Chesapeake Bay. The project will protect the shoreline from further erosion and provide aquatic habitat for native wetland vegetation and sea life. The cost to construct a living shoreline would be approximately $250 per foot or $62,500.

BMP – Shoreline Structural Stabilization (Concept 13)

Description

This type of shoreline protection is structural stabilization that are rigid, barrier-type structures that result in a "hardening" of the shoreline to protect against the action of waves, currents, tides, wind driven water, runoff from storms, and/or groundwater seepage that erodes shorelines. Such structural measures include, but are not limited to: riprap, revetments, bulkheads, groins (built perpendicular to the shoreline to trap sand, also known as a jetty), and seawalls.

Concept

Concept 13 – This project would consist of replacing 550 feet of a previously failed bulkhead on a commercially utilized shoreline access spanning several property owners. The new bulkhead would reduce to near zero the current levels of shoreline erosion. The installation cost of the bulkhead would be approximately $500 per foot, or $275,000 for the project.

ESTIMATE OF REDUCTION IN ANNUAL POLLUTANT LOADS

Current stormwater best management practices pollutant removal efficiencies as detailed in Section 6 of the Chesapeake Bay Watershed Model Phase 5.3 were utilized to evaluate the potential pollutant load reductions that could be achieved with each of the proposed projects. Hydrodynamic separator pollutant removal efficiency effectiveness estimates is from field gathered testing data from Efficiency Assessment of BaySeparator and BayFilter Systems, Mid-Atlantic Stormwater Research Center September 2008. Concept 11, repairing the existing living shoreline is proposed to provide half the pollutant removal efficiency of installing a new living shoreline was quantified so that the existing living shoreline is providing some form of pollutant removal. Table 5 lists the Efficiency Effectiveness Estimate used for each of the existing and proposed BMPs.

Table 5 – Chesapeake Bay Watershed Model Phase 5.3: Pollutant Removal Efficiency Effectiveness Estimate

Urban Best Management Practice	Target Pollutant Removal Efficiencies		
	TP	TN	TSS
	%	%	%
Constructed Wetland	30	50	80
Infiltration Practices	80	85	90
Hydrodynamic Separator	30	30	50
Gravel Road Stormwater Management Control	25	40	40
Bioretention Filtering Practices	40	60	80
Living Shoreline	90	90	90
Living Shoreline - Repair	45	45	45
Structural Stabilization	75	75	75

Each stormwater and erosion control BMP retrofits was analyzed for the potential amount of pollutant removal based on the amount of impervious area treated or length of shoreline protected. For stormwater BMPs that are sized based on the drainage area, they are assumed to provide BMPs were assumed to provide 100% of the of the water quality volume. Table 6 lists the target pollutant removal for each of the proposed stormwater and shoreline erosion control BMP projects.

Table 6 – Target Pollutant Removal for Stormwater and Shoreline Erosion Control BMPs

Concept	Concept Description	Area Treated	Target Pollutant Removal		
			TP	TN	TSS
		Acres / foot	lbs/yr	lbs/yr	lbs/yr
1	Paving of Interior Road	2.9 acres	1.7	20.5	559.9
2	Bio-Swale Orchard Terrace	0.16 acres	0.1	1.7	61.8
3	Bio-Swale Poplar Street	0.52 acres	0.5	5.5	200.8
4	Bio-Swale Bellevue Park	0.25 acres	0.2	2.7	96.5
5	Hydrodynamic Structure	0.35 acres	0.2	1.9	84.5
6	Constructed Wetland – Bellevue	2.4 acres	2.0	25.6	1117.1
7	Constructed Wetland – Offsite	-	-	-	-

Table 6 – Target Pollutant Removal for Stormwater and Shoreline Erosion Control BMPs					
Concept	Concept Description	Area Treated	Target Pollutant Removal		
			TP	TN	TSS
		Acres / foot	lbs/yr	lbs/yr	lbs/yr
8	Rain Gardens – 10 lots	1.15 acres	2.1	17.3	499.5
9	Living Shoreline – Offsite	350 FT	368.2	736.3	736,344
10	Living Shoreline – SE	300 FT	315.6	631.2	631,152
11	Living Shoreline Repair – NW	50 FT	26.3	52.6	52,596
12	Living Shoreline – SW	250 FT	263.0	526.0	525,960
13	Structural Stabilization	550 FT	482.1	964.3	964,260

Each stormwater and erosion control BMP was then analyzed based on a cost per pound of pollutant removal. Total Phosphorus (TP) was used as the base pollutant to conduct the cost analysis. Table 7 ranks the proposed concepts based on capital return.

Table 7 – Cost per lb/yr of TP Removal for the Proposed Concepts					
Concept	Concept Description	Projected Project Cost	Total Phosphorus Removal	Cost per lb/yr of TP Removal	Project Rank
		dollars	lbs/yr	$/lb/yr	#
1	Paving of Interior Road	94,000	1.7	56,311	8
2	Bio-Swale Orchard Terrace	3,600	0.1	24,430	7
3	Bio-Swale Poplar Street	72,000	0.5	150,339	10
4	Bio-Swale Bellevue Park	36,000	0.2	156,352	11
5	Hydrodynamic Structure	50,000	0.2	206,815	12
6	Constructed Wetland – Bellevue	180,000	2.0	90,070	9
7	Constructed Wetland – Offsite	-	-	-	NR
8	Rain Gardens – 10 lots	20,000	2.1	9,442	6
9	Living Shoreline – Offsite	87,500	368.2	238	1
10	Living Shoreline – SE	75,000	315.6	238	1
11	Living Shoreline – NW	10,000	26.3	380	4
12	Living Shoreline – SW	62,500	263.0	238	1
13	Structural Stabilization	275,000	482.1	570	5

DISCUSSION

Based on the ranking of the stormwater management and shoreline erosion control concepts from the cost per pound of pollutant removal analysis, the most economical projects with the highest rate of return on capital investment are the protection of the shoreline. A hardened shoreline does protect property, and sometimes it is the best solution in high-energy areas, however it does not provide a viable or natural habitat for the Bay's living resources. In areas experiencing erosion of low level of erosion (2 feet per year of less), nonstructural or bioengineering shore erosion controls, that create protective vegetative buffers, should be considered as a more environmentally sensitive way to protect shorelines, reduce erosion and help provide good habitat. They also provide a more economical benefit to standard shoreline hard armoring erosion control techniques. In fact, The U.S. Army Corps of Engineers estimates that for every dollar spent to control shoreline erosion, as much as $1.75 is returned to the economy in the form of improvements to resources, including submerged aquatic vegetation, fish, benthic organisms, shellfish, and wetland habitat.

Other stormwater management concepts to provide economical return on capital investment and promotion of general improvement of the coastal community would be resurfacing of the Bellevue coastal community interior roads with some edge of road grading to promote positive drainage along with the installation of roadside bio-swales. Implementation of the rain gardens would provide a beneficial return where the cost of the projects could be mitigated with capital input from the property owners on a dollar for dollar basis. While the hydrodynamic separator and Bellevue-Oxford Parking bio-swale rank low on the cost per pound of removal ranking, not quantified is the proposed benefits of removal of other pollutants, such as oil or gas, that accumulate on the pavement from the high access of vehicular traffic to the ferry and from the used oil/grease disposal site located in the parking lot. These concepts will provide more actual benefits then those identified in this concept report and are recommended for further exploration.

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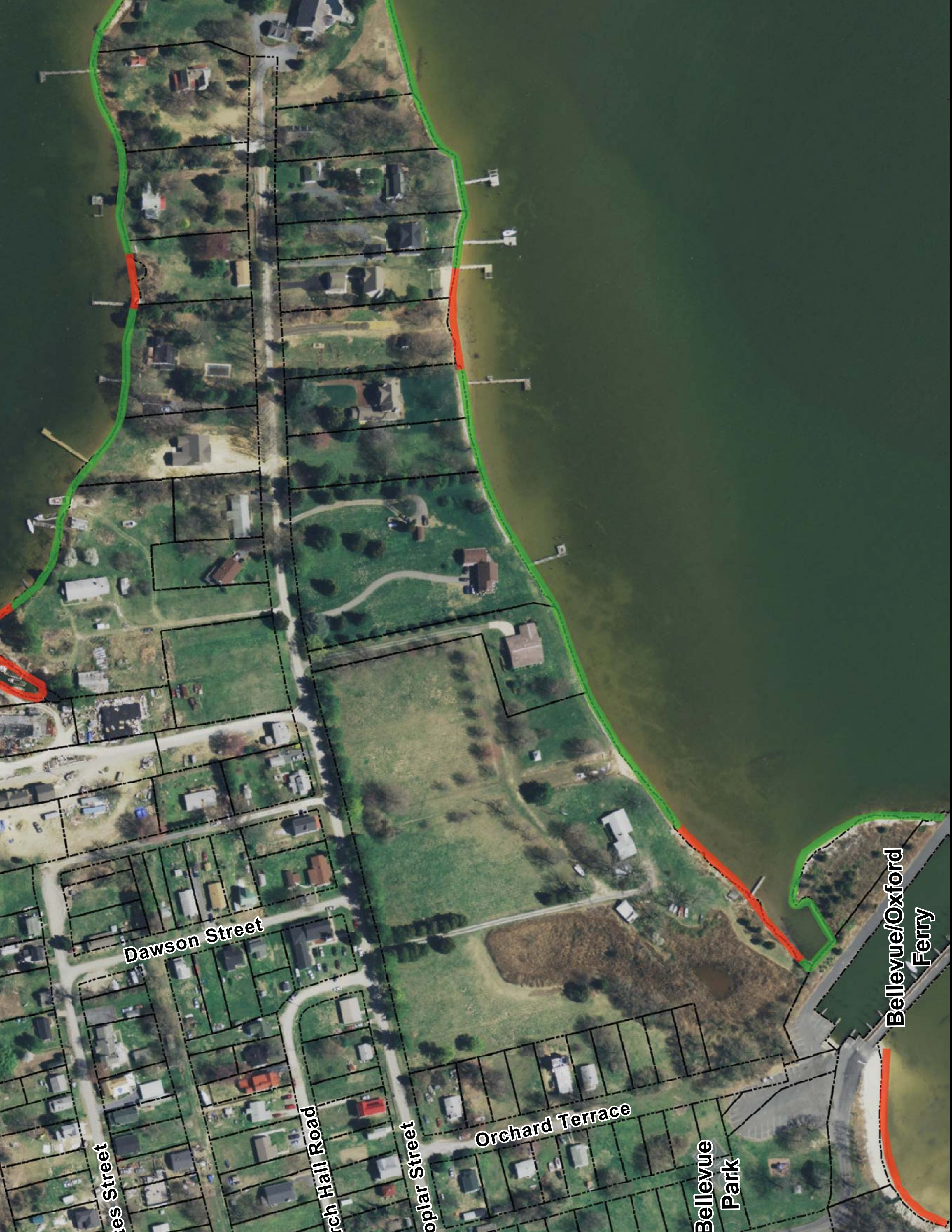
Schueler, T. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP. 1987.

Appendix 1: Shoreline Assessment



Dawson Street
Orchard Terrace
Bellevue/Oxford Ferry
Bellevue Park

Appendix 2: Shoreline Vulnerability

Dawson Street
Orchard Terrace
Hall Road

Appendix 3: Shoreline Change

Dawson Street
Orchard Terrace
Bellevue/Oxford Ferry
Bellevue Park

Appendix 4: SWM and Shoreline Erosion Control Concepts

NOTES:

1. Aerial Photography from Talbot County GIS.

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Concept 2

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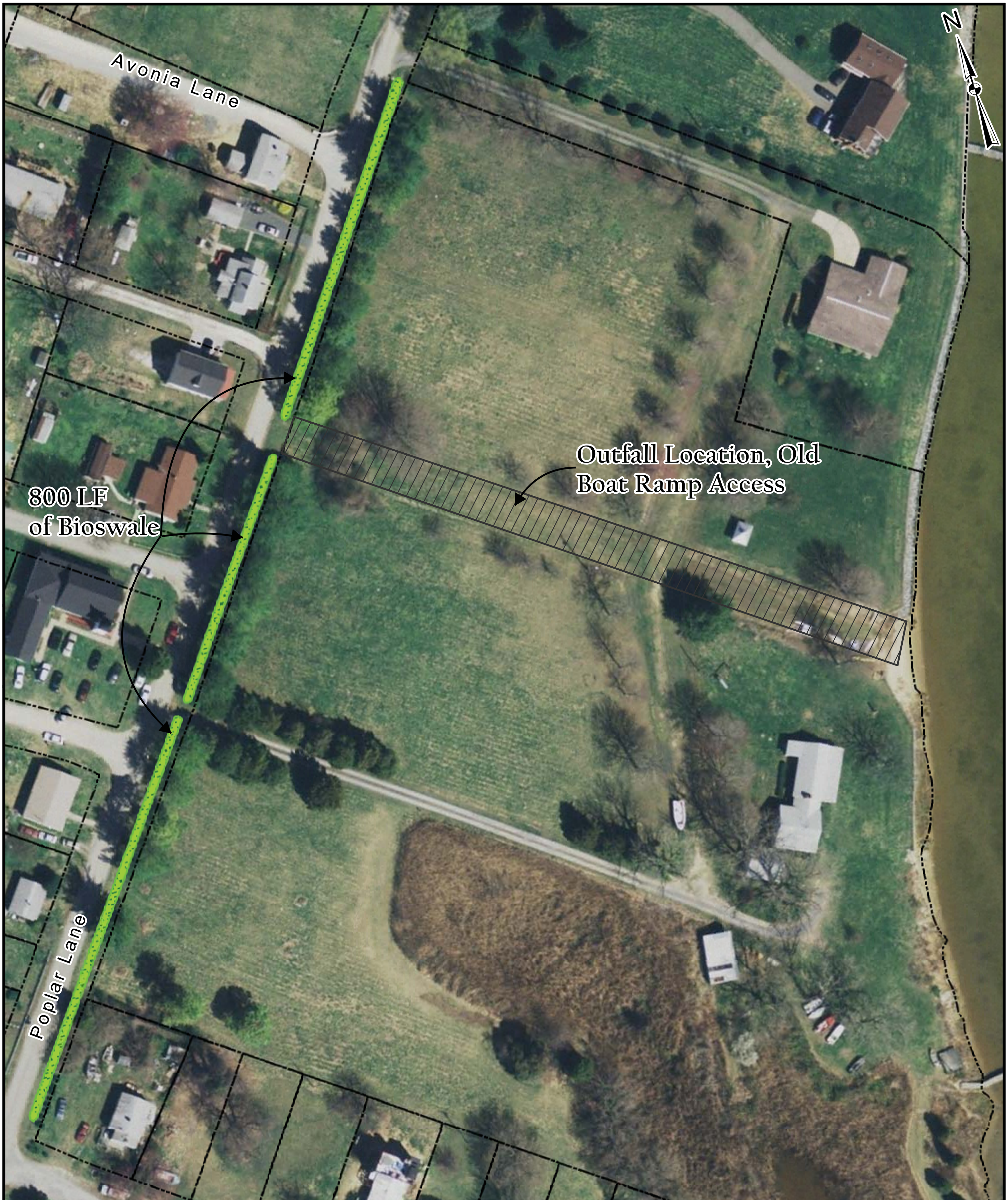

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1" = 100'

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Concept 3

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Concept 4 & 5

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Concept 6

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Concept 7

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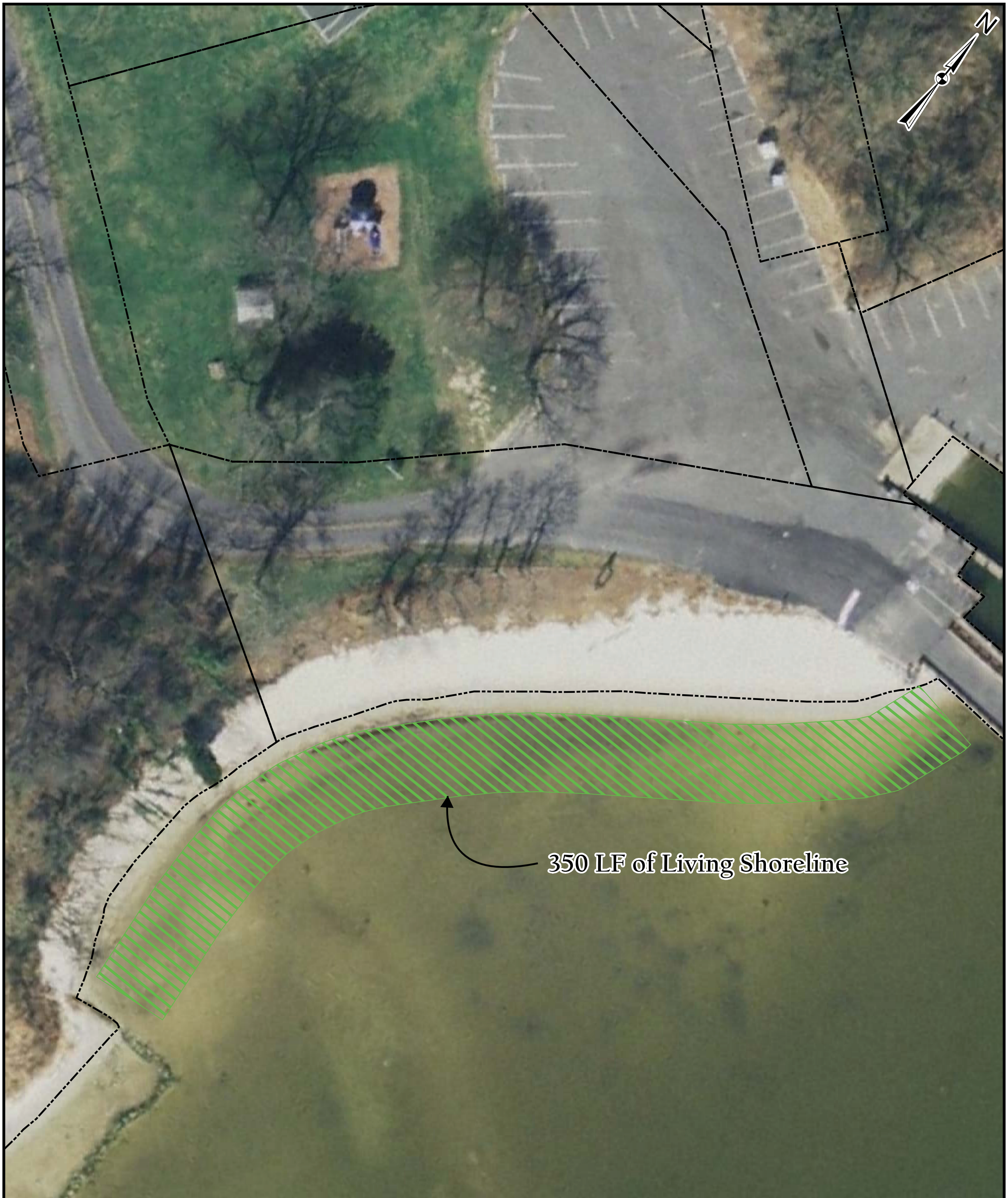
Concept 8



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Concept 9

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NOTES:

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Concept 10

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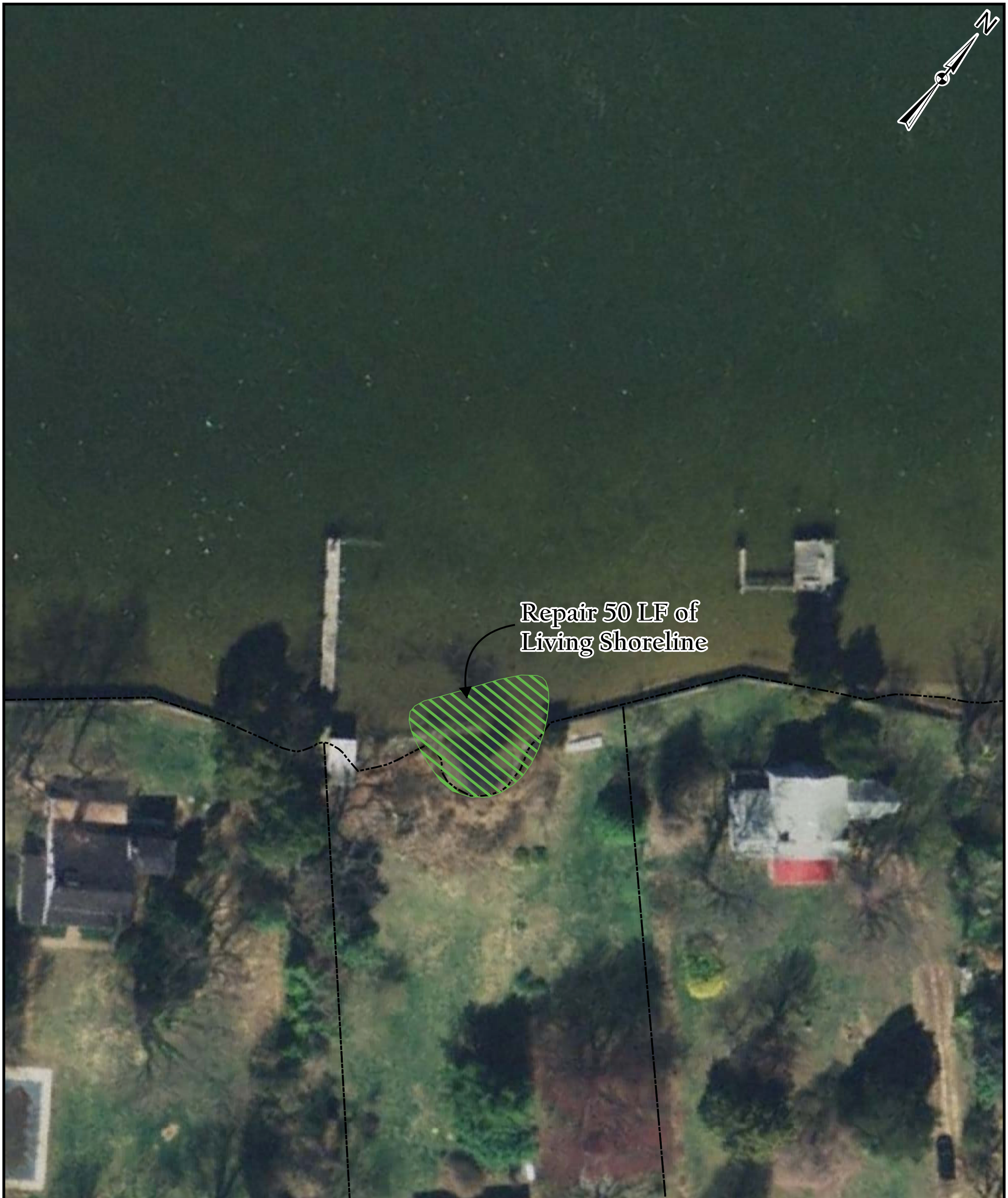

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Feet

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Concept 11

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Concept 12

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Concept 13

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Coastal Management For Traditional Villages

Community of Newcomb

Inland Stormwater Management, Shoreline Investigation and Retrofit Project Recommendation

September 2011

Prepared For:

Talbot County Office of Planning and Zoning

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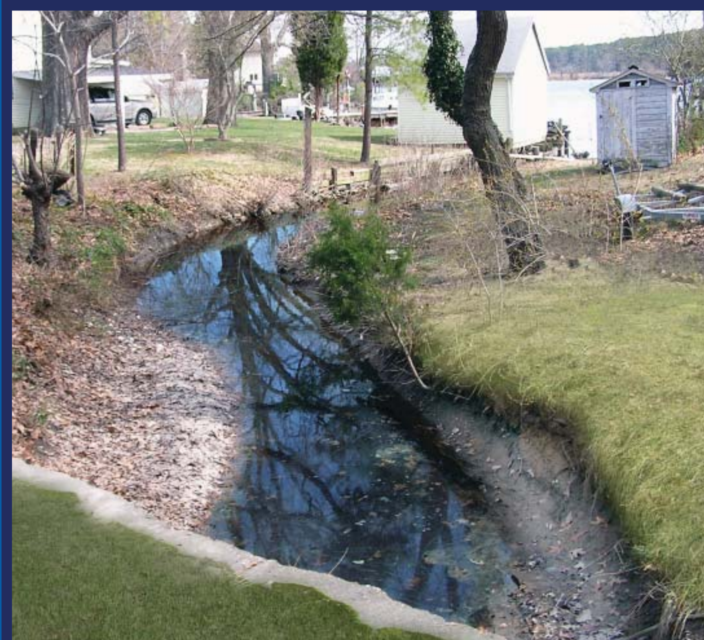


Coastal Management for Traditional Villages
Talbot County – Village of Newcomb

OVERVIEW

Talbot County is located on the Maryland's Eastern Shore, situated along the eastern coast of the Chesapeake Bay with a population of **37,782 residents (US Census Bureau, 2010)**. Although a majority of the County is inland agricultural areas, there are approximately **600 miles of shoreline** along the Chesapeake Bay and several smaller waterways. The two major rivers that feed into the Bay from Talbot County are the Miles and Choptank Rivers. The Miles River, to the north, and the Choptank River, to the south, create a large peninsula in Talbot County referred to as the 'Bay Hundred'. This area is defined as the area from the Town of Easton to the tip of Tilghman Island. From these two rivers, several smaller tributaries branch off inland, including Harris Creek, Broad Creek, Wye River, Tred Avon River, and Island Creek.

Within the Bay Hundred, St. Micheals and Tilghman Island have the highest population, averaging between 800 and 1,000 residents. Other than these two towns, the Bay Hundred is comprised of small rural villages, of which twelve are located along a waterway. A collaborative pilot program between Talbot County Planning and Zoning and Maryland's Department of Natural Resources, Chesapeake and Coastal Program, is being initiated to investigate the upland runoff and the shoreline conditions of three of these twelve villages. The program tasks are as follows:

- Analyze and describe existing conditions,
- Estimate nutrient and pollutant loading from upland sources, specifically impervious services,
- Compute quantitative flowrates entering the surrounding waterways,
- Document areas of possible inundation due to a sea level rise of 0-2',
- Determine areas of historic shoreline erosion,
- Identify possible retrofit and/or improvement locations within the Village for stormwater management and shoreline stabilization,
- Develop strategies for quantitative and qualitative management for storm runoff,
- Investigate possible sources of project funding, and
- Reach out to the community for input, feedback, project development and projected long-term schedule.

The initiative of this program, as part of the overall effort of many private and public entities, is to improve the condition of the Chesapeake Bay. In the big picture of improving the condition of the Chesapeake Bay, treating the runoff in three small villages is incidental. However, this program is joining the efforts of many other programs throughout the Chesapeake Bay watershed in a wide-scale effort to improve its quality and maintains the Bay's health.

The three villages chosen for this pilot program are Royal Oak, Bellevue, and Newcomb. These villages were chosen as representative projects for the overall twelve due to their similarities of population, land use, and topography. It is anticipated that the investigation and recommendations of these three villages can be extracted to the other nine in the Bay Hundred.

Andrews, Miller & Associates (AMA), a Division of Davis, Bowen & Friedel, Inc. is tasked with providing the investigation and recommendation report for the Village of Newcomb.

VILLAGE OF NEWCOMB

Newcomb is a 160.3 acre community located on St. Michaels Road approximately six miles southwest of Easton and three miles southeast of St. Michaels. The village is fronted by the Miles River to the north and Oak Creek to the east. The community of Royal Oak directly adjoins Newcomb to the south. Newcomb has approximately 180 residents and is comprised of single family homes with lots ranging from ¼ acre to over 5 acres. A four-building storage facility located on St. Michaels Road are the largest buildings within the Village. Royal Oak Road is the approximate boundary to the west and Acorn Road to the South. Oak Creek is a small waterway that fronts the east side of the town. Much of the investigation for this report was done along Oak Creek. With the exception of St. Michaels Road, all the roads in Newcomb are narrow paved roads with no shoulders. ***Exhibit 1*** provides an aerial photograph of Newcomb showing the Village limits, roads, waterways, and other features. ***Exhibit 2*** provides a summary map of land cover and, floodplain areas. Table 1 provides a breakdown of the land cover within the Village of Newcomb.

TABLE 1

Land Cover	Area (Ac.)	Percentage Cover (%)
Impervious Area	22.4	14
Light Woods	24.0	15
Heavy Woods	27.3	17
Open Grass Areas	86.6	54

Like many towns and villages on the Maryland's Eastern Shore, the topography in Newcomb is relatively flat with slopes ranging from 0 – 2%. According to contours from USGS aerial topography, elevations in the village range from 0.0' to +8.0'. All the roads in the village are an open-road, ditch system. Ditches are shallow trapezoidal shaped with side slopes ranging from 2:1 to 4:1 (limited to St. Michaels Road). As previously mentioned, the interior roads do not have shoulders, thus the ditch systems are directly located off a road's drive lanes. Culverts were installed, apparently many years ago, to provide roadside drainage directly into the two waterways.

UPLAND FIELD INVESTIGATION

For the purpose of this study, aerial topography and photographs were used to delineate drainage patterns for Newcomb. Since much of Newcomb is flat, and because the aerial topography is developed in 2' contours, much of the limits of the drainage areas were estimated based on relative high points and land cover. Table 2 lists the delineated drainage areas and their respective areas.

TABLE 2

Drainage Area	Total Area (Ac.)
DA-1	1.72
DA-2	3.41
DA-3	3.86
DA-4	4.84
DA-5	12.25
DA-6	8.93
DA-7	6.90
DA-8	17.48
DA-9	4.24
DA-10	6.75
DA-11	3.46
DA-12	22.13
DA-13	0.58
DA-14	2.02
DA-15	28.01
DA-16	36.01

Drainage Area	Total Area (Ac.)
DA-18	5.82
DA-19	11.27
DA-20	4.27
DA-21	1.97
DA-22	2.35
DA-23	3.25
DA-24	9.23
DA-25	3.21
DA-26	0.69
DA-27	3.14
DA-28	3.66
DA-29	1.33
DA-30	1.91
DA-31	2.68
DA-32	1.17
DA-33	0.73

DA-17	14.67	DA-34	1.05

Within each drainage area, the impervious cover was measured using the aerial photographs. Impervious cover is defined as road, rooftops, driveways, and parking lots. All gravel surfaces are considered to be impervious areas. Further, using the aerial photographs, the amount of heavy tree cover (forest) and light tree cover (sparse trees) were measured. These three items were totaled and the remaining balance within the drainage area was considered to be open grass (lawns, road right-of-ways, etc.).

Following the delineation of the drainage areas, a field investigation was performed in March and August, 2011 to either confirm or alter the drainage patterns estimated from the aerial topo. The field investigation also researched problematic areas in upland areas and along the shoreline, conditions of drainage systems (culvert, ditches, etc.), and land cover. A Drainage Area Map showing land cover and approximate limits of drainage areas is provided in ***Exhibit 3***. Photographs were taken showing the village's drainage system, both problematic and working areas. ***Exhibit 4*** provides a location map of where photographs were taken, both upland and shoreline. Some pictures are provided in this narrative. Pictures not shown herein are provided on the enclosed CD.

The most noteworthy item discovered from the field investigation was that a majority of the driveway and cross culverts were clogged between 50-75% with sediment. This factor of clogged culverts and minimum slopes in ditches results in extended ponding or flooding in the low lying areas.

Photo 63

Photo 74

Photo 104

The roadside drainage ditches are typically usually 1-2' deep, and in the case of the ditch system along Royal Oak Road, the ditch was a minimum of 2.5' up to 3.5'. Ditch bottom widths range from 6-12". The Royal Oak Road ditch system is located immediately off the driving lane. Some evidence of pavement failure is evident along the ditch system. Ditches near or under trees are filled with leaves and other debris. River and Woodside Roads have shallow parabolic grass swales that are approximately 6" deep. The drainage system along the St. Michaels Road (Rt. 33) is located off the road's shoulder on each side and tends to have milder side slopes, roughly 4:1 or less, as is typical with most State roads. All drainage ditch systems discharge into the Miles River or Oak Creek without any stormwater management devices in place.

Photo 27
(St. Michaels Road)

Photo 53
(St. Michaels Road)

Photo 65
(St. Michaels Road)

Photo 73
(Station Road)

Photo 75
(Station Road)

Photo 113
(Station Road)

Photo 106
(River Road)

Photo 107
(Woodside Road)

Photo 126
(Royal Oak Road)

Typical cross sections, approximate slopes, and ground cover were investigated in all areas of concentrated flow in the field. The information from the field investigation was incorporated into the delineated drainage areas, and after estimating a travel time and path for runoff, the drainage areas were hydrologically combined to determine the area and volume of runoff draining to a particular discharge point. The exception to this is where sheet flow discharges directly into a waterway. These areas were collectively combined to determine pollutant and sediment loading from overland flow. Table 3 lists the hydrologically combined drainage areas and their designated Drainage Group.

TABLE 3

Drainage Group	Total Drainage Area (Ac.)	Description	Drainage Areas (Hydrologically Combined)
MILES 1	33.3	Concentrated flow in tree-lined ditch along property line. Discharges into tidal floodplain area of Miles River. Located northeast of Rt. 33 and Solitude Road intersection.	6, 7, 8
MILES 2	16.5	Concentrated flow in a diagonal open swale w/ riprap bottom. Discharges into Miles River via culvert. Located on 4 properties northeast of Rt. 33 and Royal Oak Road intersection.	5, 9
MILES 3	11.6	Concentrated flow in a narrow 2' deep ditch. Discharges into Miles River via culvert. Located behind eastern properties of Beach Road.	4, 10
MILES 4	9.0	Sheet flow into Miles River along approx. 1/3 mile of hardened shoreline. Located along Rt. 33 across from Station Road.	1, 2, 3
OAK 1	1.9	Parking area at boat ramp drains into storm drain inlet and then discharges into Oak Creek via a storm drain pipe.	32, 33
OAK 2	3.7	Sheet flow into Oak Creek from areas southeast of Station Road, north of River Road.	31, 34
OAK 3	5.4	Concentrated flow into northern cove of Oak Creek. Impacted by tide.	11, 30
OAK 4	104.8	Concentrated flow into northern cove of Oak Creek. Runoff from area between Station Road and Royal Oak Road.	12, 13, 14, 15, 16, 17, 29

OAK 5	7.5	Concentrated and sheet flow into northern cove of Oak Creek. Runoff drainage from River Road.	26, 27, 28
OAK 6	6.5	Sheet flow into southern cove of Oak Creek.	23, 25
OAK 7	9.2	Concentrated flow into approximately 0.65 wetland area in southern cove of Oak Creek.	24
OAK 8	21.4	Sheet flow into Oak Creek along approx. 1/2 mile of shoreline.	18, 19, 21, 22
OAK 9	4.3	Eroded swale along property line.	20

MILES 1

Miles-1 is a 660' long, tree-lined trapezoidal-ditch that flows northeast from St. Michaels Road towards the Miles River *(Photos P39 – P41)*. Twin culverts crossing St. Michaels Road, in which are 50% clogged, pass the runoff from the south *(Photo P38)*. The ditch transforms into a wide floodplain channel before discharging into the river *(Photos P42 – P44)*. The floodplain is a tidal area. The ditch is approximately 2' deep and appears stable. However, as evidenced from a fallen tree that was identified along the ditch, it appears the ditch cannot handle the volume of water from large storm events.

Photo 38

Photo 39

Photo 42

Photo 44

All photos provided on enclosed CD

MILES 2

Miles-2 is a series of three different channels. The first channel is a 290' long, stable, trapezoidal grass channel which receives runoff via roadside ditches from both sides of St. Michaels Road *(P027 – P031)*. A large riprap apron is located on the downstream side of the culvert cross Rt. 33 and prior to the grass channel. The grass channel leads into a wide riprap channel with a grade stabilizing wall on one side *(P037)*. After the vertical walls ends, the riprap channel continues towards the river. Riprap is evident on the channel's bottom. Side slopes are mild with grass cover *(P034 – P035)*. The runoff is discharged into the river via culvert through the timber bulkhead *(P036)*. All channels appeared to be stable.


Photo 31


Photo 29


Photo 37


Photo 35


Photo 34


Photo 36

All photos provided on enclosed CD

<u>MILES 3</u>

MILES 3 is a 750' long, narrow and shallow trapezoidal ditch that bisects residential properties near Beach Road. Standing water was noticed at the upstream end of the ditch where it crosses Rt. 33 (*P021 – P023)*. A residential house was being constructed at the time of the investigation. The house is within 6' of the ditch. Several roof drains discharge into the ditch. The ditch flows into a culvert and then through the bulkhead into the river *(P024 – P026)*. There were some signs of scouring on the side slopes of the ditch. The outfall pipe and bulkhead are in disrepair.

Photo 23

Photo 24

Photo 25

Photo 24

All photos provided on enclosed CD

OAK 1

OAK 1 is a storm drain outfall directly into Oak Creek. It receives runoff from a portion of the Rt. 33 roadside ditch and the boat ramp's parking lot *(P069 – P071)*.

Photo 70

Photo 71

All photos provided on enclosed CD

OAK 3

OAK 3 is a 270' long tidal channel that receives concentrated runoff from Back Street and the northern portion of Station Road. The channel bottom has no vegetation, but is heavily vegetated on its side slopes. *(P077 – P079A)*.

Photo 78

Photo 78A

Photo 79

Photo 79A

All photos provided on enclosed CD

<u>OAK 4</u>

OAK 4 is a 1,180' long drainage channel that begins at Royal Oak Road and continues to Station Road. As listed in Table 1, OAK 4 is the focal drainage point of approximately 102 acres. A cross culvert discharges runoff into the channel from the western side of Royal Oak Road. The channel begins in a wooded area *(P135 – P138)* and then continues into an open space *(P097 – P098)*. After the open space, the channel turns sharply northeast and then east towards Station Road. After crossing Station Road in a 30" CMP culvert, it discharges into a large tidal channel off of Oak Creek. The channel has consistent cross section for its entire length between Royal Oak and Station Roads, including a 5' bottom width, 3-4' deep, and 1:1 side slopes. Some trees and limbs have fallen into the channel. After Station Road, the channel passes the historic cemetery and two private sheds that are constructed right upon the banks of the channel *(P081 – P089)*.

Photo 136


Photo 98


Photo 83

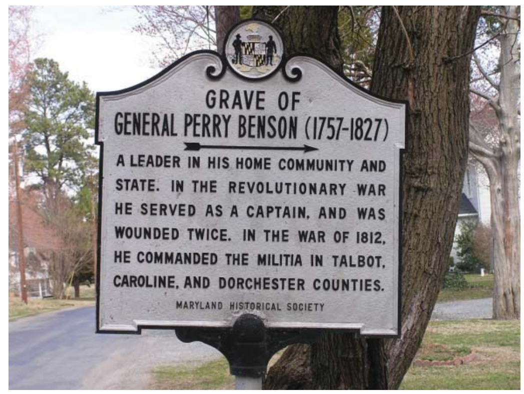


Photo 95


Photo 83

Photo 82A


Photo 84

Photo 86A

All photos provided on enclosed CD

OAK 5

OAK 5 is an outfall culvert that receives runoff from River Road. Two culvert pipes and a roadside swale drain towards the outfall culvert. Although the downstream of the pipe was identified, the upstream side was not visible *(P103 - P104)*. The outfall pipe discharges through a deteriorated timber bulkhead *(P105)* where significant washout is evident *(Photo 105A)*. In observing the elevations of the pipe's downstream invert compared to the estimated upstream invert, it appears the pipe has a negative slope. Outfall pipe and bulkhead are in disrepair.

Photo 103

Photo 104

Photo 103

Photo 105A

All photos provided on enclosed CD

OAK 9

Oak-9 is a naturally created v-ditch along a property line due to erosion *(PW10 – PW13)*.

Photo W10

Photo W13

All photos provided on enclosed CD

MILES 4, OAK 1, OAK 2, OAK 6, OAK 7, OAK8
These drainage groups represent the areas where sheet flow enters the Miles River and Oak Creek directly without becoming concentrated flow.

SEDIMENT AND NUTRIENT LOADING

Sediment and pollutant loading from upland runoff has been determined to be significant detriment to the overall health of the Chesapeake Bay and its many tributaries. Sediment loading in streams and rivers is caused by upland soil and bank erosion. Sediment loading increases the turbidity in a waterway, thereby causing a decline in Submerged Aquatic Vegetation, which limits spawning and feeding areas for fish. Pollutant loading comes from many different sources in urban, residential, and agricultural runoff. The two primary pollutants of concern are Phosphorous (Total) and Nitrogen. These two elements promote algae blooms in waterways which results in degraded oxygen levels. Reducing the levels of upland sediment and pollutant loading has become a primary goal in a wide scale effort to improve the quality of the Chesapeake Bay.

The Simple Method is a tool used to determine annual phosphorus loading levels. However, the same equation can be used to approximate the sediment and nitrogen levels as well. The Simple Method equation is as follows:

$$L = P\ Pj\ Rv\ C\ A\ 0.2266$$

where

L = Total Pollutant Loading (lbs.)
P = Annual precipitation depth (inches)
Pj = Fraction of rainfall events that produce runoff = 0.9
Rv = Runoff coeficient
C = Average pollutant runoff concentration (mg / L)
A = Watershed area (acres)
0.2266 is a conversion factor

and

- Pj = 0.9
- Annual precipitation depth = 45.85 inches

Different land covers will produce different average pollutant runoff concentrations of phosphorus, nitrogen, and sediments. Table 4 lists the values of ‘C’ for this study

TABLE 4

Land Use	Total Suspended Solids (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)
Impervious (Driveways & Roads)	145	0.44	0.43
Lawn	125	1.30	0.35
Rooftop	20	0.11	0.45
Woods	30	0.30	0.25
Trees / Landscaping	55	0.40	0.33

Using the Simple Method equation, concentration levels from Table 4, and the measured land cover, the annual pollutant loadings was determined for each Drainage Group. Table 5 lists these values.

TABLE 5

Drainage Group	Total Drainage Area (Ac.)	Annual TSS (lbs.)	Annual TP (lbs.)	Annual TN (lbs.)
MILES 1	33.3	4,742	22.3	16.6
MILES 2	16.5	3,392	15.3	12.3
MILES 3	11.6	2,545	11.5	10.6
MILES 4	9.0	1,972	8.6	7.2
Total for Miles River	70.4	12,651	57.8	46.7
OAK 1	1.9	1,468	4.8	4.5
OAK 2	3.7	1,375	5.4	5.2
OAK 3	5.4	1,070	5.3	4.5
OAK 4	104.8	9,608	49.7	41.1
OAK 5	7.5	1,786	7.5	6.9
OAK 6	6.5	964	5.0	4.2
OAK 7	9.2	771	4.4	4.1
OAK 8	21.4	2,563	14.4	10.2
OAK 9	4.3	643	3.4	2.8
Total for Oak Creek	164.6	20,248	99.8	83.4

PEAK FLOWRATES AND VELOCITIES

Erosion in upland areas is usually caused by concentrated flow with excessive velocities in an earthen channel or ditch. The rate of erosion is dependent on the velocity, the slope of channel/ditch and the soil properties. Excessive velocities are caused by infrequent storm events with tremendous rainfall. A value greater than 3.0 feet per second (fps) is generally considered a potential erosive condition. By determining the area, ground cover, and slopes within a watershed, peak flowrates, and resultantly peak velocities, can be determined for a given area of concentrated flow. On the Eastern Shore of Maryland, the typical rainfall event used to determine peak flowrates is the 2-year storm. For Talbot County, the 2-yr storm rainfall event is 3.4”. The resulting peak flowrates and corresponding velocities for each Drainage Group is listed in Table 6. A hydrologic flowchart of the drainage areas, ditches/ channels, and Drainage Groups are provided in ***Exhibit 5***.

TABLE 6

Drainage Group	Component	2-Yr. Peak Flowrate (cfs)	Max. Velocity (fps)	Avg. Velocity (fps)
MILES 1	Trap. Ditch	12.4	3.2	1.3
	Floodplain Ditch		4.5	1.5
MILES 2	Grass Channel	8.8	2.3	0.9
	Riprap Ch - Vertical Wall		2.0	0.7
	Riprap Channel - Open		1.7	0.6
MILES 3	Trap. Ditch	9.0	2.2	0.8
MILES 4	N/A – Sheet Flow	--	--	--

OAK 1	Outfall Pipe	3.8	--	--
OAK 2	N/A – Sheet Flow	--	--	--
OAK 3	Tidal Channel	4.5	2.0	0.6
OAK 4	Tidal Channel	35.1	4.0	1.3
OAK 5	Outfall Pipe / Overflow	4.1	--	4.0
OAK 6	N/A – Sheet Flow	--	--	--
OAK 7	N/A – Sheet Flow	--	--	--
OAK 8	N/A – Sheet Flow	--	--	--
OAK 9	Eroded V-ditch	2.4	3.7	1.6

SEA LEVEL RISE AND UPLAND INUNDATION

The implications of a rise in the sea level, and the area of impact, are very much a concern to the waterfront towns and communities on the Eastern Shore. The concern is for potential loss of upland areas, shorelines, beaches and environmental habitat including protective marsh areas and beds of submerged aquatic vegetation. As is the case with most of the Delmarva Peninsula, Talbot County is a coastal plane with low lying elevations generally less than +10' feet above sea level. Scientists, politicians, planners and other parties are studying and planning for an increase in the water levels around Talbot County by implementing new policies for future development and possible retrofit/ improvement projects for coastal towns, like Newcomb.

The Maryland Department of Natural Resources has developed an online tool, named *Merlin*, which uses spatial data to map vulnerable areas to possible sea level inundation in the 0-2', 2-5' and 5-10' range. This study investigated the impact area of the 0-2' inundation level for the Town of Newcomb.

According to the Merlin data, the impact along the Miles River appears to be minimal. This data can be confirmed by reviewing the contours along the shoreline. Plus, the majority of the shoreline in this area is hardened with either bulkhead or stone revetment which indicates a significant variation in elevation between water level and upland elevation. The average elevation along the Miles River shoreline is at +6.0' except near the Rt. 33 bridge over Oak Creek. This area has an average elevation of +4.0' with a smaller area at +2.0'. This hardened shoreline continues along the western shore of Oak Creek into the most northern cove of Oak Creek, where OAK3, OAK 4 and OAK 5 are located. According to the Merlin spatial data, this area is most vulnerable to inundation from a sea level rise of 0-2'. Similar to the northern cove, the wetland area of OAK 7 would be susceptible also. The remaining area of the southern cove is naturally elevated above the 0-2' inundation range. ***Exhibit 6*** shows the 0-2' inundation area along the Newcomb shoreline.

COMMUNITY INPUT

During the course of gathering information for this study, residents of Newcomb were invited to provide feedback on the conditions of the Village, specifically any problem areas of flooding or erosion. A majority of the residents interviewed mentioned the biggest problem is the flooding that occurs at the intersection of Station Road and Royal Oak Road. There are roadside ditches on both sides of the two roads; however, the problem occurs, according to the residents, in the downstream ditch along Royal Oak Road. There is a residence located 190' to the north where their driveway culvert is clogged. This blocked culvert causes backup to the intersection and further up Station and Royal Oak Road. The residents state that flooding regularly encroaches the road, creating a driving hazard. One resident, Mrs. Julie Imirie, stated the problem causes a residual effect of flooding her property. This roadside ditch (on the northbound side) receives runoff from as far south as Acorn Road. In all, the area draining to this roadside ditch is roughly 17 acres (DA14 and DA17). The 2-year storm produces approximately 12.8 cfs. If the roadside ditch was free and clear of debris, it would be able to contain this flowrate with a peak velocity of 2.4 feet/second. The following are pictures provided by Ms. Imirie and AMA.

Station Road, Facing Northeast

Station Road, Facing Southwest

Imirie Property - 7305 Station Road

Photo 118A – Facing Intersection

Photo 119 – Royal Oak Road, Northwest (Note Blocked Culvert Downstream)

Photo 119A – Facing Intersection

Many residents also stated that the County should regularly maintain the roadside ditches removing leaves and sediments. As previously mentioned, most of the driveway culverts are clogged up to 75%. The residents state if the culverts were clear, the drainage system within Newcomb would probably work sufficiently.

On the other side of the Village, Mr. Frank Cavanaugh provided information regarding the riprap swale that travels diagonally through his property and into the Miles River (MILES 2). Since a majority of the runoff entering the swale is from St. Michaels Road, Mr. Cavanaugh has expressed concerns to the Maryland State Highway Administration for years to get the channel stabilized and/or upgraded. According to Mr. Cavanaugh, the State has not assisted in the upkeep of the swale and thus Mr. Cavanaugh and his neighbors have stabilized it with riprap and an outfall pipe through a recently constructed bulkhead.

Some residents expressed their frustration with the outfall pipe on River Road (OAK 5). They state that since the outfall pipe is blocked, runoff fills the small roadside ditch and then overflows approximately 60' into the river. This is the probable reason why washout exists behind the bulkhead at the pipe's discharge point.

RECOMMENDED PROJECT LOCATIONS

To achieve the greatest benefit of water quality treatment for any retrofit projects, the locations of the recommended Best Management Practices (BMP) projects are located in areas of concentrated flow near tidal outfalls. With the exception of two parcels located on Rt. 33 and a small public park near the boat ramp, all the land is private property. Thus, all retrofit projects will require either property acquisition or drainage easements. It is believed that the strongest possibility of implementing any retrofit BMP projects within Newcomb would be in the form of linear applications. Ideally, the BMPs should be constructed 'offline' of the primary drainage system. Offline projects are where a BMP is constructed adjacent to a flow area. The 'first flush' of most storms would be directed to the BMP. Larger storm events would bypass the BMP in the original, or modified, drainage swale or ditch. Although offline systems are preferable, this would require additional land and thus additional property acquisition or easements. In this study, only one (MILES 1) of the seven recommended projects are proposed to be offline of the main drainage system. The locations of the recommended projects are Drainage Groups MILES 1, MILES 2, MILES 3, OAK 3, OAK 4, OAK 5 and OAK 9 as described in Table 3. Table 7 provides a list of Drainage Groups where a retrofit project is not proposed.

TABLE 7

Drainage Group	Reason
MILES 4	Sheet flow
OAK 1	Storm drain pipe under paved parking area
OAK 2	Sheet flow
OAK 6	Sheet flow
OAK 7	Wetland area in place.
OAK 8	Sheet flow

RECOMMENDED RETROFIT PROJECTS

The recommendations for water quality and quantity improvements are all linear applications, taking place in, or next to, the original drainage system. There are a several factors which influence the recommendations made herein. First being the soil type of the area. According to National Resource Conservation Service (NRCS) website, the soil conditions for the Newcomb area consists mostly of silt loams (*Soil Report provided on enclosed CD*). These soils are generally found in low lying areas, drain poorly, and have a Hydrologic Soil Group (HSG) rating of C or D. The HSG is an estimate of the soils runoff potential. A HSG of 'A' means the soil has a high infiltration rate. Conversely, a rating of 'D' means the soil has a minimal infiltration rate. According to the Soil Report, the majority of the subsurface near the waterfront areas has a HSG of 'C'. As you go further inland, the soil becomes a 'D' type.

A second factor in determining the best BMP for a site is the groundwater elevation. The low lying elevations in the Newcomb area result in a groundwater elevation that may be only 1-3' below the surface. This presents a problem for any type of infiltration system, since there is minimum vertical distance requirement between the bottom of a BMP and the groundwater elevation.

Several BMPs use the combination of a filter media and retention (i.e. bioretention, bioswales, sand filters) to treat runoff. The runoff would enter the BMP and then filter down through a substrate material that absorbs the pollutants. In soils with an HSG of A or B, these BMPs can be constructed without and underdrain system. In C and D soils, an underdrain system is recommended to withdrawal any water that does not infiltrate into the subsurface soil. The problem for implementing these types of BMPS in any of the existing drainage ditches or swales is that the low lying elevations would prevent an underdrain system with an adequate outfall. These BMPs systems can be constructed without the underdrain system; however over time the filter media may become permanently saturated which may reduce its performance capabilities of removing pollutants.

A BMP's rate of pollutant removal is also a strong factor in determining where it should be used. Wetlands and filtering systems tend to have a higher removal rate of phosphorus and nitrogen due to their aerobic zones. BMP's with a capability of reducing the volume of runoff from exiting the system tend to have a larger rate of TSS removal. Table 8 lists pollutant removal rates of various BMP devices.

TABLE 8 – BMP Pollutant Removal Rates (%)

	TSS	TP	TN
Dry Pond	49	20	24
Wet Pond	80	52	64
Wetland	72	48	24
Filtering	86	59	32

Bioretention	59	5	46
Infiltration	89	65	42
Open Channel	81	24	56

The BMP that is recommended for most of the retrofit projects in Newcomb is a Submerged Gravel Wetland (SGW). These systems are recommended for areas with a high groundwater table and poorly drained soils (HSG of C/D). The system contains a 2-4' layer of stone media covered by 6" of a planting substrate like mulch or compost. Wetland plants are then planted over the substrate material. Pollutant removal is achieved through biological uptake of the wetland plants. A large drainage area is recommended for these systems to ensure an adequate water supply for the wetlands. However a high groundwater table can compensate for a smaller drainage area.

The concern for implementing a SGW into existing channels and ditches is the possibility of excessive velocities that would be detrimental to the wetland plants. By implementing a series of low-profile, stone check dams to diffuse the velocity, and specifying plants with a strong root system (i.e. River Bulrush), a SGW could sustain an area of concentrated flow.

Based on factors such as community input, drainage area, pollutant loading, peak flowrates, and location, the recommended retrofit projects have been prioritized, as shown in Table 9.

TABLE 9

Recommended Project Priority	Drainage Group	Drainage Area (Ac.)	Total Impervious Area (Ac.)	Annual TSS Loading (lbs.)	Annual TP Loading (lbs.)	Annual TN Loading (lbs.)
1	OAK 5	7.5	1.5	1,786	7.5	6.9
2	MILES 1	33.3	3.2	4,742	22.3	16.6
3	OAK 4	104.8	7.2	9,608	49.7	41.1
4	MILES 2	16.5	2.6	3,392	15.3	12.3
5	MILES 3	11.6	2.3	2,545	11.5	10.6
6	OAK 3	5.4	1.0	1,070	5.3	4.5
7	OAK 9	4.3	0.6	643	3.4	2.8

OAK 5

OAK 5 is a location where the drainage area is relatively small (7.5 ac.), however the existing pipe that is the outfall for the upland area is buried and needs to be replaced. A small 80' long Submerged Gravel Wetland (SGW) is proposed in-line with the existing roadside ditch. This concept plan proposes to remove, replace, and relocate the old outfall pipe with a new one. The new outfall pipe would discharge into a stone plunge pool as part of a living shoreline concept proposed at this location (see *Shoreline Improvement Recommendations)*. According to the residents, a 50' wide County Right-Of-Way exists on the north side of River Road near the River Road/ Woodside Road intersection. This ROW was established to allow fire trucks to access Oak Creek for water withdrawal. The new outfall pipe would be located in this unpaved ROW area. ***Exhibit 7*** shows a conceptual plan view and profile of OAK 5.

MILES 1

The recommended retrofit project MILES 1 presents the greatest opportunity to reduce upland pollutants from entering a tidal area, in this case the Miles River, and a minimal imposition to private property. The existing ditch runs along a property line near the northwest corner of Newcomb. Facing downstream, to the left is a grass buffer area for the adjacent farm. The concept plan for MILES 1 recommends expanding the existing ditch into this buffer strip. The expansion area would be excavated lower than the existing ditch invert. A linear wetland is proposed in the expansion area. A linear wetland was chosen over a Submerged Gravel Wetland because of the potential length (~500') of the project. The cost of a 500' long SGW would make the project infeasible for the area it treats (33 ac.). By creating a wetland, a less amount of planting substrate would have to be imported and placed as opposed to bank run gravel, thereby reducing the costs.

Runoff from smaller storms would be directed into the SGW. During large storm events, the wetland area would be filled, thus the runoff would overflow into the original ditch. The northern side slope of the linear wetland would be restored to a meadow, similar to existing conditions. ***Exhibit 8*** shows a conceptual plan view and profile of MILES 1.

OAK 4
The outfall location of OAK 4 receives approximately 45% of the drainage runoff from the Village of Newcomb and beyond. It is evident that this area of concentrated flow receives a large volume of runoff due to the channel's configuration. Beginning at Royal Oak Road and continuing to Station Road, the channel has an average 5' bottom width and a depth of 3.5'. It is a dry bed, thus it is only active during storm events. According to the HydroCAD Stormwater Management program, the 2-year storm produces 34.6 cubic feet per second (cfs) in the channel, but only has a 3.7 feet per second (fps) peak velocity and a 1.4' depth of water.

The large drainage area of OAK 4 presents an ideal scenario for a water quality project, however site constraints limit any expansion of the channel. Near the downstream end, a residence is located to the north and a historical cemetery is located to the south. The cemetery contains the burial site of General Perry Benson, a commander of local militia in the Revolutionary War and War of 1812. Further, both the property owners to the north and south have constructed sheds right along channels banks.

The concept plan for OAK 4 includes placing three (3) stone check dams downstream of the culvert crossing Station Road to reduce the runoff velocity. The check dams would be placed at a minimum height to retain runoff from small storms and dissipate the velocity for larger storms. A SGW is proposed in between the check dams to provide water quality. River Bulrush (Scirpus fluviatilis) would be planted along the channel bottom in the SGW, creating a wetland area. This plant is typically used as a shoreline stabilizer and can withstand up to 0.5 ppt of salinity. The side slopes of the channel would be planted with various upland shrubs (i.e. Tussock Sedge, Red Chokeberry, Square Stemmed Monkey Flower, Sweet Flag and Swamp Milkweed) that can withstand temporary inundation, thrive in wet soil conditions, and are salt tolerant. An additional set of three check dams would be placed further upstream for additional velocity reduction. This recommended plan would tie directly into a living shoreline project located at the mouth of the channel (see *Shoreline Improvement Recommendations)*. ***Exhibit 9*** shows a conceptual plan view and profile of OAK 4.

Due to site constraints of the area, the amount of pollutant removal for OAK 4 would be minimal, although it is a reduction from a large drainage. This study focused on the downstream portion of the channel (~ 170'). If funding was available, it is conceivable that the project could be extended further upstream with more check dams and planting areas. The upstream open area is a realistic location for a possible project expansion.

The development the OAK 4, or one of similar concept, should incorporate a maintenance plan by the County. Since the channel can receive large volumes of water, debris can travel down the channel and possibly get backed up in the wetland plants and/ or at the check dams. To ensure the longevity and effectiveness of OAK 4, it would be necessary to periodically inspect the channel and remove any debris.

MILES 2
MILES 2 presents a favorable situation to treat runoff from a State Road. The County could consider approaching SHA to acquire supplemental funds for this project. MILES 2 proposes to maintain the flow path of the swale, however implement a water quality SQW under the riprap channel. An overflow pipe could be constructed through the existing timber bulkhead. Wetland plantings would be installed along the channel bottom. The existing swale side slopes are relatively flat. The slopes are a part of the property owner's maintained lawn. So as not to obstruct any more of the water view than necessary, no upland plantings are proposed on the side slopes. ***Exhibit 10*** shows a conceptual plan view and profile of MILES 2.

MILES 3
The location of MILES 3 is such that it would not only provide water quality treatment for approximately 11.6 acres, but also improve a drainage ditch where the outfall is in a state of disrepair. The development area for MILES 3 is very narrow. A residential house is only 30' from the project site. However, as mentioned, two services can be improved with this project. A 100' long SGW is proposed in-line with the existing ditch. In

order to upgrade the existing outfall, a storm drain yard inlet and outfall pipe would be constructed at the downstream end of the SGW. A 10' long section of the deteriorating bulkhead would have to be replaced as part of the outfall construction. Considering the condition of the existing ditch, it is believed that the adjacent property owners would approve of the project in order to improve the condition of the ditch. ***Exhibit 11*** shows a conceptual plan view and profile of MILES 3.

OAK 3
The configuration of OAK 3 is similar to that of OAK 4, where a wide drainage channel discharges into a mud flat of tidal waters. The difference is that OAK 3 has a 95% smaller upland drainage area than OAK 4. Thus is the reason why OAK 3 is the fifth recommend priority for project retrofit within Newcomb. The residents on both sides of the tidal channel grow and promote vegetation on the channel side slopes (*Photo 78A*). The vegetation along the channel is very stable and healthy. Although OAK 3 has a smaller drainage area, the concept plan is similar to OAK 4. The result is a larger percentage of upland pollutants can be treated with the proposed improvements. A series of three stone check dams are proposed in the channel with a Submerged Gravel Wetland constructed in between the dams. Also similar to OAK 4, a living shoreline would be constructed in the tidal area downstream of the channel (see *Shoreline Improvement Recommendations)*. ***Exhibit 12*** shows a conceptual plan view and profile of OAK 3.

Similar to OAK 4, a maintenance schedule should be set up with the development of OAK 3.

OAK 9
OAK 9 is conceptual project to rectify a drainage problem between two residential properties. Apparently, runoff coming from further upland makes it way between the houses. Since there is no ditch to receive the runoff, erosion has occurred where the runoff is draining to the river. The eroded ditch is shallow and winding. A SGW is proposed along the eroded ditch area to provide water quality management for the runoff. Further, two small check dams are placed in the SGW to reduce any erosive velocities that may occur. ***Exhibit 13*** shows a conceptual plan view and profile of OAK 9.

Using Table D.4.6 from the Maryland Department of Environment Stormwater Management Manual and the removal rate for a wetland as shown in Table 8, the amount of pollutant load removed can be determined. Table 10 lists the percentage and load amount of pollutant removed for each concept plan listed above.

TABLE 10

Project	TSS Removed as % of Total Annual Load	Estimated TSS Load Removed (lbs./yr.)	TP Removed as % of Total Annual Load	Estimated TP Load Removed (lbs./yr.)	TN Removed as % of Total Annual Load	Estimated TN Load Removed (lbs./yr.)
OAK 5	3	48	2	0.1	1	0.1
MILES 1	14	663	9	2.1	5	0.8
OAK 4	4	366	3	1.3	1	0.5
MILES 2	12	391	8	1.2	4	0.5
MILES 3	11	281	7	0.9	4	0.4
OAK 3	15	159	10	0.5	5	0.2
OAK 9	22	143	15	0.5	7	0.2

OAK 3 AND OAK 4 ALTERNATE
The recommendation for OAK 3 and OAK 4 incorporates a Submerged Gravel Wetland and upland wetland vegetation in the concept design. Depending on the design elevations within the channel, the upland wetland plantings could be replaced with tidal or inter-tidal vegetation. Further, a sand media would replace the bank run gravel media. However, there would be a concern of how the fresh water runoff would impact the tidal/ inter-tidal vegetation. These factors should be investigated prior to any project implementation.

HISTORIC SHORELINES

The Merlin website also provides data on historical shorelines from 1847, 1942, 1994, and 2010. ***Exhibit 14*** overlays these shorelines on an aerial photograph. Areas of a receding and ascending shoreline are clearly visible along Miles River and Oak Creek. Along the Miles River, the shoreline has receded between 40 and 100’ since 1847. It is expected that this recession occurred prior to the installation of the bulkheads and stone revetments. In observing the comparison between the 1994 and 2010 shorelines, there is no change indicating a stable shoreline. In Oak Creek, from the bridge south to the northern cove, the shoreline appears to be stable through the years. The northern cove of Oak Creek had shoreline loss in the areas of OAK 4 (~80’ receded length) and OAK6 (~50’ receded length). These locations, as previously mentioned, are points of concentrated flow, thus the cause of shoreline loss is from upland storm runoff rather than wave/ wind activity. Continuing south around the peninsula, the shoreline has recessed slightly (~20’). However, this shoreline has been stabilized with a stone revetment and is currently stable. The southern cove has experienced both recession and accession of shoreline. The floodplain of OAK 7 was previously a open water area (1942 shoreline) that has apparently filled in with sediment (2010 shoreline) creating a wetland area. As the shoreline continues south along the western coast of Oak Creek, the shoreline has changed very little since 1942.

SHORELINE FIELD INSPECTION

The shoreline within the Village of Newcomb is about 1.7 miles long. This includes 0.7 miles along the Miles River and 1.0 miles along Oak Creek. This area was visually inspected by boat to determine unstable areas possible causes of any unstable areas. The investigation started on the southeast edge of Newcomb, near Acorn Lane, continued under the Rt. 33 Bridge, and along the Miles River up to the limits of Newcomb. Table 11 is a summary of the shoreline investigation. Sections 1 through 14 are on located on Oak Creek and Section 15 through 17 are on the Miles River. A location map of the 17 sections is provided on ***Exhibit 15***.

TABLE 11

Section	Length	Structure	Condition	
1	600’	Minor Stone Revetment	Stable	
Photos: W03 – W17 Remarks: Revetment is a minor structure protecting low lying residential properties. Minor erosion in isolated areas. Single concrete boat ramp. This section is where OAK 9 is located, but shoreline is not erosive.				
2	945’	Stone Revetment	Stable	
Photos: W18 – W30 Remarks: Revetment is a tall structure protecting mostly one residence. Higher upland elevations result in taller structure.				

3	315’	Natural - Wooded	Unstable	
Photos: W31 – W34 Remarks: Natural shoreline is mud flat beach with sparse trees and heavy vegetation. Some scouring and tree roots apparent. Area is secluded thus it is anticipated that erosion is caused by either rainfall or refracted waves from adjacent bulkhead.				
4	170’	Bulkhead / Stone Revetment	Stable	
Photos: W35, W38 Remarks: Combination of timber bulkhead and stone revetment protecting single property.				
5	200’	Natural - Floodplain	Stable	
Photos: W36 – W37, W39 – W45 Remarks: Natural floodplain area (OAK 7).				
6	685’	Stone Revetment	Stable	
Photos: W46 – W54 Remarks: Stone revetment for protecting two properties. Storm drain pipe daylights through revetment (Photo W48). Upstream end of pipe unknown. No erosion evident. Apparent fill outboard of revetment for approximately 125’ (Photo W49).				
7	315’	Minor Stone Revetment	Mostly Stable	
Photos: W55 – W62 Remarks: Minor stone revetment that is non-linear and non-uniform in height and width. Revetment area mostly stable. Last 30’ of revetment is concrete rubble in disrepair (Photo 62). Undercutting of rubble revetment is evident. Rubble revetment located adjacent to OAK 5.				

			Photo 62	
8	120’	Old Timber Bulkhead	Moderately Unstable	
Photos: W63 – W67 Remarks: Aged bulkhead in need of replacement. Openings between timber sheeting boards evident. At time of investigation, water was draining from hole in bulkhead (shown in picture). Pipe visible in hole (Photo 67). OAK 5 daylights through bulkhead. Area behind OAK 5 is washed out (Photo 103 & 105A).				
9	265’	Natural - Vegetation	Moderately Unstable	
Photos: W68 – W73 Remarks: Small peninsula and mud flat area with a natural shoreline. Broken piles are evident around perimeter of peninsula, indicating possible bulkhead existed here at one time. Elevations on peninsula are high enough to support upland evergreen trees. Peninsula transforms into a mud flat area which is the outfall of OAK 4 (Photo 73).				
10	75’	Make Shift Bulkhead	Moderately Unstable	
Photos: W74 – W75 Remarks: Make shift bulkhead made from various sized and located boards. Sheds/buildings located directly behind bulkhead.				
11	280’	Natural - Wooded	Unstable	
Photos: W76 – W77 Remarks: Natural shoreline covered with sparse vegetation and trees. Limbs and minor scouring are evident on northwest side of cove. Mud flat outfall of OAK 3 is located before scoured shoreline. Area is secluded thus it is anticipated that erosion is caused by either rainfall or refracted waves from nearby bulkhead.				

<table>
<tr><td>12</td><td>640’</td><td>Bulkhead / Stone Revetment</td><td>Stable</td><td rowspan="2"></td></tr>
<tr><td colspan="4">Photos: W78 – W85

Remarks: Mostly stone revetment shorelines with small section of timber bulkhead. With the exception of one area at the before timber bulkhead begins (Photo 81), all structural shoreline appears stable.</td></tr>
<tr><td>13</td><td>400’</td><td>Steel / Timber Bulkhead</td><td>Stable</td><td rowspan="2"></td></tr>
<tr><td colspan="4">Photos: W86 – W91

Remarks: Steel then timber bulkhead on County property. Timber bulkhead continues along Rt. 33 bridge.</td></tr>
<tr><td>14</td><td>330’</td><td>Natural – Beach / Armor stone</td><td>Stable</td><td rowspan="2"></td></tr>
<tr><td colspan="4">Photos: W92 – W95

Remarks: Beach located on south side of bridge. Armor stone protects bridge abutment abutment.</td></tr>
<tr><td>15</td><td>1,250’</td><td>Stone Revetment</td><td>Stable</td><td rowspan="2"></td></tr>
<tr><td colspan="4">Photos: W92 – W95

Remarks: Stone revetment with high elevation (~ +6.0’).</td></tr>
<tr><td>16</td><td>1,665’</td><td>Timber Bulkhead</td><td>Mostly Stable</td><td rowspan="2"></td></tr>
<tr><td colspan="4">Photos: W96 – W109

Remarks: Timber bulkhead of various ages. Appears bulkheads have been sporadically replaced over the years. Some sections are recent construction. 165’ of bulkhead fronting new construction at end of Beach Av. is in state of disrepair (Photos W106). This is the outfall location of MILES 3 (Photo 105). Sand accretion is apparent in front of some bulkhead sections.</td></tr>
</table>

Photos W106 (Bulkhead) and W105 (Outfall of MILES 3).				
17	380’	Stone Revetment	Stable	
Photos: W110 – W111 Remarks: Tall stone revetment protecting two residences. Stone revetment ends at outfall of MILES 1.				

SHORELINE IMPROVEMENT RECOMMENDATIONS

The shoreline along the Miles River and Oak within Newcomb is mostly stable and hardened. Most of the the waterfront property owners with stone revetments or bulkheads have a lasting, non-eroding shoreline. There are exceptions where a bulkhead is aged and deteriorating such Section 8 and the newly constructed house in Section 16 (at MILES 3 outfall). The two shoreline areas that are considered ‘unstable’ are naturally vegetated and have signs of undercutting (Section 3 and 11). For Section 3, a rapid progression of shoreline erosion is not expected due to its protected location. The waterfront property owners along the Miles River have a continual line of shoreline protection of revetments or bulkhead, leaving no area exposed to possible lateral shoreline erosion. The condition of the shoreline along Oak Creek varies from property to property. Table 12 provides a summary of the inspected shoreline sections and their stability classification.

TABLE 12

Shoreline Condition	Length (ft.)	Percentage of Total Length
Stable	5,600	64.9
Mostly Stable	1,980	22.9
Moderately Unstable	460	5.3
Unstable	595	6.9

Stable:	Shoreline shows no sign of erosion and is good condition.
Mostly Stable:	Majority of shoreline is in good condition. Some isolated repair/replacement areas are recommended.
Moderately Unstable:	Shoreline is near the end of its service life or has a possibility of failing or eroding over the next 5-10 years.
Unstable:	Shoreline shows signs of undercutting, sediment seepage, or washout.

SECTION 7

Section 7 has approximately 30’ of a concrete rubble revetment (Photo 62) that should be removed (see Table 11). Instead of replacing the revetment, a living shoreline is proposed. This could be tied into the OAK 5 project. The outfall pipe would discharge into a stone plunge pool to dissipate the velocity. Tidal wetlands would be planted behind coir fiber logs. The logs would provide protection from any minor wave activity that enters the cove. A plan view of the living shoreline is shown on ***Exhibit 7***.

SECTION 8
Section 8 is a bulkhead that has reached the end of its service life. As mentioned in Table 11, the openings between the sheeting boards have expanded over the years. This expanded opening is an avenue for sediment loss. The County can provide recommendations and guidance to the property owner for bulkhead replacement.

SECTION 9
The shoreline along Section 9 provides the greatest opportunity for a living shoreline. The remnant of a small peninsula is an ideal location to restore upland area and also create a tidal wetland. A combination of low-profile stone sills and coir logs could be installed around the peninsula. The elevation within the living shoreline could easily be designed to vary between upland and wetland. This living shoreline would also provide protection to the historical cemetery located directly upland of the peninsula. As stated in OAK 4, a living shoreline located at the small peninsula could be tied into the water quality project in the existing channel (OAK 4). It is recommended that the Section 9 and OAK 4 be considered one project. The OAK 4 project reduces the exiting velocities that approach the peninsula. The low-profile stone sill proposed with Section 9 provides a defined channel into open waters. ***Exhibit 9*** provides a conceptual site plan of the living shoreline located at the outfall of OAK 4. The living shoreline was not continued further north due to presence of a moored boat located approximately 65' from the mouth of the existing channel.

SECTION 10
Section 10 is a make-shift bulkhead which is directly outboard of three small buildings. Although the bulkhead currently appears stable, it is expected that this structure will not endure. It is recommended that this structure be replaced with a typical bulkhead structure of pilings and sheeting.

SECTION 11
Similar to Section 9, a living shoreline is proposed in connection with improvements to a drainage channel (OAK 3). However, unlike Section 9, the upland drainage area is not large and the velocities exiting the channel are not considered erosive. The primary purpose for a living shoreline at this location is to stabilize and improve the existing northern shoreline. As mentioned in Table 12, there are some minor signs of undercutting and fallen trees. The cause of the eroding shoreline is not known, although it is anticipated that refracted waves are the cause. A living shoreline would prevent further erosion. ***Exhibit 12*** shows the living shoreline in respect the water quality project (OAK 3).

SECTION 16
The 165' of bulkhead located near Beach Avenue is in state of disrepair and should be replaced. It is recommended that this project coincide with the implementation of MILES 3. The remaining 1,500' of bulkhead is in good condition.

EFFECT OF SEA LEVEL RISE ON RECOMMENDED UPLAND AND SHORELINE PROJECTS

As previously stated, the areas where sea level rise would cause inland inundation are primarily in the northern and southern coves of Oak Creek. Three upland projects (OAK 3, OAK 4, OAK 5) and three shoreline projects (Section 7, Section 9, Section 11) are proposed in the northern cove area. Two of the upland projects (OAK 3 & OAK 4) are proposed in existing drainage channels. The long term effect of sea level rise at these two locations is that the channels would slowly become a full tidal area as opposed to upland or inter-tidal areas. This would result in a slow degeneration of the wetland plants being proposed. For the OAK 4 project, the proposed improvements could be moved further upstream to elevate it above the 0-2' inundation range. Since the drainage area to a relocated SGW would become smaller, the project could potentially be a longer project in the upstream channel, thereby maintaining the same level of pollutant removal as currently proposed.

Site constraints prohibit OAK 3 from moving inland. A rise in sea level is not expected to impact OAK 5.

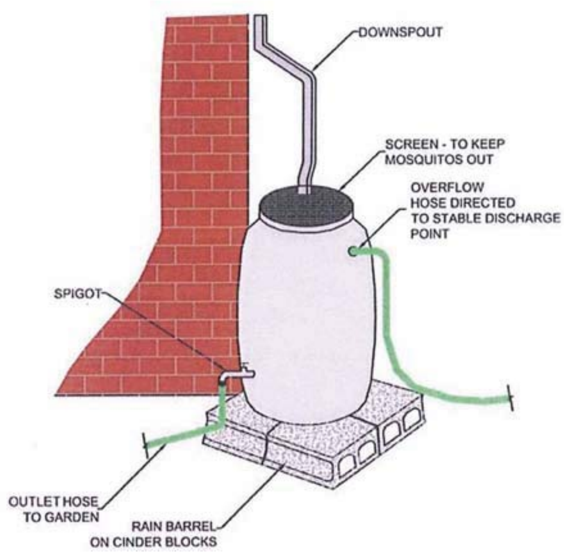
In a living shoreline, a low-profile or a coir log is installed around an area to protect it from low-energy wave activity and to contain the imported planting material. In order to account for a rise in sea level, the top of the containment structures should be elevated 6-9" above the current spring tide line. With a raised wetland area, less inter-tidal and more upland plants would be placed. Over time, the inter-tidal plants would adjust to the different tide levels, while the upland plants will slowly degenerate. The down side of an elevated containment structure is that it might meet resistance from nearby property owners because they would consider an eyesore.

The elevations at the remaining recommended projects (MILES 1, MILES 2, MILES 3, OAK 9) are all above the 2' inundation range, therefore it is not anticipated that a rise in sea level will affect these areas.

RECOMMENDATIONS FOR THE INDIVIDUAL PROPERTY OWNER

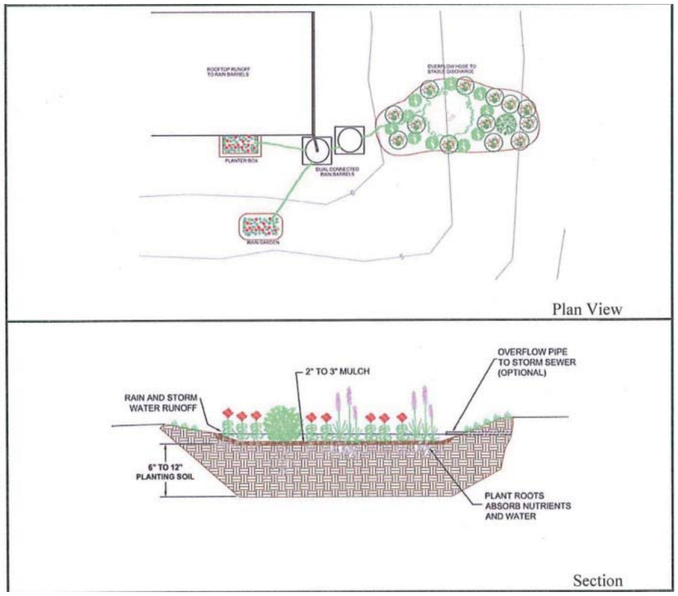
RAIN BARREL

Apart from County Capital projects, there are small scale projects that can be suggested to the individual property owners to improve the water quality from their home. One individual practice is to install Rain Barrels at their downspouts. Rain barrels capture and temporarily store rainfall from a home's rooftop area. The stored water can be used for watering gardens, landscaping, or any other non-potable use. Any pollutants that are present from rooftop runoff is captured and then distributed over a pervious area during a non-storm event. This promotes infiltration of the runoff rather than it possibly becoming part of a concentrated flow into a nearby waterway. A typical rain barrel detail obtained from the MDE SWM Manual is shown below.



RAIN GARDEN

In a similar fashion, a Rain Garden can be implemented at a downspout or some other location of shallow concentrated flow in a yard. As defined in the MDE SWM Manual, a rain garden is a "shallow, excavated landscape feature or a saucer-shaped depression that temporarily holds runoff for a short period of time." The excavated area is filled with planting soil, then a 2-3" layer of mulch, and then a variety of shrubs, grasses, and flowers are planted in the depressed area. Runoff from small storms will drain into the garden and then filter down through the planting material. The garden is designed such that it will hold a small amount runoff. Any significant rainfall will simply fill and then overflow the garden. This practice is usually used for small impervious area such as a rooftops or driveways. The plan view and detail shown below is obtained from the MDE SWM Manual.



GRASS FILTER STRIP

A 5-10 foot wide grass filter strip is a practice that waterfront property owners can implement to promote pollutant removal before runoff enters a waterway. The filter strip would receive runoff in the form of sheet flow. Allow the grass to grow 9-12" would increase the capability of removing pollutants more so than if the area is regularly maintained. The area should be mowed 2-3 times a year in order to prevent unwanted growth of trees, shrubs, or other vegetation.

SCHEDULED MAINTENANCE OF COUNTY ROADS

The biggest concern that the residents expressed was the lack of maintenance on the roadside ditches and driveway culverts. As previously mentioned, the ditches and culverts have become filled/ clogged with leaves, sediment, and other debris. Over time, some of the driveway culverts become fully blocked. As the culverts remain blocked, sediment builds up in the ditch causing the flow line (bottom) to rise. The end result, as stated by the residents, is that water overflows from the ditches and backups into the yards.

Residents stated they have contacted the County about maintaining the ditches and culverts. Due to budget shortfalls, this maintenance item is typically postponed or eliminated from the County's maintenance programs. The County may consider requesting a volunteer from Newcomb to coordinate an effort once or twice a year to clean out the ditches and culverts. If the County could possibly provide the machinery and trucks to remove the debris, the residents could possibly perform the work of debris removal. This is just one possibility that could be initiated by the County. It is recommended that the County investigate other possibilities of a joint effort for ditch and culvert maintenance because it is a very important and frustrating issue to the residents of Newcomb.

INTERSECTION OF ROYAL OAK ROAD AND STATION ROAD

The issue of the Royal Oak Road / Station Road intersection flooding during storm events is discussed in the section *Community Input*, above. Due to the pressing concern that this flooding is currently a driving hazard, the County should promptly proceed with installing a new driveway culvert at the residential property located on Royal Oak Road. The field inspection revealed that the remaining culverts leading to the large channel are free of debris. Installing this single culvert should rectify the flooding problem at the intersection.

PROJECT CONSTRUCTION COSTS

Estimated construction costs have been developed for each of the seven recommended projects. The costs were developed using the latest unit costs for similar type projects. The listed figures should be used for budgetary reasons only and should not be considered final. The costs provided in Table 13 do not include any consultant services such as permitting, design, survey, or construction administration.

TABLE 13

Recommended Project Priority	Drainage Group	Estimated Construction Costs	Includes Living Shoreline	Living Shoreline Section	Exhibit
1	OAK 5	$27,700	Y	Part of 7	7
2	MILES 1	$39,200	N	--	8
3	OAK 4	$59,100	Y	9	9
4	MILES 2	$15,800	N	--	10
5	MILES 3	$34,800	N	--	11
6	OAK 3	$28,500	Y	11	12
7	OAK 9	$4,600	N	--	13

SUMMARY

The Village of Newcomb presents several opportunities to develop a pollutant reduction and water quality improvement project through Environmental Site Design. The locations of the seven recommended retrofit projects were chosen because they are areas of concentrated flow where maximum treatment can be obtained for an upland area. All projects propose work on private property, thus an open line of communication should be established with the residents of Newcomb in the possible implementation of the above concept projects. The field investigation and above report also identify areas where the drainage system within the Village should be improved and/ or replaced due to its age and neglect over the years. These failed/ neglected systems are critical factors in current driving hazards, upland flooding, or threats to historical areas within the Village.

For the most part, the coastal shoreline in Newcomb is stable due to property owners implementing various types of shoreline protection over the years. There are some isolated natural shorelines that show signs of eroding (i.e. undercutting, fallen trees and scouring). The recommendations listed above attempt to combine a shoreline stabilization project with an upland water quality project to maximize their overall effect.

The Village of Newcomb is a quiet community with several features that make it attractive to its residents. It is the intent that the recommended projects provided herein can not only improve the water quality of runoff entering the Miles River and Oak Creek, but also add an aesthetic environmental feature that compliments the community.

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Web Soil Survey. U.S. Department of Agricultural, Natural Resource Conservation Service.
(http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx)

Google Earth.

Mr. Frank Cavanaugh, Resident, Village of Newcomb.

Mr. and Mrs. Pete Imirie, Residents, Village of Newcomb.

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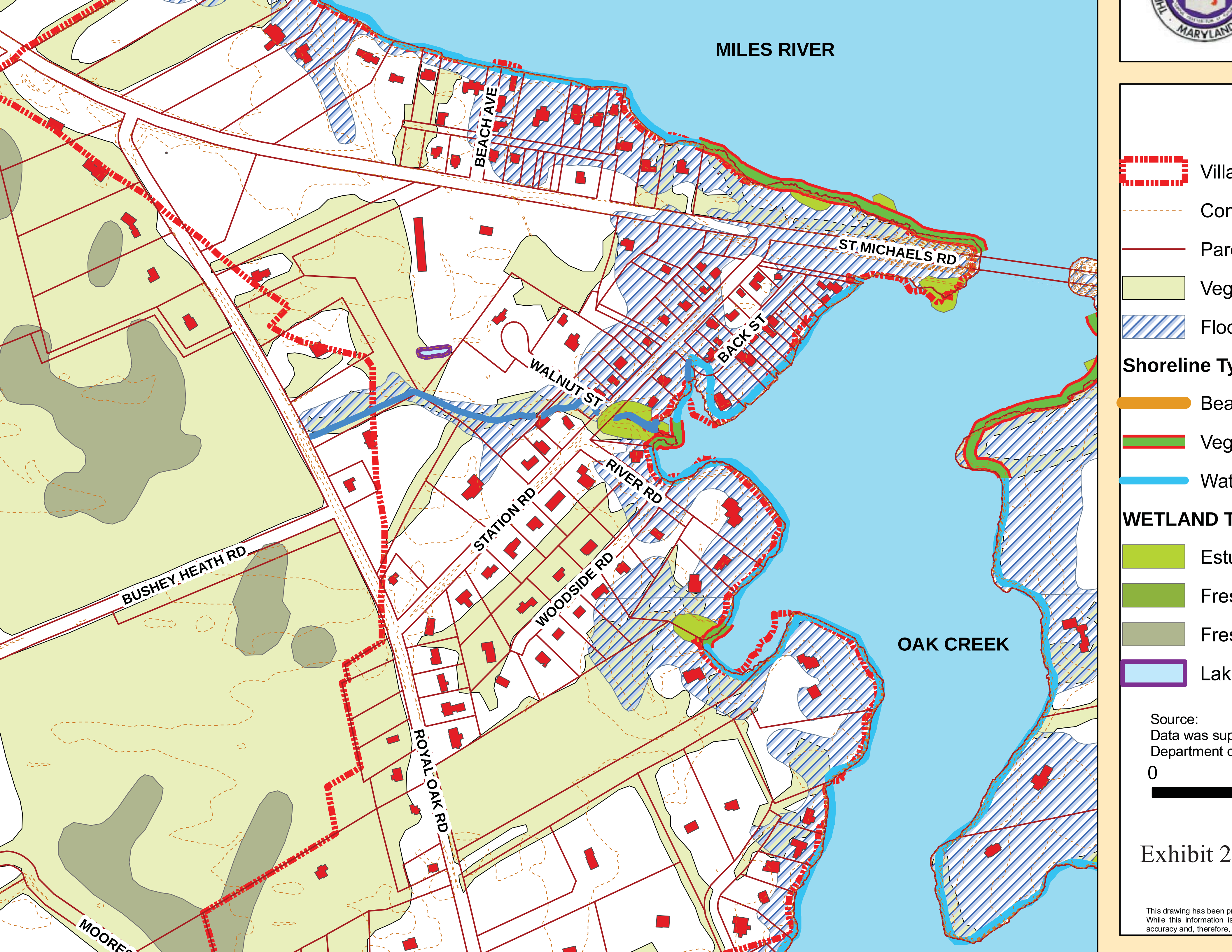

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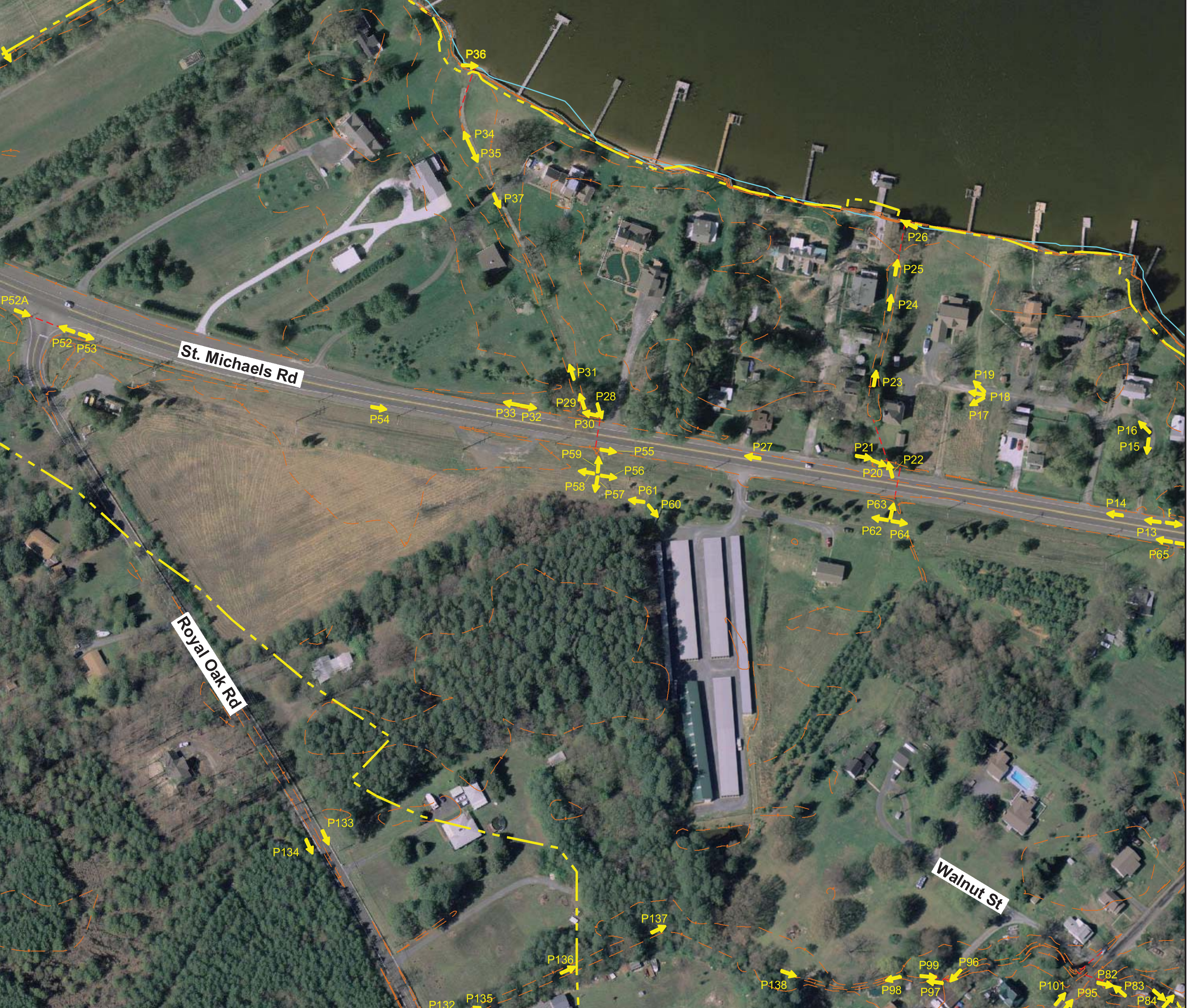

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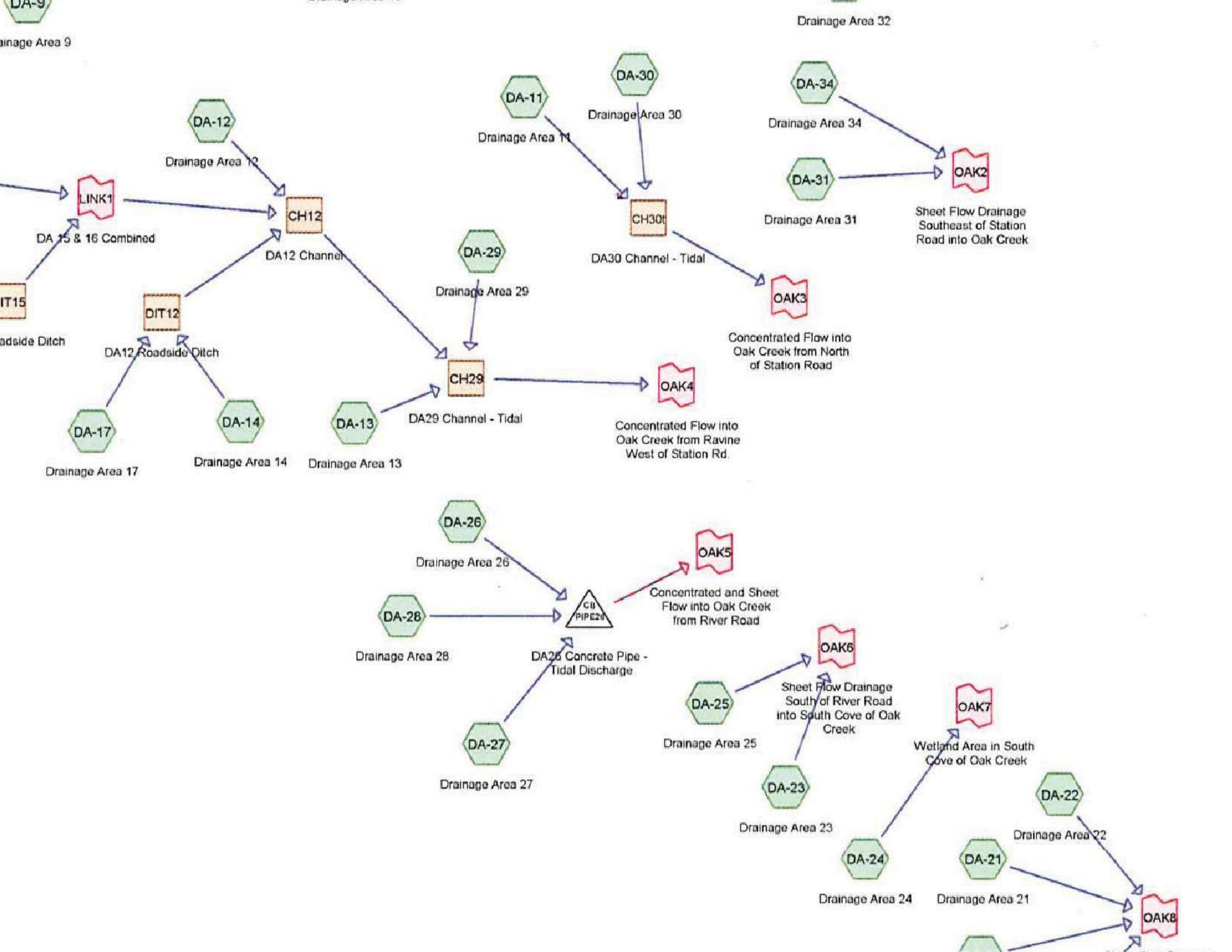
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DA-30
Drainage Area 30
DA-11
Drainage Area 11
DA-34
Drainage Area 34
DA-31
Drainage Area 31
OAK2
Sheet Flow Drainage Southeast of Station Road into Oak Creek
DA-12
Drainage Area 12
LINK1
DA 15 & 16 Combined
CH12
DA12 Channel
CH30
DA30 Channel - Tidal
OAK3
Concentrated Flow into Oak Creek from North of Station Road
DA-29
Drainage Area 29
DIT12
DA12 Roadside Ditch
CH29
DA29 Channel - Tidal
OAK4
Concentrated Flow into Oak Creek from Ravine West of Station Rd.
DA-17
Drainage Area 17
DA-14
Drainage Area 14
DA-13
Drainage Area 13
DA-26
Drainage Area 26
OAK5
Concentrated and Sheet Flow into Oak Creek from River Road
DA-28
Drainage Area 28
CB PIPE26
DA26 Concrete Pipe - Tidal Discharge
DA-27
Drainage Area 27
OAK6
Sheet Flow Drainage South of River Road into South Cove of Oak Creek
DA-25
Drainage Area 25
DA-23
Drainage Area 23
OAK7
Wetland Area in South Cove of Oak Creek
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Drainage Area 22
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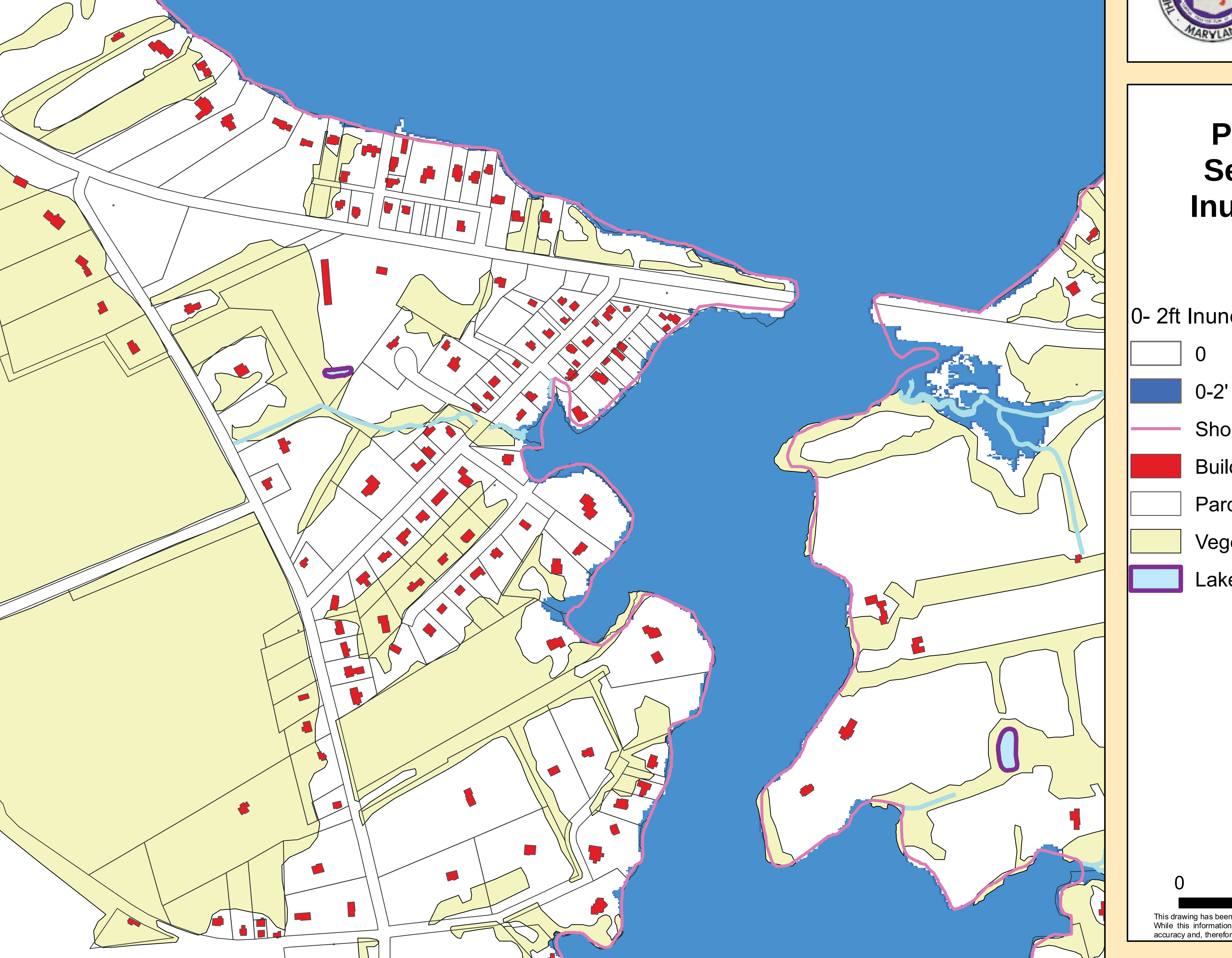
Drainage Area 21
OAK8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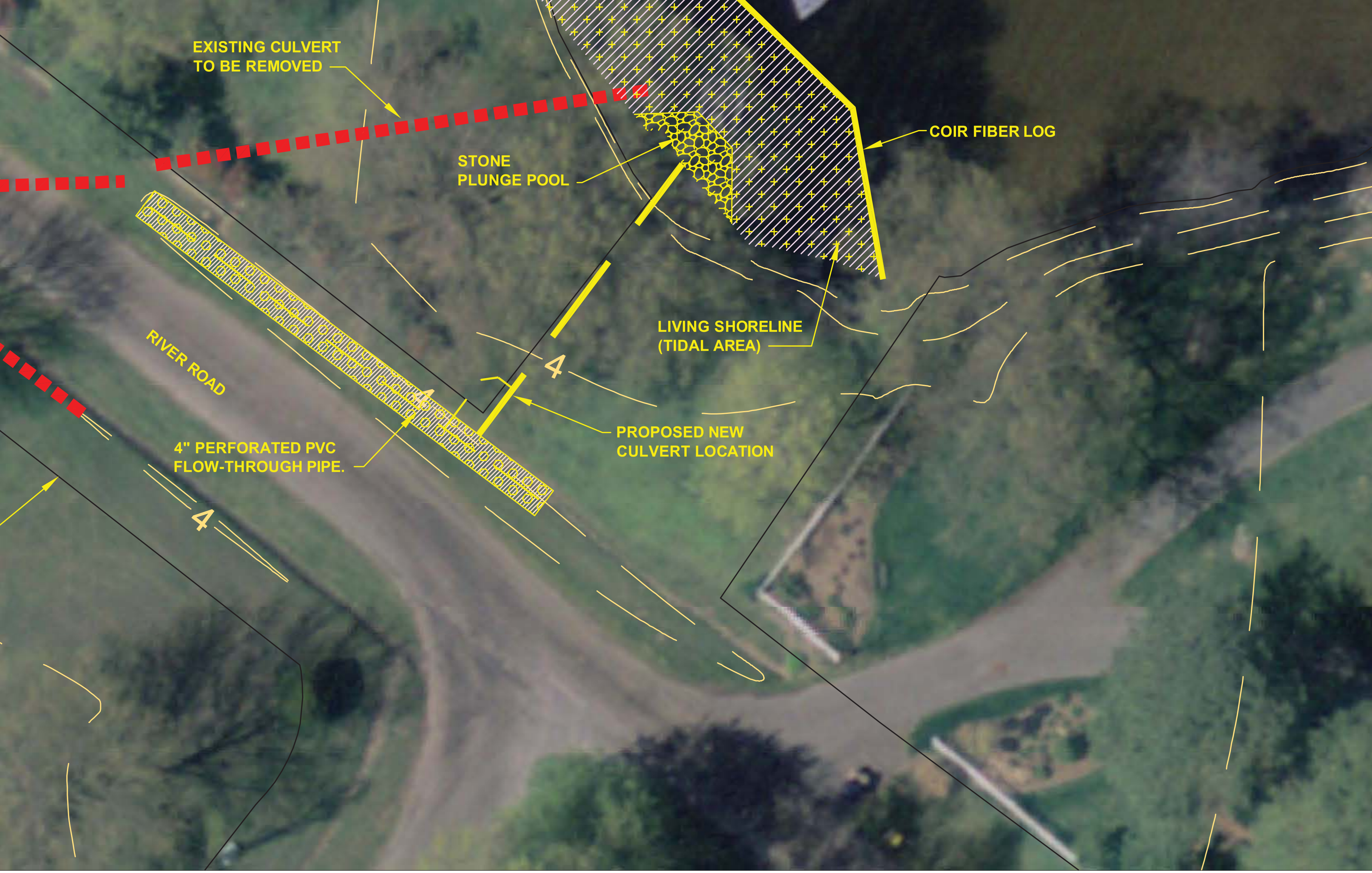
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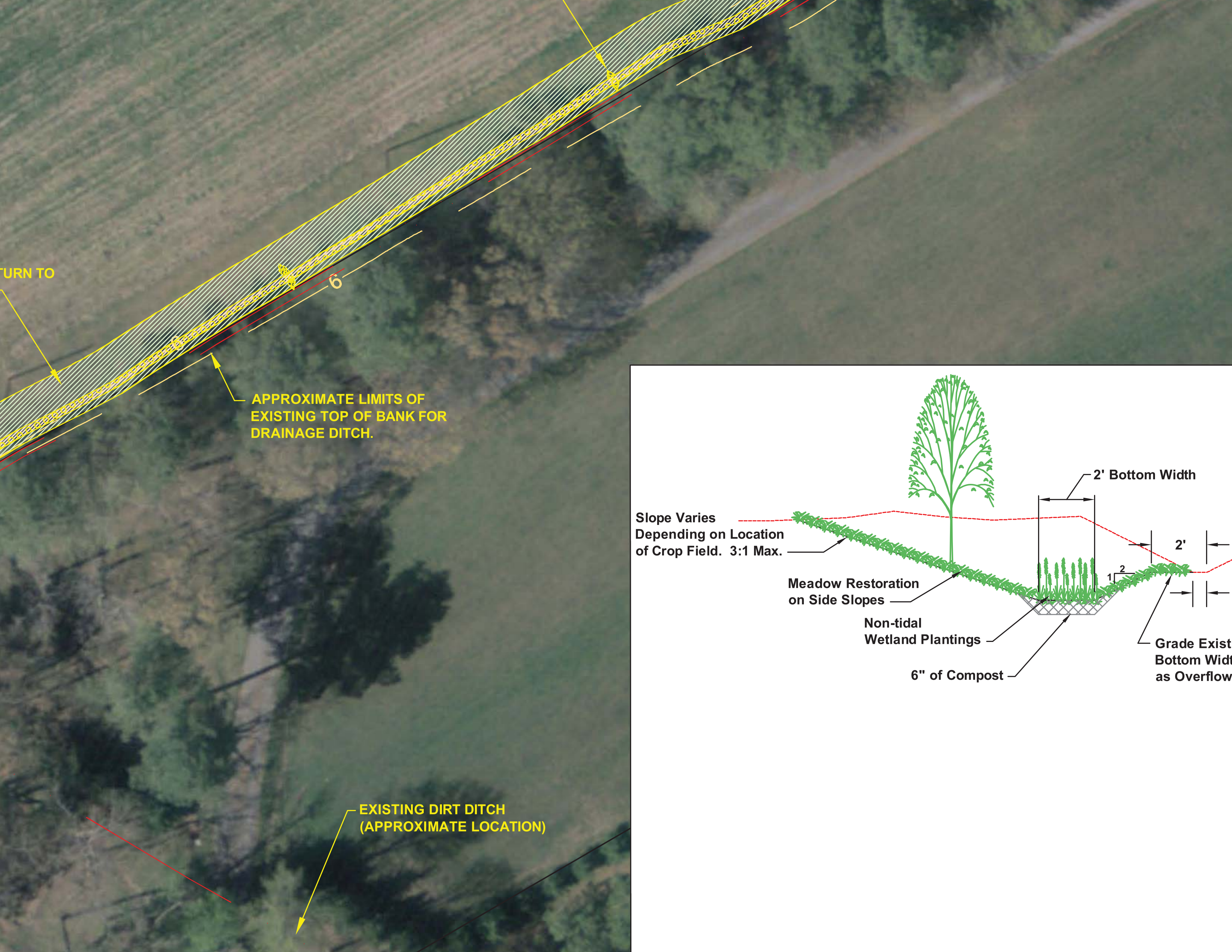
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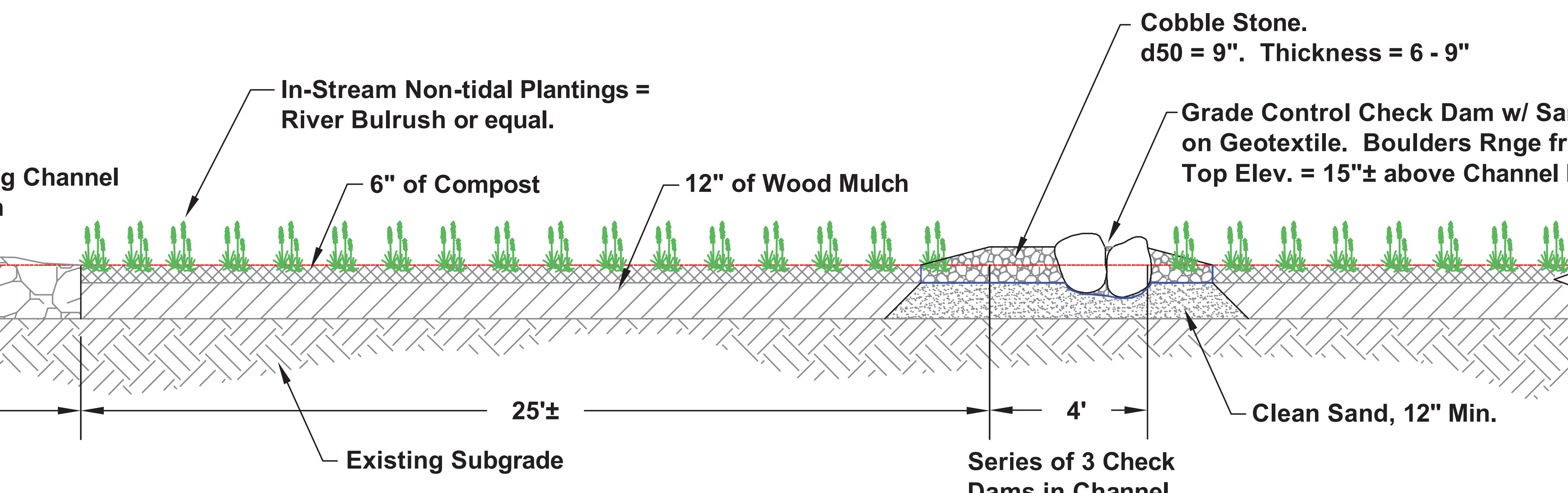
Non-tidal
Wetland Plantings
6" of Compost
Grade Exist
Bottom Widt
as Overflow

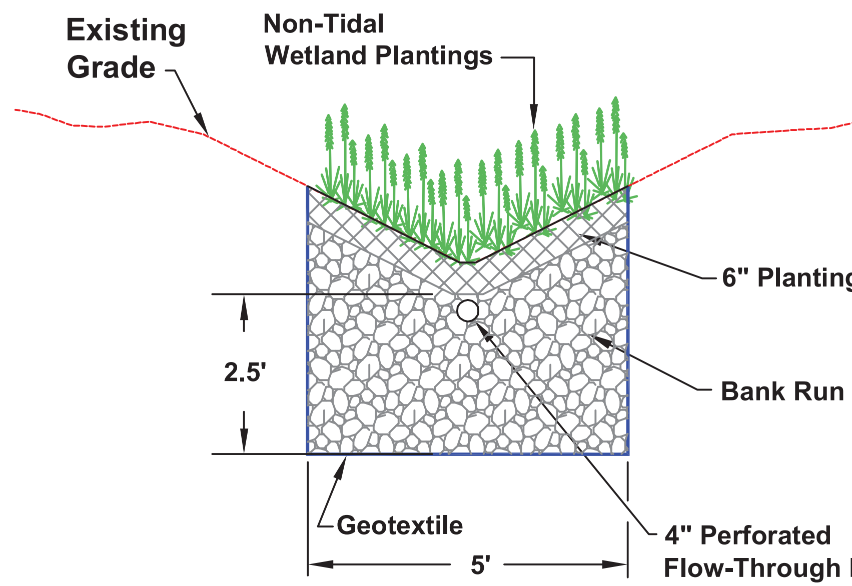
PARCEL LINE
(APPROXIMATE)
COIR FIBER LOG
LOW-PROFILE
STONE SILL
STATION ROAD
NATURAL TIDAL
CHANNEL TO REMAIN
EXISTING SHED
LIVING
(TIDAL
UPLAND
PLANTING AREA
COIR FIBER LOG
6
4
8
0

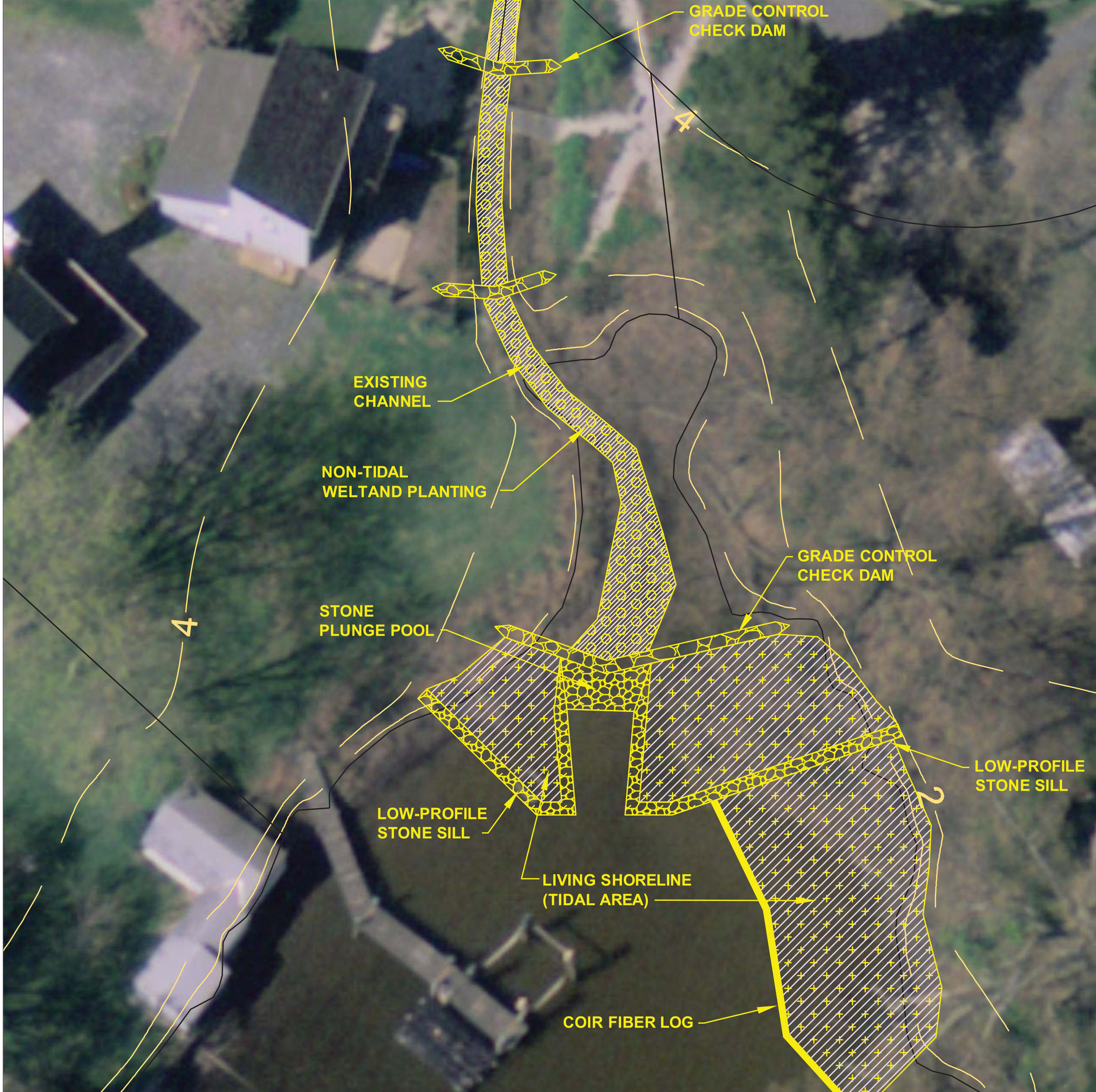


Cobble Stone.
d50 = 9". Thickness = 6 - 9"
In-Stream Non-tidal Plantings =
River Bulrush or equal.
Grade Control Check Dam w/ San
on Geotextile. Boulders Rnge fro
Top Elev. = 15"± above Channel B
g Channel
6" of Compost
12" of Wood Mulch
25'±
4'
Clean Sand, 12" Min.
Existing Subgrade
Series of 3 Check
Dams in Channel


SUBMERGED
GRAVEL WETLAND
EL LINE
ROXIMATE LOCATION)
6" PERFORATED PVC
FLOW-THROUGH PIPE.
EXISTING RIPRAP CHANNEL
TO REMAIN
4
4
6
2

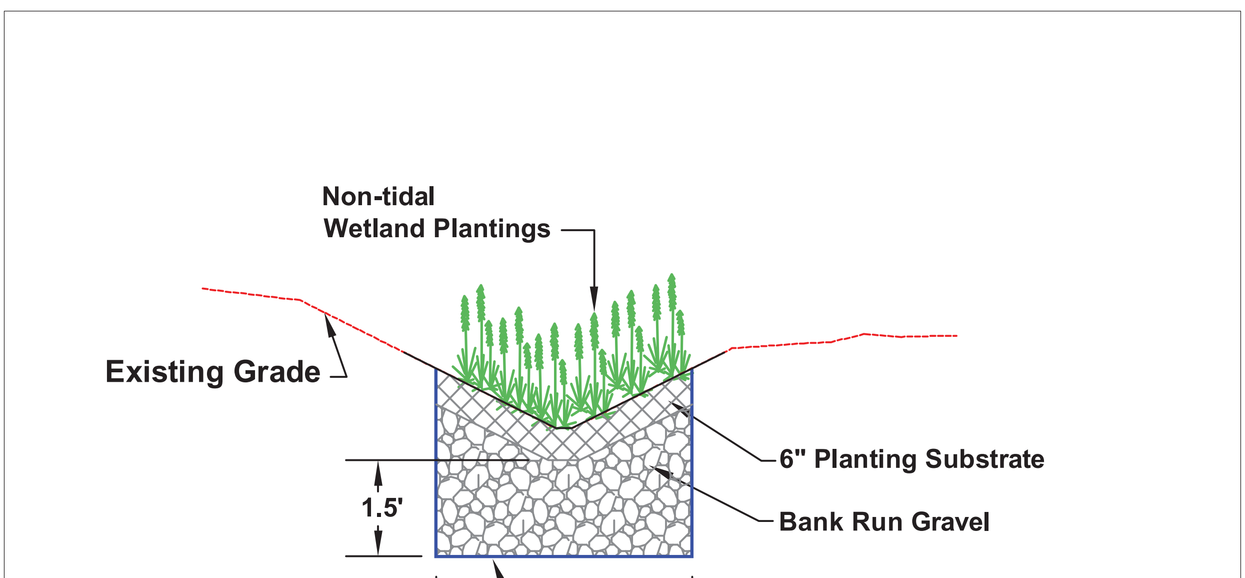

PROPOSED STORM DRAIN INLET FOR RUNOFF OVERFLOW.
SUBMERGED GRAVEL WETLAND.
4" PERFORATED PVC FLOW-THROUGH PIPE.
CH TO BE REGRADED
R POSITIVE FLOW TO
GRAVEL WETLAND.


Existing Grade
Non-Tidal Wetland Plantings
6" Planting
Bank Run
2.5'
Geotextile
4" Perforated Flow-Through
5'



t Existing Side
s to Match Existing
tion.


EXISTING ERODED DIRT CHANNEL
WITH TIDAL DISCHARGE.
SUBMERGED
GRAVEL WETLAND
OAK CREEK
4
2


Non-tidal
Wetland Plantings
Existing Grade
6" Planting Substrate
Bank Run Gravel
1.5'

Section 2
945'
Section 3
315'
Section 4
170'
Section 5
200'
Section 6
685'
Section 7
315'
Section 8
120'
Section 9
265'
Section 10
75'
Section 11
280'
Section 12
640'
Section 13
400'
Section 15
1,250'