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STORMWATER MANAGEMENT & SHORELINE PROTECTION

INVENTORY & MASTER PLAN

OXFORD, MARYLAND

GMB PROJECT NO. 140187.A

Prepared for:

COMMISSIONERS OF OXFORD

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STORMWATER MANAGEMENT AND SHORELINE PROTECTION INFRASTRUCTURE

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1.0 INTRODUCTION

1.1 Background

Oxford is a quaint historic town located on the Eastern Shore of Maryland and surrounded by the waters of the Tred Avon River and its tributaries. As a coastal community of the Chesapeake Bay, Oxford enjoys the lifestyle afforded by close proximity to the water. The economics of Oxford are fueled by sailing, boating and tourism. Yet the lure of waterfront life is also linked to the burden of dealing with flooding as a routine event. With the forecast of climate change and associated sea level rise and worsening storm events, flooding conditions in Oxford are expected to worsen over time.

1.2 Purpose of Study

The purpose of this study was to develop a comprehensive inventory of stormwater and shoreline infrastructure coupled with a master plan of capital improvement projects to be implemented over the next 5 to 8 years to mitigate the impacts of flooding. The study was accomplished in two phases, 1)Stormwater Shoreline Infrastructure Inventory and 2)Stormwater Shoreline Master Plan.

The Phase 1 Inventory was completed in 2015 and it included field survey and mapping of the Town's existing stormwater instrastructure. The inventory maps are included in the back of this report. The Phase 2 Master Plan utilized the data collected under Phase 1 to generate computer models which were then used to evaluate the system hydraulics and consider modifications to improve stormwater drainage and reduce flooding. The desired result of the

Master Plan study was to recommend specific recommendations and provide cost estimates along with a prioritized schedule for implementation.

1.3 Stormwater and Flood Management Financing Study

The Inventory and Master Plan study was an outgrowth of a prior study completed in 2013 by the University of Maryland Enviromental Finance Center (EFC). The EFC study focused on the generation of community support, through outreach and education, toward the development of structured financing mechanisms for capital improvements to address stormwater. The study recommended creation of a stormwater utility fund that would be supported through annual fees collected on the basis of impervious surface and contributing runoff.

2.0 INFRASTRUCTURE INVENTORY AND PHYSICAL FACTORS

2.1 Stormwater Management

The Town of Oxford's stormwater infrastructure consists of multiple networks of closed pipe systems, catch basins, open drainage ditches, swales, bioswales and outfalls. The stormwater facilities were located by field survey during the period November 2014 thru January 2015, as shown on the Stormwater Inventory Map contained in the back of this report. Oxford is divided into fifteen (15) sub-drainage areas, each identified by its outfall pipe as shown in Table 2-1.

Table 2-1 – Outfall Inventory					
Outfall Location	Receiving Water	Pipe Size (inches)	Invert Elevation	Drainage Area (acres)	Tide Gate
The Causeway	Town Creek	27	-1.85	18.06	✓
The Causeway	Town Creek	15	-1.17	3.48	
S. Morris St @ Caroline	Town Creek	14	-1.25	4.02	
313 S. Morris St	Town Creek	12	-0.74	9.84	
South St	Town Creek	18	0.63	3.46	
Banks St	Town Creek	24	-1.86	22.37	✓
Tilghman St @ Boat Ramp Parking Lot	Town Creek	12	-1.58	3.74	
Mill St @ Oxford Boat Yard	Town Creek	12	-0.07	8.18	✓
The Strand – East of Ferry Terminal	Tred Avon	12	6.55	0.34	
The Strand @ Tred Avon Yacht Club	Tred Avon	6	-0.94	1.07	
Jack's Point @ Myrtle St	Town Creek	12	-0.03	1.36	
Jack's Point @ Bonfield Ave	Town Creek	24	-0.68	10.86	
Jack's Point @ Third St	Town Creek	15	0.47	8.09	
Jack's Point @ First St	Town Creek	12	1.74	1.11	
West Pier St	Tred Avon	18	-2.28	20.19	✓

The outfalls at Banks Street, West Pier Street and The Causeway represent the largest drainage areas.

The stormwater infrastructure inventory also includes several best management practices (BMPs) for water quality improvement such as bioswales. Bioswales are found in the following locations:

- Banks Street @ intersection with Market St
- S. Morris Street @ Causeway Park
- JL Thompson Drive @ Town Dog Park

Bioswales are a linear form of bioretention used to improve water quality and attenuate flooding while also serving as a means of conveyance. The bioswales have been completed over the past few years as retrofit projects to help alleviate flooding.

2.2 Tidal Effects

The hydraulics of the stormwater infrastructure are affected by tailwater conditions, i.e. tide level, at the outfalls. Tide data was obtained from the National Oceanic and Atmospheric Administration (NOAA) and the National Oceanic Service (NOS) for the nearest tidal bench mark Station CAMM2 8571892, Cambridge, Maryland, as in Table 2-2 as follows:

Table 2-2 Tide Data	
	Elevation
Mean Higher High Water	0.93
Mean High Water	0.72
Mean Low Water	-0.90
Mean Lower Low Water	-1.11
2-Year Spring Tide	3.00

The tidal survey datum is based upon the North American Vertical Datum of 1988 (NAVD 88) and Tidal Epoch 1983-2001.

Accordingly, the tidal range is 1.62 feet between mean high and mean low tide. Tide gates are installed at several outfalls as indicated in Table 2-2 above to prevent inflow during tide levels above the pipe inverts, yet allow water to flow freely in one direction when tide levels recede, or when stormwater backs-up in the system above tide level.

2.3 Soil Types

The volume and rate of stormwater runoff is affected by soil type. Soils are classified by the Natural Resource Conservation Service (NRCS) into four (4) Hydrologic Soil Groups (HSG) based on the soil's runoff potential. The HSGs are A, B, C and D. HSG A soils are the most permeable and have the least runoff potential. HSG D soils are the least permeable and have the greatest runoff potential.

Over 75% of the soils found in Oxford are poorly draining, HSG C or D soils with little capacity for absorption of stormwater and high runoff potential.

The prevailing soils types found in Oxford are are listed and described in Table 2-3.

Table 2-3 Soil Types			
Soil Type	Soil Characteristics	HSG	Percent of Area
Crosiadore Silt Loam	Somewhat poorly drained	C/D	50.7
Elkton Silt Loam	Poorly drained	C/D	3.5
Hambrook-Sassafras complex	Well drained	B	0.4
Honga Peat	Very poorly drained, very frequently flooded, tidal	C/D	12.8
Mattapex Silt Loam	Moderately well drained	C	0.6
Nassawango Silt Loam	Well drained	C	8.2
Othello Silt Loam	Poorly drained	C/D	5.5
Sunken Mucky Silt Loam	Very poorly drained, occasionally flooded	C/D	5.3
Udortjemts Loam	Well drained	C	12.0
Urban Land		Not classified	1.0

2.4 Shoreline Protection

Oxford's shorelines are lined with various protective measures, predominantly hardscapes such as riprap revetments and bulkheads. Green infrastructure, or living shorelines, have become more popular in recent years and are are beginning to differentiate the Oxford landscape. Green shoreline practices provide many benefits to fish and wildlife populations as well as increasing the shoreline's resistance to erosive forces.

Existing shoreline infrastructure types were identified by physical survey during the period November 2014 thru January 2015, as shown on the Shoreline Inventory Map contained in the back of this report. Notable green infrastructure shorelines are located as follows:

- Ferry Terminal, at north end of Morris Street
- Oxford Town Park, at Morris and Market Street
- Private residence, south end of South Street
- Cooperative Oxford Laboratory, 904 S. Morris Street

While most of the Oxford shoreline runs along private property, there are scattered parcels of land or rights-of-way that are owned by the Town and provide suitable candidates for future shoreline enhancement projects. Living shoreline projects are proposed in the report sections which follow. New construction of riprap revetments and bulkheads are discouraged due to their negative impacts as a result of wave reflection.

2.5 Accomodations for Sea Level Rise

The threat of sea level rise is a growing concern to coastal communities globally. In addition, land subsidence is projected to worsen the effects of sea level rise in the Chesapeake Bay region. Land subsidence of the Chesapeake Bay region is occurring due to extensive withdrawal of groundwater and resulting compaction of underground water bearing aquifers. It is projected that land subsidence will double the impact of sea level rise on the Delmarva Peninsula.

In recognition of these natural threats, the NOAA Office for Coastal Management, US Army Corps of Engineers (USACE), and the Maryland Chesapeake & Coastal Service have published sea level rise forecasts and recommendations for adapting to sea level rise. NOAA has predicted a sea level rise of up to 6 feet by the year 2090, as a worst case scenario. Over the next 30 years, the sea level rise predictions published by NOAA and USACE range from 0.5 – 1.95 feet. Reasonable accommodations should be made to incorporate sea level rise projections into the design criteria for future public works projects, most especially stormwater related infrastructure. For the longer term, the adaptation to sea level rise will require much more than construction of stormwater infrastructure.

2.6 Stormwater Modeling

The existing stormwater infrastructure was evaluated using Autodesk AutoCAD Civil 3D SSA software which provides hydrodynamic modeling tools for analysis and design of urban drainage systems. The analysis work involved breakdown of the drainage ares into subbasins and entry of all attributes (pipes, outfalls, catch basins, swales, etc.) definition all links and nodes. Each attribute of the system was defined by size, length, cross-section, inlet elevation, outlet elevation, ground elevation, roughness coefficient, soil types, etc. Hydrodynamic model runs were performed to simulate various storm events and tide levels using the SCS methodology as developed by the USDA Natural Resources Conservation Service, formerly called the Soil Conservation Service or SCS.

The rainfall depths are assigned by the model for selected return storm events as shown in Table 2-4.

Table 2-4 Rainfall Depths				
State	County	Return Period	Rainfall Depth	Rainfall Distribution
Maryland	Talbot	1	2.8	SCS Type II 24-hr
Maryland	Talbot	2	3.4	SCS Type II 24-hr
Maryland	Talbot	10	5.3	SCS Type II 24-hr

There is a 100 percent probability of a 1-year return storm occurring in any given year. For a 2-year storm, the annual probability is 50 percent and for a 10 year storm, the annual probability is 10 percent.

2.7 Community Tolerance for Flooding

The 2013 report by the Maryland Environmental Finance Center discussed the local tolerance for flooding and explained that low magnitude flooding that occurs frequently, say once per month, is expected and generally not viewed as a major problem in Oxford. On the other end of the spectrum, the high magnitude flooding that occurs infrequently, say once a decade, is recognized as the result of “rare natural disasters that cannot be controlled.” Instead, it is the flooding that occurs with medium frequency, say 3 to 4 times per year, that are particulary burdensome and of prime concern to the residents of Oxford.

Accordingly, the stormwater models and analyses that are presented in later sections of this report were centered around a 1 year return storm event, except for the Causeway which due to its criticality was assessed for 1-year, 2-year and 10-year storm events.

Additionally, it is important to recognize the difference between flooding caused by rain-induced runoff and tidal flooding caused by extreme high tides. Properly functioning tide gates can be effective in the prevention of backflow into outfall pipes during extreme high tides, thereby preventing the storm tides to flood low lying areas, and preserving pipe capacity for rain events. However, during concurrant tide and rainfall events, the pipes will fill with stormwater which then will surcharge out of low lying inlets, causing flooding. For low-lying streets with elevations of about 3.0’ or less, it is impracticable to avoid tidal inundation during extreme high tide events. An exhibit showing the Elevation 3’ storm tide is included in the back of the Appendix to this report.

Detailed descriptions of each outfall and its associated drainage area are provided in the report sections which follow, covered in order by severity of the reported flooding problems.

3.0 CAUSEWAY – CAUSEWAY PARK

3.1 Existing Conditions

Flooding of The Causeway was reported to be area of most concern because it serves as the principal access into and out of the Oxford historic town center, threading between the head of Town Creek and the Town-owned Causeway Park.

Flooded conditions along The Causeway (Photo provided by Cheryl Lewis)

A 27-inch outfall pipe crosses the Causeway from Causeway Park and discharges through the bulkhead into Town Creek. A dual chamber vault located on the south side of the Causeway houses the tide gate for this outfall. The chamber is fed by an 18-inch storm drain pipe entering from the east and a 15-inch storm drain pipe entering from the west. The tide gate is a custom made stainless steel flap gate and it is 16-inch in diameter.

Causeway Tide Gate (Photo by GMB)

An 18-inch storm drain extends from the tide gate vault eastward along Oxford Road and southward into Causeway Park. It drains a total of 32.75 acres including portions of Oxford Road, Causeway Park, E. Pier Street, JL Thompson Drive, and 2nd Street. In addition, the drainage basin is fed by ditches and swales that collect runoff from agricultural lands east of the fire station on Oxford Road and east of the wastewater treatment plant off of JL Thompson Dr. A portion of the open drainage ditch near the Town Dog Park was retrofitted as a bioswale by Town forces.

A 15-inch storm drain extends westward along the Causeway and southward along S. Morris Street to the Causeway Park bioswale. This subsystem drains a total of 10.38 acres including portions of S. Morris Street, Pleasant Street, Robes Harbor Court and Causeway Park.

Exhibit 3-1 shows the existing stormwater system and drainage areas. The total drainage area for the 27-inch outfall at the Causeway is 43.13 acres.

Excess flooding has been reported along S. Morris Street and the Causeway in addition to areas within Causeway Park and the Town Dog Park.

Flooded conditions along S. Morris Street (Photo provided by Cheryl Lewis)

Flooded conditions between Causeway Park and Pier St (Photo provided by Cheryl Lewis)

Flooded conditions along the Dog Park (Photo provided by Cheryl Lewis)

Two projects are planned and underway within the Causeway drainage basin to help alleviate flooding. The first project, known as "Oxford Gateway Park", is currently under construction. It is located on County-owned land on Oxford Road, east of the Oxford town limits. This project involves redevelopment of conservation lands and creation of a park with picnic areas, nature trails, enhanced landscaping and stormwater improvements. This project will create an expanded stormwater retention area which will outfall on the north side of Oxford Road, discharging to a headstream of Town Creek. This will reduce runoff entry into the existing roadside swale system which connects to the Town stormwater system along Oxford Road at the fire station. A plan showing the proposed Oxford Gateway Park is contained in the Appendix.

The second project involves the construction of stormwater retention basins within Causeway Park. This project has received grant funding from MDE and is currently in design. It involves expansion of the Causeway Park bioswale and creation of two other retention areas—one near the Dog Park to control the release of runoff from the adjacent agricultural field, and the other adjacent to Causeway Park on its east side. A plan showing the proposed retention basin project is contained in the Appendix.

3.2 Results of Analysis

Grades within the Causeway drainage area range from below zero within drainage ditches in the park to a high end of Elev. 6.5' near the wastewater treatment plant.

The Causeway drainage basin was evaluated using Autodesk AutoCAD Civil 3D SSA software which provides hydrodynamic modeling tools for analysis and design of urban drainage systems. The analysis work involved breakdown of the 43.13 acre drainage basin into 20 subbasins. Hydrodynamic model runs were performed to simulate various storm events and tide levels such as:

- 1-year storm at mean low tide elevation
- 1-year storm at mean high tide elevation
- 2-year storm at mean low tide elevation
- 2-year storm at mean high tide elevation
- 10-year storm at mean low tide elevation
- 10-year storm at mean high tide elevation

The model input and output summaries are provided in the Appendix.

Analysis of the stormwater model resulted in the following findings:

- The existing stormwater infrastructure is adequate to convey a 1 year storm, without flooding, under low tide conditions, but not at high tide conditions.

- Flooding occurs along along S. Morris Street and the Causeway, within the Causeway Park and in the area of the Dog Park, all as reported, for the 1-year storm at high tide and the 2-year and 10-year storms at all tide conditions.

- The existing bioswale located in Causeway Park, adjacent to S. Morris Street, is low-lying and forms a sump within the drainage shed. The bioswale basin is too low to completely empty even at low tide. This condition is further exacerbated by a “reverse slope” on the bioswale outlet pipe. When tide conditions in Town Creek are such that the outfall tide gate is closed or partially closed, stormwater within the Causeway pipe system is forced to backflow into the bioswale, rather than discharging through the Town Creek outfall. Consequently, filling and overtopping of the Causeway Park bioswale is routine even for low intensity storms.

- The hydraulics within the existing tide gate chamber are problematic. First of all, the tide gate is set at a higher elevation than the two incoming pipes such that the pipes can not completely empty, even on extreme low tide, consequently the full pipe carrying capacities of the incoming 18-inch and 15-inch pipes are compromised. Secondly, the tide gate is smaller in diameter than the outfall pipe (16-inch vs. 27-inch) creating a severe restriction in flow and undue head loss.

- Two sections of the 18-inch storm drain along the Causeway are reverse in slope and create double “sag points” in the pipe profile. This condition negatively impacts the hydraulic capacity of the system.

- The existing agricultural lands on the east side of town are contributing significant runoff to the Causeway drainage basin. The planned projects within the County Park and adjacent to the Town Dog Park will offer alleviate some flooding.

- Even with completion of the proposed projects in progress, 1 and 2-year storms will still create flooded conditions. Additional improvements are needed in combination with the proposed projects to handle the 2-year storm without flooding.

3.3 Proposed Improvements

The Autodesk SSA hydrodynamic model was utilized to consider various improvements and their relative impact on flooding severity within S. Morris St., the Causeway, Causeway Park and the Dog Park environs, using a 2-year design storm. Discussions of the proposed improvements are presented as follows:

- Tide Gates – Additional tide gates are needed to correct the hydraulic deficiencies that are causing filling and overtopping of the S. Morris Street bioswale. A new tide gate is proposed, to be positioned where shown on Exhibit 3-2. This proposed tide gate will serve to prevent backflow into the bioswale under all tide conditions, while also optimizing water storage within the proposed expanded bioswale. The proposed tide gate will also serve to optimize storage with the proposed expanded retention area, which will in turn help to alleviate flooding conditions along South Morris Street and the south side of the Causeway. Finally, the existing 16-inch tide gate which causes a restriction in flow should be upsized to 27-inch.

- Storm Drain Upsizing/Fix Reverse Slopes – The existing 18-inch storm drain between the tide gate vault and the east end of Gateway Park should be replaced with a larger diameter pipe with consistant slope, i.e. remove sag points.

- Causeway Roadside Enhancements – There are opportunities for the enhancement of water quality and flood attenuation along the Causeway corridor, within the right-of-way or on lands along the fringes of Causeway Park. In-situ rain gardens are proposed at the locatons shown on Exhibit 3-2. The rain gardens should be constructed as depressions which surround the existing catch basins. The rain gardens will promote recharge and increase flood storage in addition to providing water quality benefits and improved aesthetics.

- Oxford Road Drainage – The proposed Oxford Gateway Park and its associated stormwater improvements will benefit the Town of Oxford through recharge and storage of stormwater with controlled discharge to the headwaters of Town Creek. Upon completion of the first phase of the project, the roadside swale system beyond town limits should be “disconnected” from the Town drainage system. A check dam to be placed within the roadside swale on the east side of the Oxford Fire Company, as shown on Exhibit 3-2. will allow the Oxford Road drainage to outflow to Town Creek via the Oxford Gateway Park culvert crossing rather than through the town system. The check dam could be constructed of stone or sandbags.

- Causeway Park Retention Basins – The proposed retention basin project was modeled with additional storage volume at the locations shown on Exhibit 3-2 and 3-2. The retention basins will provide increased storage for for flood attenuation in addition to water quality enhancement through filtration and biological uptake. A minimum volume of xx acre-feet of volume is recommended.

- Bioswale Check Dam Modifications – Through field survey and modeling, it was determined that certain check dams within the Dog Park bioswale could be modified to enhance the hydraulics and storage without creating excessive tailwater.

Exhibit 3-2 and 3-3 detail the proposed improvements for the Causeway Park drainage area.

Even with the improvements discussed above, flooding during higher intensity (lower frequency) storms can still be expected. To address the extreme storms will require major construction projects as presented following.

- Stormwater Pumping Station – The practice of using tide gates must be combined with adequate storage volume to hold runoff for a period of time until tidal conditions are such that the volume can be released. In low-lying areas, it is difficult to achieve adequate storage volume because of lack of sufficient head, or elevation differential. In the case of S. Morris Street, the elevation of the street is only 1.3 feet above mean high tide, such that in higher intensity storms, the associated runoff volume overtops the bioswale and thereafter fills the street. A stormwater pumping station would alleviate this condition. Stormwater pumps would be activated based upon a level control that is set at a lower elevation than the street or other property to be protected. Ideally, the stormwater pumping station would be designed in combination with storage to provide for optimal pumping efficiency.

- Causeway Reconstruction – Raising of the Causeway will eventually be needed to remedy the flooding conditions which will become more frequent over time as a result of climate change and rising sea levels. A 1 to 2 foot rise in the elevation of the Causeway should be included in the long range plan for this drainage area. This scenario may also include reconstruction of adjacent shoreline with raised bulkhead or seawall in combination with green practices to protect from tidal encroachment. Alternate funding sources should be investigated including Maryland State Highway Administration and Federal Emergency Management Agency (FEMA).

3.4 Cost Estimates

Cost estimates were developed for the proposed improvements and are presented in Table 3-1.

Stormwater Master Plan
Oxford, Maryland

Table 3-1 Cost Estimate
July, 2016

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
The Causeway/Causeway Park						
Phase 1						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Excavation & Embankment - Retention Basins	-	CY	$15.00	15000	$225,000
3	Furnish and Install Stormwater Control Structure	-	EA	$10,000.00	2	$20,000
4	Furnish and Install Stormwater Vault w/ Tide Gate	15"	EA	$15,000.00	1	$15,000
5	Check Dam Installation/Modifications		EA	$1,500.00	2	$3,000
6	Rip-rap Outlet Protection	14"	CY	$200.00	50	$10,000
7	Furnish and Install Silt Fence	-	LF	$3.25	3500	$11,375
8	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	18000	$9,000
9	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	3	$4,500
10					Subtotal:	$317,875
11	Construction Contingency (20%)	-	-	20.00%	-	$63,575
12	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$79,469
13	Inflation to Project Start date			5.00%		$15,894
					Subtotal:	$158,938
			TOTAL PROJECT COST:			**$476,813**
Phase 2						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Storm Drain	24"	LF	$100.00	300	$30,000
3	Furnish and Install Stormwater Inlet	-	EA	$4,000.00	4	$16,000
4	Furnish and Install Stormwater Manhole	-	EA	$8,000.00	2	$16,000
5	Furnish and Install Stormwater Vault w/ Tide Gate	27"	EA	$18,500.00	1	$18,500
6	Furnish and Install In-Situ Rain Garden		SF	$20.00	2600	$52,000
7	Rip-rap Outlet Protection	14"	CY	$200.00	20	$4,000
8	Furnish and Install Silt Fence	-	LF	$3.25	600	$1,950
9	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	288	$144
10	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
11					Subtotal:	$160,094
12	Construction Contingency (20%)	-	-	20.00%	-	$32,019
13	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$40,024
14	Inflation to Project Start date			10.00%		$16,009
					Subtotal:	$88,052
			TOTAL PROJECT COST:			**$248,146**

4.0 HISTORIC DISTRICT - BANKS STREET

4.1 Existing Conditions

Banks Street is a low-lying area with street grades ranging from Elev. 1.4’ at the intersection with Wilson Street to Elev. 2.4’ at the south end intersection with Market Street. A 24-inch outfall pipe discharges thourgh the bulkhead at the intersection of Banks Street and Wilson Street into Town Creek. A dual chamber vault is located between Banks Street and the bulkhead and it houses the tide gate for this outfall. The chamber is fed by three (3) pipes, namely 1) An 18-inch storm drain pipe entering from the west, 2) a 15-inch storm drain pipe entering from the south, and 3) a single adjacent yard inlet entering from the north. The tide gate is a custom made stainless steel flap gate, 14-inches in diameter.

Tide Gate Vault at Banks Street Outfall (Photo taken by GMB)

The 18-inch pipe crosses Banks Street then extends in both directions on Banks Street and up Wilson Street to Morris Street. It drains a total of 14.49 acres including portions of the following streets: Banks, Market, Wilson, Morris, Tighlman, and Stewart.

The 15-inch pipe extends southward to a bioswale located at the intersection of Banks and Market Streets. The bioswale was formerly a ditch that was retrofitted in 2013. The bioswale is fed by a swale system on Market Street in addition to a closed pipe system coming from South Street and extending up High Street. The total drainage area of the bioswale is approximately 7.41 acres.

Exhibit 4-1 shows the existing stormwater system and drainage areas. The total drainage area for the 24-inch outfall at Banks Street is 22.37 acres.

Excess flooding along Banks Street especially, in addition to Tilghman and Stewart Streets, has been reported as a major problem.

Flooded conditions at intersection of Banks and Wilson Streets (Photo provided by Cheryl Lewis)

Flooded conditions at intersection of Banks and Market Streets (Photo provided by Cheryl Lewis)

4.2 Results of Analysis

The Banks Street drainage basin was evaluated using Autodesk AutoCAD Civil 3D SSA software which provides a hydrodynamic modeling tools for analysis and design of urban drainage systems. The analysis work involved breakdown of the 22.37 acre drainage basin into 52 subbasins. Hydrodynamic model runs were performed to simulate a 1-year return frequency storm events at varying tide levels. The model input and output summaries are provided in the Appendix.

Analysis of the stormwater model resulted in the following findings:

- The existing stormwater infrastructure is inadequate to convey a 1 year storm, without flooding, either under low tide or high tide conditions. A schematic of the model network at high tide is shown in the Appendix. Pipes shown in red are above capacity and junctions shown in blue are surcharging at grade, i.e. flooding. The model shows that flooding occurs along Banks Street and

Tilghman Street as reported, in addition to Morris, Market, Wilson and High Streets.

- The 12-inch storm drain along Banks Street is severely undersized and its profile is irregular. There are “sags’ along the profile which create hydraulic sluggishness. See pipe profile in the Appendix.

- The existing outfall is 24-inch in diameter however the tide gate is sized at 14-inch. This reduction in pipe size creates significant head loss in the system. In addition, the tide gate is set at an elevated position, i.e. higher than the incoming storm drain, which negatively impacts the performance of the system.

- The intersection of Banks and Wilson Streets lies within a sump area of the drainage basin. Morris Street is nearly 6 feet higher in elevation. At high tide when the tide gate is closed, stormwater overflows out of the low-lying inlets and into the street. There are four (4) inlets within the intersection, the lowest of which are set barely higher than mean high tide.

- The adjacent shoreline is stabilized with timber bulkhead with a top elevation at roughly Elev. 3.0’. Under extreme high tide conditions, flooding of the intersection occurs by bulkhead overtopping, even in the absence of rainfall.

4.3 Proposed Improvements

The Autodesk SSA hydrodynamic model was utilized to consider various improvements and their relative impact on flooding severity within Banks Street, Tilghman Street, and Market Street. for a 1-year return design storm. Discussions of the proposed improvements are presented as follows:

- Raise the Intersection – Reconstruction of the intersection of Banks and Wilson Streets will serve to reduce the frequency of intersection flooding. The reconstruction would be designed to elevate the pavement and inlet rims along the southbound travel lane of Banks Street. In particular, there are four (4) existing inlets that could be raised by 7 ½ inches or more. This rise in the street grade can be accommodated while still allowing tie-in to the existing driveway at the boatyard on Banks Street and to the post office off of Wilson Street.

- Storm Drain Replacement – The existing storm drain on Banks Street is undersized and needs to be replaced with a larger diameter 24-inch storm drain laid. The new storm drain would extend along Banks Street from Wilson Street to Tilghman Street.

- Tide Gate – The existing 14-inch tide gate causes a restriction in flow and should be upsized to 24-inch to match the existing outfall and the proposed storm drain replacement.

- New Bioretention Basin – In conjunction with the replacement storm drain and street reconstruction work, a bioretention basin is recommended at the intersection, located as shown on Exhibit 4-1. The basin would provide additional storage volume for flood attenuation in addition to water quality enhancement through filtration and biological uptake. The proposed location is ideally suited to receive runoff direct from the post office parking lot and portions of Banks and Wilson Streets. One or more of the catch basins which are currently located at the edge of the street would be relocated into the bioretention area and rims elevated to serve as overflow structures.

- Dual Outfall – A second outfall is needed in parallel to the existing outfall to serve as a dedicated outlet for the piped flows received from Wilson Street and Morris Street. By disconnecting the Wilson/Morris Street network from Banks Street will serve to relieve hydraulic pressure on the Banks Street system by the Morris Street system which is nealy 6 feet higher in elevation. This dedicated outfall for Wilson/Morris will not need a tide gate since the street grades on Morris Street are sufficiently higher than Banks Street.

- Expand/Extend Existing Bioswale – The existing bioswale at the south end of Banks Street appears to be effective and should be expanded to the extent practicable. The property at the corner of Banks and Market Street is owned by the Town and partially vacant. The bioswale should be extended to form an “L” shape such that it wraps around the corner and alongside of Market Street. With this improvement, it is also recommended that the stormwater that collects in the northwest corner of the Banks/Market Street intersection be collected and piped across Banks Street to the expanded bioswale.

- Stormwater Pumping Station – A stormwater pumping station should be considered as a longer term upgrade. As presented previously, it is difficult to achieve adequate stormwater storage volume in low-lying areas such as Banks Street, where the elevation of inlet rims are only a few inches above mean high tide, and causing filling of the street during high intensity storms. A stormwater pumping station would alleviate this condition. Stormwater pumps would be activated based upon a level control that is set at a lower elevation than the street or other property to be protected. Ideally, the stormwater pumping station would be designed in combination with storage to provide for optimal pumping efficiency. The proposed location of a stormwater pumping station is shown in Exhibit 4-2.

Exhibit 4-2 shows the proposed improvements for the Banks Park drainage area.

4.4 Cost Estimates

Cost estimates were developed for the proposed improvements and are presented in Table 4-1.

5.0 HISTORIC DISTRICT - TILGHMAN ST

5.1 Existing Conditions

Tilghman Street extends from N. Morris Street to the Oxford town boat ramp. The block between N. Morris Street and Banks Street has adequate fall and drains into inlet/culverts that feed the Banks Street storm drain system. Within the blocks between Banks Street and Stewart Street, the street is relatively flat and is completely lacking any stormwater infrastructure. There are no catch basins or closed pipe system and the roadside swales are ill-defined, perhaps having filled with sediment over the years. For the last block east of Mill Street, there is a defined roadside swale system which drains to a 12-inch outfall pipe that exits through the bulkhead at the Oxford Boat Ramp parking lot. There is also one (1) catch basin within the parking lot that ties into the outfall pipe. The drainage area of the Tilghman outfall pipe is approximately 3.74 acres.

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Oxford, Maryland

Table 4-1 Cost Estimate
July, 2016

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Banks Street						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Storm Drain	15"	LF	$75.00	50	$3,750
3	Furnish and Install Storm Drain	18"	LF	$85.00	100	$8,500
4	Furnish and Install Storm Drain	24"	LF	$100.00	650	$65,000
5	Furnish and Install Stormwater Inlet	-	EA	$4,000.00	5	$20,000
6	Furnish and Install Stormwater Manhole	-	EA	$8,000.00	2	$16,000
7	Furnish and Install Stormwater Vault w/ Tide Gate	24"	EA	$17,000.00	2	$34,000
8	Furnish and Install Stormwater Outfall	-	EA	$10,000.00	1	$10,000
9	Furnish and Install Bioretention System w underdrain	-	SF	$35.00	3000	$105,000
9	Furnish and Install Bioswale System w underdrain	-	SF	$35.00	2500	$87,500
10	Street Reconstruction	-	SY	$58.00	550	$31,900
11	Furnish and Install Silt Fence	-	LF	$3.25	700	$2,275
12	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	667	$334
13	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	2	$3,000
14					Subtotal:	$407,259
15	Construction Contingency (20%)	-	-	20.00%	-	$81,452
16	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$101,815
17	Inflation to Project Start date			15.00%		$61,089
					Subtotal:	$244,355
			TOTAL PROJECT COST:			**$651,614**

Flooding routinely occurs along Tilghman Street in the areas between Banks and Mill Streets. Stewart Street also experiences flooding on the lower end as it is affected by the lack of infrastructure on Tilghman Street and surcharging from the Banks Street system. It is reported that drainage is adequate at the boat ramp.

Flooded conditions at intersection of Tilghman and Stewart Streets (Photo provided by Cheryl Lewis)

5.2 Results of Analysis

Tilghman Street is low-lying and lacking stormwater infrastructure within the blocks between Stewart Street and Mill Street. Grades within this area range from Elev. 2.3' to 4.0' at the street crown, with lower grade along the pavement edge.

The block of Tilghman Street between Banks Street and Stewart Street was modeled as part of the Banks Street drainage area and the model output indicates routline flooding even in low intensity storms. Consideration was given to “disconnection” of Tilghman Street from the Banks Street system, and rerouting to a new dedicated outfall.

5.3 Proposed Improvements

A new closed pipe storm drain network with a dedicated outfall is recommended to provide positive drainage on Tilghman Street. The outfall should be located in the vicinity as shown on Exhibit 5-1 . The outfall would need to cross private property(s) to connect to the water’s edge. It is for this reason that the exact location of the outfall cannot be indicated until such time as an easement can be negotiated.

The outfall would connect to a new closed pipe storm drain system that would run east-west along Tilghman Street between Banks and Mill Street. The storm drain would be sized at 24-inch and consistently sloped at 0.20% mimimum. Because of the low-lying nature of the street, the outfall should be equipped with a tide gate. It is also recommended that the system extend onto Stewart St, to further relieve the Banks Street system. Further, to provide for storage volume during high tide conditions when the tide gate is closed, a retention basin or bioswale should also be added, subject to availability of adequate land within the right-of-way or additional easement area to be acquired.

Stormwater Master Plan
Oxford, Maryland

Table 5-1 Cost Estimate
July, 2016

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Tilghman Street						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Storm Drain	18"	LF	$85.00	60	$5,100
3	Furnish and Install Storm Drain	24"	LF	$100.00	900	$90,000
4	Furnish and Install Stormwater Inlet	-	EA	$4,000.00	12	$48,000
5	Furnish and Install Stormwater Vault w/ Tide Gate	-	EA	$17,000.00	1	$17,000
6	Furnish and Install Bioswale/Bioretention System w underdrain		SF	$35.00	1000	$35,000
7	Street Reconstruction	-	SY	$58.00	1400	$81,200
8	Rip-rap Outlet Protection	14"	CY	$200.00	20	$4,000
9	Furnish and Install Silt Fence	-	LF	$3.25	1150	$3,738
10	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	1000	$500
11	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
12					Subtotal:	$306,038
13	Construction Contingency (25%)	-	-	20.00%	-	$61,208
14	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$76,509
15	Inflation to Project Start date			15.00%		$45,906
					Subtotal:	$183,623
			TOTAL PROJECT COST:			**$489,660**

Exhibit 5-1 shows the proposed improvements for Tilghman Street.

5.4 Cost Estimates

Cost estimates were developed for the proposed improvements and are presented in Table 5-1.

6.0 HISTORIC DISTRICT - MILL STREET

6.1 Existing Conditions

The drainage area of Mill Street and Norton Street is served by a 12-inch outfall pipe that discharges thourgh the bulkhead at the Oxford Boat Yard and extends across the private property to Mill Street. A three-chamber vault that houses the tide gate for this outfall is located on the west side of Mill Street. The vault is fed by an 12-inch storm drain pipe entering from the north and a 6-inch storm drain pipe entering from the south. The tide gate is situated in an inverted position in the outlet pipe where it exits the vault. The tide gate is 12-inch in diameter.

Mill Street Outfall (Photo by GMB)

The 12-inch pipe extends northward on Mill Street to The Strand, reducing to 8-inch for the last run. The 12-inch pipe also intercepts an open swale system that runs between properties and extends to Norton Street and beyond to Stewart Street. The 6-inch pipe extends southward on Mill Street, terminating north of the intersection with Tilghman Street.

Exhibit 5-1 shows the existing stormwater system and drainage areas. The total drainage area for the 12-inch outfall at Mill Street is approximately 8.16 acres.

6.2 Results of Analysis

Grades within the drainage area range from a low points of Elev 2’ on the street centerlines of both Mill Street and Norton Street to a high point of Elev 10’ on The Strand. There are sump areas at mid block on Norton Street and near the south end of Mill Street. The Mill/Norton stormwater network was modeled using Autodesk AutoCAD Civil 3D SSA for the 1-year storm at low and high tide conditions. The model input and output summaries are provided in the Appendix.

Analysis of the stormwater model resulted in the following findings:

- The existing stormwater outfall pipe has a “reverse slope” which creates excess surcharging in the upstream pipe network. Despite this condition, the existing swales on either side of the horticultural center provide offsetting storage volume.
- Street flooding occurs along the south end of Mill Street for the 1-year storm at both high tide and low tide conditions. The existing 6-inch pipe is not adequate to convey the storm peak.

- Flooding also occurs along the north end of Mill Street, but it seems to be limited to the shoulder area, which is over a foot lower than the street.

- The stormwater infrastructure along Norton Street appears to be suitable to handle the 1-year storm.

6.3 Proposed Improvements

The Autodesk SSA hydrodynamic model was utilized to consider various improvements and their relative impact on flooding severity within Mill Street, Norton Street and the affiliated backyard swales, for a 1-year design storm. Discussions of the proposed improvements are presented as follows:

- Replace Tide Gate – The existing tide gate is antiquated and does not properly seal. The tide gate should be replaced, sized at 12-inch to match the outfall pipe.

- Upsize Storm Drain Pipes - All existing 6-inch pipes along Mill Street should be replaced with new pipes of 12-inch minimum diameter. See extent of proposed pipe replacement on Exhibit-xx. This will improve drainage conditions particularly at the south end of Mill Street.

Exhibit 6-2 shows the proposed improvements for the Mill Street drainage area.

In addition, as recommended for other low lying areas, future upgrade should include:

- Stormwater Pumping Station – A stormwater pumping station should be considered as a longer term upgrade. As presented in prior sections, it is difficult to achieve adequate stormwater storage volume in low-lying areas such as Mill and Norton Streets, where the elevation of inlet rims are only a few inches above mean high tide, and causing filling of the street during high intensity storms. A stormwater pumping station would alleviate this condition. Stormwater pumps would be activated based upon a level control that is set at a lower elevation than the street or other property to be protected. Ideally, the stormwater pumping station would be designed in combination with storage to provide for optimal pumping efficiency. The proposed location of a stormwater pumping station is shown on Exhibit 6-2.

6.4 Cost Estimates

Cost estimates were developed for the proposed improvements and are presented in Table 6-1.

7.0 THE STRAND

7.1 Existing Conditions

The Strand occupies a prominent position overlooking the Tred Avon River and the Oxford-Bellevue Ferry Terminal. A tree-lined grass strip and rock revetment with intermittent beach areas provide separation and protection for the street from the erosive forces of the river. In general, the street is crowned with the north side draining to the grass strip along the river and the south side draining back onto other intersecting town streets. There is only one (1) catch basin on The Strand. It has a limited drainage area and a 12-inch outfall direct to the Tred Avon River.

The Tred Avon Yacht Club is situated at the west end of The Strand. There is one (1) catch basin within the parking lot of the yacht club that discharges to the Tred Avon River via a 6-inch outfall pipe.

The only reported flooding problem associated with The Strand is related to stormwater runoff from the Town-owned parking lot on the east end of The Strand. The Strand Parking Lot is generally sloped toward the street and the runoff tends to collect in a

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Table 6-1 Cost Estimate
July, 2016

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Mill Street						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Storm Drain	15"	LF	$75.00	140	$10,500
3	Furnish and Install Stormwater Inlet	-	EA	$4,000.00	3	$12,000
4	Furnish and Install Stormwater Vault w/ Tide Gate	12"	EA	$15,000.00	1	$15,000
5	Street Reconstruction	-	SY	$58.00	300	$17,400
6	Furnish and Install Silt Fence	-	LF	$3.25	180	$585
7	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	60	$30
8	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
9					Subtotal:	$77,015
10	Construction Contingency (20%)	-	-	20.00%	-	$15,403
11	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$19,254
12	Inflation to Project Start date			15.00%		$11,552
					Subtotal:	$46,209
			TOTAL PROJECT COST:			**$123,224**

sump area along the edge of ThStrand. There are no catch basins along the street edge, nor is there a defined flow line to carry the stormwater to a positive outlet.

Ponding area along The Strand at Town Parking Lot (Photo by GMB)

Another problem is that the parking lot backs up to Town Creek and it is subject to tidal inundation during storm surges because of its low elevational position and its adjacency to the water on two sides. It is reported that rushing waters during receding tides have caused erosion along the rock revetment shoreline adjacent to The Strand. The shoreline along the back side of the parking lot is unprotected by structural measures and vulnerable to erosion from tidal, wind and wave forces.

7.2 Results of Analysis

The analysis of the parking lot drainage area involved a detailed topographic field survey and visual analysis following a heavy rain event. Grades within the parking lot range from a high elevation of Elev 3.6’ in the northeast corner to a low area of Elev 2.1’ along the edge of the street. Infrastructure improvements were considered ranging from a closed pipe system with new outfall to green practice alternatives.

7.3 Proposed Improvements

A stormwater infrastructure system is needed at the Strand Parking Lot for protection of the street and utilities. The following improvements are suggested:

- New Bioswale Basin – A linear bioretention area is recommended to be located as shown on Exhibit 7-1. The bioswale will serve to intercept stormwater that sheet flows across the parking lot toward The Strand. The basin will provide storage volume for flood attenuation in addition to water quality enhancement through filtration and biological uptake. An inlet will be positioned at one end of the bioswale to serve a point of overflow in the event of a large storm, yet allowing runoff from smaller storms to infiltrate. The inlet will be piped to an existing outfall pipe that exits through the bulkhead in the southeast corner of the parking lot, discharging to Town Creek.

- Living Shoreline – Enhancement of the natural vegetated shoreline is recommended along the back side of the town parking lot. A living shoreline consisting of a variety of plant types along with structural and organic materials, such as coir fiber logs and stone sills, will provide long-term stabilization of the shoreline while improving water quality through filtration and creating habitat for aquatic and terrestrial species.

Over the longer term, raising the elevation of the street in the area of the beach parking lot should be considered as the frequency of tidal inundation becomes intolerable as a result of sea level rise.

In addition, the installation of living shoreline practices along Strand Beach would provide for long term protection of the beach and street. A series of living shoreline concept plans for areas along The Strand, including Strand Beach, Strand Parking Lot and Lovers Lane (west end of The Strand) are included in the Appendix to the report.

7.4 Cost Estimates

A cost estimate of the proposed stormwater and shoreline infrastructure improvements along The Strand is shown in Table 7-1.

Stormwater Master Plan
Oxford, Maryland

Table 7-1 Cost Estimate
September, 2016

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Strand Parking Lot and Living Shoreline						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Storm Drain	12"	LF	$70.00	50	$3,500
3	Furnish and Install Stormwater Inlet	-	EA	$4,000.00	1	$4,000
4	Furnish and Install Bioswale System w underdrain	-	SF	$35.00	1600	$56,000
5	Street Reconstruction	-	SY	$24.00	35	$840
6	Rip-rap Outlet Protection	14"	CY	$200.00	5	$1,000
7	Furnish and Install Living Shoreline Stabilization Measures		LF	$350.00	115	$40,250
7	Furnish and Install Silt Fence	-	LF	$3.25	100	$325
8	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	100	$50
9	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
10					Subtotal:	$127,465
11	Construction Contingency (20%)	-	-	20.00%	-	$25,493
12	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$31,866
13	Inflation to Project Start date			15.00%		$19,120
					Subtotal:	$76,479
			TOTAL PROJECT COST:			**$203,944**

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Strand Beach Living Shoreline						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Bioretention Basins	-	SF	$35.00	3980	$139,300
3	Furnish and Install Living Shoreline Stabilization Measures		LF	$400.00	520	$208,000
4	Furnish and Install Silt Fence	-	LF	$3.25	520	$1,690
5	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	600	$300
6	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
7					Subtotal:	$370,790
8	Construction Contingency (20%)	-	-	20.00%	-	$74,158
9	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$92,698
10	Inflation to Project Start date			15.00%		$55,619
					Subtotal:	$222,474
			TOTAL PROJECT COST:			**$593,264**

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Lovers Lane Living Shoreline						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Living Shoreline Stabilization Measures		LF	$400.00	100	$40,000
3	Furnish and Install Silt Fence	-	LF	$3.25	100	$325
4	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
5					Subtotal:	$61,825
6	Construction Contingency (20%)	-	-	20.00%	-	$12,365
7	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$15,456
8	Inflation to Project Start date			15.00%		$9,274
					Subtotal:	$37,095
			TOTAL PROJECT COST:			**$98,920**

8.0 SOUTH STREET

8.1 Existing Conditions

South Street extends from Market to Morris Street. The north end block between High Street and Market Street drains to the Banks Street outfall. The south end of South Street drains to the Morris Street outfall. South Street has one outfall that drains the middle block through a 18-inch outfall pipe that discharges through private bulkhead into Town Creek. The 18-inch pipe extends across private property into at catch basin on South Street, then extends southward and connects to a second catch basin on South Street. There is no tide gate on this outfall.

The 18-inch pipe crosses Banks Street then extends in both directions on Banks Street and up Wilson Street to Morris Street. The outfall drains a total of 3.46 acres limited to South Street and its fronting properties.

There are no reported flooding issues in this section of South Street.

8.2 Results of Analysis

Although the South Street outfall is not equipped with a tide gate, it is not deemed necessary because of the elevation of the street (Elev 5.5') and the small relative drainage area. No further analysis was deemed necessary and no improvements are recommended for the South Street stormwater infrastructure system.

9.0 MORRIS STREET

9.1 Existing Conditions

The stormwater infrastructure along Morris Street within the historic district consists of a combination of catch basins, closed pipes and shallow roadside ditches. Within the blocks between The Strand and High Streets, the closed pipe/ditch network feeds the Banks Street outfall via pipe systems extending down High, Market and Wilson Streets.

There is a separate 12-inch diameter outfall at 313 S. Morris Street that drains a portions of Morris, South, West Division, Benoni, and Tred Avon Streets. The outfall discharges through private bulkhead to Town Creek and crosses private property to extend to a catch basin on Morris Street. From there, a 12-inch pipe extends along Morris Street to South Street where it is fed by a narrow ditch along South Street. The outfall is not equipped with a tide gate. The total drainage area of this Morris Street outfall is approximately 9.84 acres. There are no reported flooding issues in this section of Morris Street.

Another outfall pipe is located near the intersection of Morris and Caroline Streets. The 14-inch outfall discharges through the bulkhead at the Town-owned dock. This outfall is also not equipped with a tide gate. The 14-inch outfall is fed by a yard inlet located within the grassy yard area to the north of the dock parking area. The yard inlet drains a portion of the parking lot and a portion of Morris Street. The total drainage area for the 14-inch outfall at Caroline Street is 4.02 acres.

In addition, there is a problematic stormwater inlet on the west side of Morris Street at the end of Caroline Street. The inlet receives two culvert pipes, one that crosses from the north side of Caroline Street and the other that extends a short distance up Caroline Street. The drainage area of the inlet includes a portion of Morris Street, Caroline Street and Tred Avon Ave. for a total drainage area of 3.64 acres.

Photo of Inlet at Caroline Street and Morris Street (Photo taken by GMB)

It is reported that the inlet frequently overflows causing storm water to travel toward S. Morris Street, eventually accumulating in Causeway Park and worsening that flooding situation.

9.2 Results of Analysis

The analysis of the Morris Street outfalls and drainage areas involved physical survey, detailed review of State Highway Administration road plans and visual analysis during a rain event. It was determined that the inlet at S. Morris Street and Caroline Street is actually not connected to the 14-inch outfall on the east side of Morris Street, as previously mapped. Instead, the water backflows into a shallow ditch that extends approximately 30 feet along Morris Street toward the southwest. Without a positive pipe outlet, the flow path of this water creates flooding across South Morris Street as it seeks a lower position.

9.3 Proposed Improvements

The recommended improvements for the Morris Street drainage areas include the following:

- Tide Gates – The Morris Street outfalls are subject to tidal backflow since neither are equipped with a tide gate. Further, the street elevations are such that open ditches experience occasional back flow during storm tide conditions. For these reasons, installation of a tide gates at each outfall would be advantageous. The location of tide gate vaults are shown on Exhibit 9-1.

- New Inlet and Storm Drain Crossing – The existing inlet at end of Caroline Street should be replaced and a pipe extended across Morris Street and connected to the new tide gate vault to provide a positive outlet for the stormwater. The existing outlet ditch could be then be filled.

- In-Situ Rain Garden – An opportunity exists to create a water quality BMP alongside of the Town dock parking lot as shown on Exhibit 9-2. A rain garden is proposed as a mild depression surrounding the existing catch basin. The rain gardens will promote recharge and increase flood storage in addition to providing water quality benefits and improved aesthetics.

9.4 Cost Estimates

Cost estimates were developed for the proposed improvements and are presented in Table 9-1.

Stormwater Master Plan
Oxford, Maryland

Table 9-1 Cost Estimate
July, 2016

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Morris Street						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Storm Drain	15"	LF	$75.00	70	$5,250
3	Furnish and Install Stormwater Inlet	-	EA	$4,000.00	1	$4,000
4	Furnish and Install Stormwater Manhole	-	EA	$8,000.00	1	$8,000
5	Furnish and Install Stormwater Vault w/ Tide Gate	12"	EA	$14,000.00	1	$14,000
6	Furnish and Install Stormwater Vault w/ Tide Gate	14"	EA	$15,000.00	1	$15,000
7	Furnish and Install In-Situ Rain Garden		SF	$20.00	750	$15,000
7	Street Reconstruction	-	SY	$120.00	50	$6,000
8	Furnish and Install Silt Fence	-	LF	$3.25	120	$390
9	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	50	$25
10	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
11					Subtotal:	$89,165
12	Construction Contingency (20%)	-	-	20.00%	-	$17,833
13	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$22,291
14	Inflation to Project Start date			15.00%		$13,375
					Subtotal:	$53,499
			TOTAL PROJECT COST:			**$142,664**

10.0 WEST PIER STREET

10.1 Existing Conditions

An 18-inch outfall pipe discharges through the bulkhead behind the Pier Street Court Condominium complex situated between West Pier Street and Robes Harbor Court. The outfall is equipped with a flap style tide gate on the end of the pipe on the outside face of the bulkhead. The 18-inch pipe extends southward across private property to a set of two (2) catch basins, one on each side of West Pier Street and from there extends southward across private property to a low-lying catch basin behind existing houses. From there a 24-inch pipe extends eastward to S. Morris Street, where it is fed by two (2) 12-inch pipes that extend in each direction along S. Morris Street, on each side of the street, and intercepts storm drains from intersecting streets including East

Tide Gate at West Pier Street (Photo taken by GMB)

Exhibit 10-1 shows the existing stormwater system and drainage areas. The total West Pier Street drainage area is approximately 20.15 acres.

No major flooding problems were reported in this drainage area. No further analysis was deemed necessary and no improvements are recommended for the South Street stormwater infrastructure system.

11.0 JACK'S POINT

11.1 Existing Situation

The Jack's Point neighborhood of Oxford is situated on a neck of land that is surrounded by the waters of Town Creek on three sides. Bonfield Avenue is drained via a 24-inch outfall at the east end of Richardson Street which discharges to a short gut that feeds Town Creek. The 24-inch pipe extends along Town right-of-way to a manhole on Bonfield Avenue which is fed by a 12-inch storm drain from the north and a 24-inch storm drain from the south. The outfall does not have a tide gate. The drainage area encompasses the full length of Bonfield Ave. along with portions of Town Creek Rd, Richardson Street and East Division Street. The total drainage area of the Bonfield outfall is approximately 10.84 acres.

Outfall location on Bonfield Avenue (Photo taken by GMB)

Another outall is on Third Street just north of the intersection of Third and Town Creek Rd. The outfall is 15-inch and discharges to a wetland area on private property along the fringes of Town Creek. This outfall receives runoff from the length of Third Street and portions of Town Creek and Jack's Point Roads. The drainage area is approximately 8.09 acres.

A third stormwater outall is located at the west end of Richardson Street at the intersection with Myrtle Avenue. The outfall is 12-inch in diameter and crosses private property to discharge through bulkhead to Town Creek. Stormwater enters the upstream end of the outfall pipe from a rock lined gutter. The drainage area encompasses portions of Richardson Street and Myrtle Ave, and is approximately 1.36 acres in size.

Rock-lined gutter and Outfall Pipe at Richardson and Myrtle (Photo taken by GMB)

A fourth outfall within Jack's Point is located at the north end of First Street. It is 12-inch is size and discharges to the shoreline of Town Creek at the end of the Town street right-of-way. The outfall receives runoff from a portion of First Street, approximately 1.11 acres.

Exhibit 11-1 shows the existing stormwater system and drainage areas within Jack's Point.

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Flooding has been reported to routinely occur along Bonfield Avenue particulary around the intersection with Town Creek Road, on Third Street at the vicinity of the outfall, and at the intersection of Richardson and Myrtle.

11.2 Results of Analysis

The streets within Jack's Point range in grade from a high of Elev 6' at the north and south ends of Bonfield to a low of Elev 2.5' at the various sag intersections. The Bonfield Avenue drainage basin was modeled using the Autodesk AutoCAD Civil 3D SSA software, while the smaller drainage basins were "analyzed by hand". The Bonfield analysis work involved breakdown of the 10.84 acre drainage basin into 14 subbasins. Hydrodynamic model runs were performed to simulate a 1-year return frequency storm events at varying tide levels. The model input and output summaries are provided in the Appendix.

Modeling and analysis and resulted in the following findings:

- The existing stormwater infrastructure along Bonfield Avenue is inadequate to convey a 1 year storm, without flooding, throughout the tidal range modeled. The worst area of flooding occurs along Bonfield Ave within the intersection with Town Creek Rd and southward.
- The intersection of Bonfield and Town Creek forms a sump area where the elevational difference between the street and the high tide is slightly more than a foot. This condition of low available head, coupled with the long run of 12 and 15-inch pipe, facilitates surcharging at grade. Increased pipe capacity is needed.
- The outfall ditch at Third Street has standing water and does effectively drain across the wetlands. This condition, coupled with the minimal difference in elevation between the receiving wetland and the street level, creates routine street flooding. To correct this situation would require the excavation of a

widened and deepened outfall ditch but because the lands are privately owned and protected as wetlands under State and federal regulations, this approach may not be feasible. As an alternative, consideration was given to the impact of enlarging the existing roadside swales as further described hereinafter.

11.3 Proposed Improvements

The recommended improvements for the Jack's Point drainage areas include the

following:

- Bonfield -Twin Outfall and Tide Gates – A parallel 24-inch outfall with tide gates is needed to increase hydraulic capacity of the Bonfield storm drain network and prevent tidal flooding. The existing manhole at the edge of the street would be replaced with a new vault which would house twin tide gates.

- Bonfield - Upsize Existing Storm Drain Pipes – In addition to the twin outfalls, a parallel 24-inch pipe is proposed between the new tide gate vault and the existing inlets at East Division Street. From that intersection southward, the existing 15 and 12-inch pipes would be replaced with 24-inch.

- Third Street - Roadside Swale – The existing swale on the west side of Third Street between the outfall and Town Creek Rd should be widened to the maximum extent allowable within the right-of-way or within an expanded easement area, to provide for additional flood attenuation volume. Similarly, the swale widening could extend along the north side of Town Creek Rd between Third Street and Jack's Point Rd. The additional storage volume would give the water a place to lie at a lower position that the street, resulting in less frequent street flooding. If open water is not tolerable, then a bioswale or underground pipe storage could also be considered within the same footprint as the widened swale.

- Richardson Street Outfall – *Recommendations for improved hydraulics at this outfall are pending additional observation during a large storm event.*

Exhibit 11-2 shows the proposed improvements for the Jack's Point drainage areas.

11.4 Cost Estimates

A cost estimate of the proposed stormwater infrastructure improvement is shown in Table 11-1.

Stormwater Master Plan
Oxford, Maryland

Table 11-1 Cost Estimate
July, 2016

Item No.	Description	Size or Depth	Unit	Unit Price	Quantity	Total Price
Jack's Point						
Bonfield Avenue						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Storm Drain	24"	LF	$75.00	1350	$101,250
3	Furnish and Install Stormwater Inlet	-	EA	$4,000.00	10	$40,000
4	Furnish and Install Stormwater Manhole	-	EA	$8,000.00	1	$8,000
5	Furnish and Install Stormwater Vault w/ Dual Tide Gate	24"	EA	$25,000.00	1	$25,000
6	Furnish and Install Stormwater Outfall	-	EA	$10,000.00	1	$10,000
7	Street Reconstruction	-	SY	$58.00	1850	$107,300
8	Rip-rap Outlet Protection	14"	CY	$200.00	5	$1,000
9	Furnish and Install Silt Fence	-	LF	$3.25	1050	$3,413
10	Furnish and Install Hydroseed Stabilization	-	SY	$0.50	1100	$550
11	Furnish and Install Stabilized Construction Entrance	-	EA	$1,500.00	1	$1,500
12					Subtotal:	$318,013
13	Construction Contingency (20%)	-	-	20.00%	-	$63,603
14	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$79,503
15	Inflation to Project Start date			15.00%		$47,702
					Subtotal:	$190,808
			TOTAL PROJECT COST:			**$508,820**
Third St						
1	Mobilization	-	LS	$20,000.00	1	$20,000
2	Furnish and Install Bioswale System w underdrain	-	SF	$35.00	2000	$70,000
3	Rip-rap Outlet Protection	14"	CY	$200.00	20	$4,000
4	Furnish and Install Silt Fence	-	LF	$3.25	360	$1,170
5					Subtotal:	$95,170
6	Construction Contingency (20%)	-	-	20.00%	-	$19,034
7	Other Project Costs (Engineering, Legal, Inspection-25%)			25.00%		$23,793
8	Inflation to Project Start date			15.00%		$14,276
					Subtotal:	$57,102
			TOTAL PROJECT COST:			**$152,272**

Richardson St			
		TOTAL PROJECT COST:	**$661,092**

12.0 BACHELOR'S POINT

Bachelor's Point is located at the south end of Bachelor's Point Road and consists of 1-acre residential lots on higher ground (Elev 6' to 8'). It appears that the subdivision was constructed with adequate roadside swales and stormwater ponds.

It is reported that the Bachelor's Point streets are not subject to routine flooding. Accordingly, no further analysis was deemed necessary and no stormwater improvements are recommended.

13.0 MASTER PLAN

13.1 Recommendations and Prioritization

The recommended projects as presented in the sections herebefore are summarized in Table 13-1, and listed in order of priority. The projects were prioritized in consideration of the combination of effectiveness, cost, and complexity. *This section to be expanded in Final Report pending input from Town officials.*

13.2 Potential Funding Options

The 2013 Environmental Finance Center report presented an in-depth study of financing options for the needed stormwater improvements, ranging from grants and loans to enterprise funds supported through the collection of runoff fees. The study concluded that a “blending funding” program should be structured to include contributions from the town’s general fund in addition to a creation of a stormwater utility fund.

A listing of potential grant and loan opportunites in Maryland is provided in Table 13-2.

13.3 Next Steps

This section is intentionally left blank in the Draft report, pending input from Town officials.

Table 13-1 Master Plan Recommendations				
Year Priority	**Flooding Problem Area**	**Recommended Improvement**	**Location**	**Estimated Cost**
Year 1-2	Causeway / Causeway Park / S. Morris St. / Dog Park	Phase I Improvements:		$476,813
		Construct additional tide gate to restrict backflow into existing bioswale on S. Morris St	Causeway Right-of-Way	
		Construct retention basin to collect / control runoff from agricultural lands	Town-owned lands east of Dog Park	
		Expand existing swale to create retention/wetland basin for additional storage volume	East side of Causeway Park	
		Expand existing bioswale for additional storage volume	S. Morris Street	
		"Disconnect' County park lands by placing check dam in roadside swale	Oxford Road	
		Lower top elevation of existing check dam	Community Dog Park	
Year 2-4	Causeway / Causeway Park / S. Morris St. / Dog Park	Phase 2 Improvements:		$248,146
		Replace Existing Undersized Storm Drain and remove sags	Causeway ROW	
		Replace/Upsize Existing Tide Flap Gate	Causeway ROW	
		Regrade roadside to create In-situ Rain Gardens	Causeway Park	
Future	Causeway / Causeway Park / S. Morris St. / Dog Park	Future Improvements:		
		Construct Stormwater Pumping Station to enable discharge at high tide with sea level rise	Causeway ROW	$625,000
		Major road re-construction project to Elevate Causeway	Causeway	$422,500
Year 4-6	Historic District - Banks Street			$651,614
		Reconstruct and raise intersection and inlet rim elevations	Intersection of Banks and Wilson Sts.	
		Construct bioretention basin to create additional storage volume	Intersection of Banks and Wilson Sts.	
		Replace Existing Undersized Storm Drain	Banks Street between Wilson and Tilghman	
		Install dual outfall with tide gates	Intersection of Banks and Wilson Sts.	
		Replace/Upsize Existing Tide Flap Gate	Intersection of Banks and Wilson Sts.	
		Extend existing bioswale to create additional storage volume	Intersection of Banks and Market Sts.	
		Construct new inlet at northwest corner and pipe to existing bioswale	Intersection of Banks and Market Sts.	
Year 4-6	Historic District - Tilghman Street			$489,660
		Construct new closed pipe stormwater network with dedicated outfall and tide gate	Tilghman Street	
		Construct bioretention basin to create additional storage volume	Tilghman Street	
		Disconnect Stewart Street from Banks St to new Tilghman St storm network	Tilghman Street	

Table 13-1 Master Plan Recommendations

Year Priority	Flooding Problem Area	Recommended Improvement	Location	Estimated Cost
Year 4-6	Historic District - Mill Street			$123,224
		Replace Existing Undersized Storm Drain	Mill Street	
		Replace existing tide gate and vault	Mill Street	
Future	Historic District	Future Improvements:		
		Construct Stormwater Pumping Station to enable discharge at high tide with sea level rise	Intersection of Banks and Wilson Sts.	$625,000
		Construct Stormwater Pumping Station to enable discharge at high tide with sea level rise	Tilghman Street	$625,000
		Construct Stormwater Pumping Station to enable discharge at high tide with sea level rise	Mill St	$625,000
Unassigned	Morris Street / Caroline St			$142,664
		Install Tide gate at existing outfall	Next to Town Dock Parking Lot	
		Install Inlet and Storm Drain Crossing to existing outfall	Intersection of Morris St / Caroline St	
		Regrade roadside to create In-situ Rain Gardens	Next to Town Dock Parking Lot	
		Install Tide gate at existing outfall	313 S. Morris St	
Unassigned	The Strand			$203,944
		Construct Bioswale between parking lot and edge of roadway	Strand Parking Lot	
		Construct overflow structure and extend outlet from Bioswale to existing outfall	Strand Parking Lot	
		Living Shoreline Stablilization	Strand Parking Lot	
Unassigned	The Strand			
		Living Shoreline Stablilization	Strand Beach	$593,264
		Living Shoreline Stablilization	Lovers Lane Street End	$98,920
Year 6-8	Jack's Point			$661,092
		Install dual 24-inch outfall with tide gate	Intersection of Bonfield Avenue & Richardson St	
		Replace Existing Undersized Storm Drain	Bonfield Avenue	
		Expand existing roadside swales to create additional storage volume	Third Street and Town Creek	
			Intersection of Richardson & Myrtle Sts	
			SUBTOTAL (YEAR 1-8)	$3,689,341
			TOTAL ((YEAR 1-8) + FUTURE)	$6,611,841

Table 13-2 Funding Resources in Maryland in Support of Local Government Goals

	Focus/ Types of Projects	Funding Source	Qualified Applicants	Cycle	Funding Limits	Environmental Benefits	Geographic Limitations	Contact for more information	Other Notes
1	Small Watershed Grants	Chesapeake Bay Stewardship Fund, National Fish and Wildlife (NFWF)	Municipal Agencies, Local Communities	Ongoing		Bay restoration by reducing pollution in surrounding waterways.	Statewide	Jake Reilly (Program Director) Jake.Reilly@NFWF.org Elizabeth Nellums (Manager) Elizabeth.Nellums@NFWF.org Mark Melino (Coordinator) Mark.Melino@NFWF.org Phone: (202)-857-0166	Stewardship fund works with local government's storm water strategies to improve the health of the Bay. Link: http://www.nfwf.org/chesapeake/Pages/home.aspx
2	Chesapeake Watershed Assistance	Chesapeake Bay Trust	Municipal Agencies, Non-profit Applicants	Annually: September 28th, 2016	\$5,001 - \$75,000	Accelerate nutrient and sediment reductions to benefit local communities and the Bay.	Statewide	Emily Stransky (Grant Manager) EStransky@cbtrust.org Phone: (410)-974-2941 x101	This program prioritizes design assistance, watershed planning and protection, and overall water quality. Link: http://www.cbtrust.org/site/c.miJPKXPCJnH/b.5457627/k.463C/Watershed_Assistance.htm
3	Community Resiliency Grant	Chesapeake and Coastal Service	Municipalities and counties in coastal zones	Annually: March 4th, 2016	Up to \$75,000	Supports a project submission track for proposals aimed at planning for coastal hazards	Maryland Coastal Counties	Kate Skaggs Maryland Department of Natural Resources Kate.Skaggs@maryland.gov Phone: (410)-260-8743	These funds are aimed at addressing coastal hazards issues. Talbot is a critical area as described by the MD Critical Areas Commission. Link: http://dnr2.maryland.gov/ccs/coastsmart/Documents/cs_RFP.pdf
4	Innovative Nutrient and Sediment Reduction Grants	Chesapeake Bay Stewardship Fund, NFWF	Municipal Agencies, Local Communities	Ongoing	\$20,000 - \$1,000,000	Reduction of nutrient pollution in local watersheds.	Statewide	Jake Reilly (Program Director) Jake.Reilly@NFWF.org Elizabeth Nellums (Manager) Elizabeth.Nellums@NFWF.org Mark Melino (Coordinator) Mark.Melino@NFWF.org Phone: (202)-857-0166	Priorities include demonstrations and strategies that reduce nutrient pollution. A large factor of this is nonpoint sources. Link: http://www.chesapeakebay.net/about/rfps/innovative
5	Innovative Technology Fund	Chesapeake and Atlantic Coastal Bays Trust Fund, EPA, MD DNR	Any Maryland Company	Ongoing	\$50,000 - \$150,000	Investments that could accelerate Bay restoration efforts.	Statewide	Akbar Dawood Adawood@UMD.edu www.mtechventures.umd.edu Phone: (301)-314-9770	Nonpoint source pollution from nutrients would be mitigated by proper storm water management in Oxford. http://dnr2.maryland.gov/ccs/Pages/funding/intechfund.aspx

	Focus/ Types of Projects	Funding Source	Qualified Applicants	Cycle	Funding Limits	Environmental Benefits	Geographic Limitations	Contact for more information	Other Notes
6	Green Streets, Green Jobs, Green Towns	Chesapeake Bay Trust, EPA	Municipalities, Non-Profit Organizations, Community Organizations	March 3, 2016	Up to $75,000	Promotes minimal change the environment while still investing help in storm water management.	EPA Region 3, Includes MD	Jeff Popp (Grant Manager) Jpopp@cbtrust.org Phone: (410)-974-2941 x103	Supports the implementation of "green" solutions such as permeable surfaces, minimal impact on the surroundings, and systems that increase the rate of infiltration. Link: http://www.cbtrust.org/site/c.miJPKXPCJnH/b.7735695/k.9142/Green_Streets.htm
7	319 Nonpoint Source Program	Maryland Department of the Environment	State and local projects	Annually		Eliminate water quality impairments caused by nonpoint sources.	Statewide	Eric Ruby 1800 Washington Blvd. Suite 540 Baltimore MD Eric.Ruby@maryland.gov Phone: (410)-537-3685	By improving storm water management nonpoint sources impacts are reduced significantly. Link: http://www.mde.state.md.us/programs/water/319nonpointsource/Pages/Programs/WaterPrograms/319NPS/index.aspx
8	Water Quality Revolving Loan	Maryland Water Quality Financing Admin	Capital projects across the state	Ongoing		Investments in improving water quality for point source projects and non-point source pollution.	Statewide	Jag Khuman (Director) Jag.khuman@maryland.gov Phone: (410)-537-3119	Provides financial assistance in the form of low interest rate loans and grants. Includes non-point source pollution control projects. Link: http://www.mde.state.md.us/programs/Water/QualityFinancing/Pages/Programs/WaterPrograms/Water_Quality_Finance/index.aspx
9	Flood Mitigation Assistance Grant Program	Federal Emergency Management Agency (FEMA)	States, Territories, Local Governments	Annually; March through June		Prevents long term damage to surrounding structures.	Nationwide	"Sub applicants submit mitigation planning and project sub applications to their State during the open application cycle… Funds are only available to support communities participating in the National Flood Insurance Program (NFIP)."	FMA provides funding for projects that plan on reducing or eliminating long-term risk of flood damage to structures insured under the NFIP. Link: https://www.fema.gov/flood-mitigation-assistance-grant-program
10	Hazard Mitigation Grant Program	Federal Emergency Management Agency (FEMA)	States, Territories, Local Communities,	Following Hazards		Low impacts to the environment to prevent cyclical hazards.	Nationwide	"Please contact your State Hazard Mitigation Officer, or federally-recognized tribal/local government official to obtain information on the HMGP application process."	The FEMA is highly concerned with the loss of property, the impact on human wellbeing. Link: https://www.fema.gov/hazard-mitigation-grant-program

	Focus/ Types of Projects	Funding Source	Qualified Applicants	Cycle	Funding Limits	Environmental Benefits	Geographic Limitations	Contact for more information	Other Notes
11	Pre-Disaster Mitigation Grant Program	Federal Emergency Management Agency (FEMA)	States, Territories, Local governments,	Annually; March through June		Low impacts to the environment to prevent future disasters.	Nationwide	"Sub applicants submit mitigation planning and project sub applications to their State during the open application cycle…" Plans must be adopted by the jurisdictions and approved by FEMA.	Concerned with implementing a solution prior to disasters happening to reduce the overall risk to people and structures. Also concerned with breaking the disaster cycle saving grief and reducing the overall reliance on the federal government for funding. Link: http://www.fema.gov/pre-disaster-mitigation-grant-program
12	Emergency Management Performance Grant	50% Federal and 50% state/locally funded. (FEMA)	Municipalities, Non-Profit Organizations, Community Organizations	Annually		Low impacts to the environment to prevent catastrophic hazards.	Statewide	More information and registration can be found at http://gopi.maryland.gov/	This program centers on improving emergency management and mitigation capabilities. "Enhances and supports preparedness and mitigation efforts of the state and the ability to respond and recover from all hazards." https://www.fema.gov/emergency-management-performance-grant-program

EXHIBITS

APPENDICES

Appendix A: Stormwater Analysis Model Input/Output Data – Causeway

Appendix B: Stormwater Analysis Model Input/Output Data – Banks Street

Appendix C: Stormwater Analysis Model Input/Output Data – Mill Street

Appendix D: Stormwater Analysis Model Input/Output Data – Bonfield Ave

Appendix E: Stormwater Analysis Model Input/Output Data – Pier Street

Appendix F: Construction Plan - Oxford Gateway Park

Appendix G: Concept Plans – Future Living Shorelines