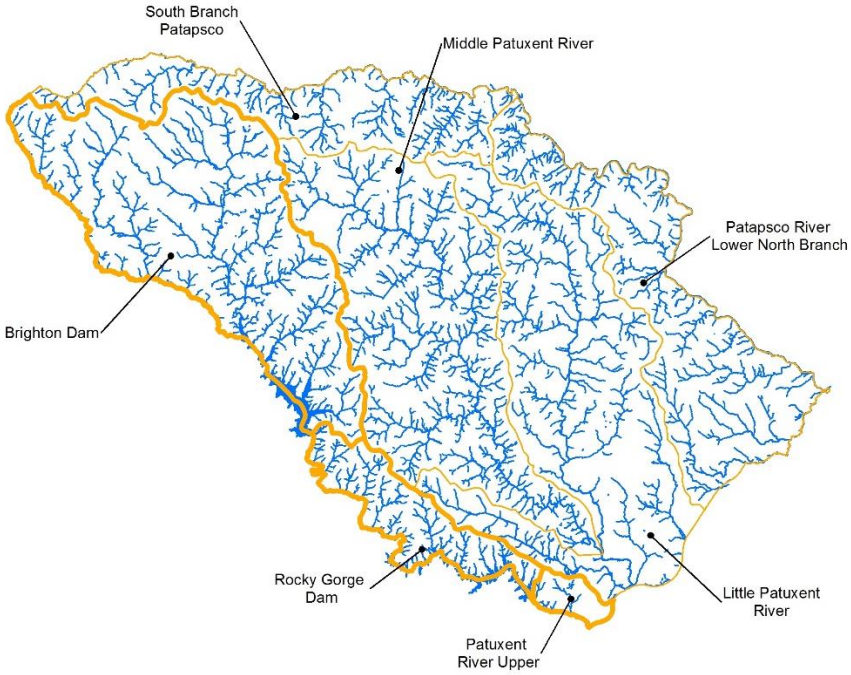
PATUXENT RIVER

BRIGHTON DAM, ROCKY GORGE DAM, AND PATUXENT RIVER UPPER WATERSHED ASSESSMENT



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EXECUTIVE SUMMARY

Howard County, Maryland, is developing Watershed Assessments to identify specific restoration opportunities to provide greater treatment of stormwater from urban impervious areas and to reduce pollutant loads associated with urban runoff. The assessment of the Middle and Little Patuxent River was completed in 2015 and served as an example for the current assessments of the Patuxent River Watershed, which includes Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds. The main purpose of these assessments is to (1) assess current conditions and (2) recommend watershed restoration opportunities. Implementation of recommendations will assist the County in meeting its 20% impervious restoration goal by December 2019 and Total Maximum Daily Load (TMDL) targets established for phosphorus and sediment in the Patuxent River watersheds.

Employing GIS analysis and field investigations, the project team recommended a suite of opportunities including upgrades to existing stormwater Best Management Practices (BMPs), new BMPs, tree plantings, stream restoration, and stabilization of stormwater outfalls. These structural practices will be combined with non-structural programmatic practices (e.g. street sweeping, septic system upgrades) that the County is implementing as part of its overall strategy. In all, the Brighton Dam Watershed Assessment yielded 82 potential projects and produced concept plans for 19 of the top ranked opportunities identified. The assessment for Rocky Gorge Dam yielded 21 potential projects and produced concept plans for 6 top ranked opportunities. The assessment for Patuxent River Upper yielded 20 potential projects and produced concept plans for 10 top ranked opportunities.

GIS data, including data compiled from studies previously conducted within the watersheds, were used as the first step to identify candidate retrofit and restoration sites for further investigation in the field. Candidates initially selected were reviewed by Howard County staff to finalize the suite of field sites to be visited.

Field data collection was customized for each of the five site types and focused on assessing current conditions and identifying and describing restoration opportunities. Field data were collected with mobile tablet devices via an ESRI ArcCollector application. Some previously visited sites were evaluated via desktop assessment only, making use of prior data collected. In Brighton Dam, a total of 46 sites and 2.9 stream miles were assessed. In Rocky Gorge Dam, 12 sites and 1.4 stream miles were assessed. In Patuxent River Upper, a total of 16 sites and 3.2 stream miles were assessed.

A standardized method was developed for comparing, ranking, and prioritizing the proposed project opportunities identified. Projects were ranked in two ways. First, each project was ranked against all other projects of the same type. Second, all projects were pooled together and ranked against one another, to enable ranking across project type, and to determine those projects that should be taken to the next design stage.

Ranking criteria were developed within the following categories of factors:

- Permit contribution – how a project will help towards the County meeting the impervious surface treatment requirements and pollutant reduction goals;
- Biological uplift – if a project will provide additional benefits, such as building onto existing green infrastructure or protecting wetlands;

- Programmatic benefit – how project has added value such as visible demonstration projects or public education; and
- Feasibility – estimation of the ease or difficulty of project implementation, including public versus private ownership, site accessibility, or whether a repair is already required at a site.

For the pooled project type ranking, scores were based on permit contribution criteria—specifically, acres of impervious treatment, pollutant load reduction, and cost per acre of impervious treatment—along with a combined score for the remaining three factor categories.

Ranking scores were used to select the highest-ranked projects for concept plan development at this time. A four-page concept plan was developed for each of the projects, providing location information, description of existing condition (including photos), details of the proposed project (including a design drawing), implementation information (such as utility constraints and other nearby projects), potential impervious treatment credits, and cost estimate.

A pollutant load model was created to calculate nitrogen, phosphorus, and sediment load reductions for each project concept. Results included a summary of estimated pollutant load reductions for the implementation of recommended projects, including how reductions were credited, pollutant removal efficiencies, and potential load reductions. This information has been incorporated into the County's restoration plan, Countywide Implementation Strategy (KCI, 2017b), where implementation timeframes and overall TMDL goals, milestones, and progress is discussed in more detail.

ACKNOWLEDGEMENTS

The Patuxent River Watershed Assessment report was prepared by KCI staff: Susanna Brellis and Mike Pieper. The complete Patuxent River Watershed Assessment effort was a collaborative effort among the Howard County Stormwater Management Division, Biohabitats, KCI Technologies, Inc, McCormick Taylor, and Straughan Environmental, Inc. The following staff were instrumental in the completion of the watershed assessment.

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1. Introduction

1.1 Overview

The Patuxent River watershed assessment was conducted to identify restoration opportunities to treat stormwater from urban impervious areas in Howard County, Maryland. This assessment is part of a larger effort to assess all watersheds within Howard County. The Patuxent River is divided into several subwatersheds within Howard County. The Little Patuxent River and Middle Patuxent River watershed assessments were completed in 2015 (Versar, 2016a and Versar, 2016b). In 2016, watershed assessments were conducted in three subwatersheds of the Patuxent River: Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper (Figure 1). The Patapsco River watershed assessment was also conducted in 2016 and is described in a separate report (KCI, 2017a). That assessment includes two subwatersheds: South Branch Patapsco and Patapsco River Lower North Branch. The goals of the watershed assessments are to assess current conditions and recommend restoration opportunities. The Patuxent River watershed assessment resulted in 123 potential project sites and 35 concept plans for the top-ranked projects. Recommended restoration opportunities include new best management practices (BMPs), BMP conversions, tree plantings, stream restoration, and outfall stabilization.

1.2 Background

Howard County, along with other medium sized jurisdictions in Maryland, has been operating its municipal separate storm sewer system (MS4) under a National Pollutant Discharge Elimination System (NPDES) permit issued by the Maryland Department of the Environment (MDE). In recent years these permits and other stormwater regulations have expanded. The County's current permit requires compliance with pollutant load limits from both the Chesapeake Bay Total Maximum Daily Load (TMDL) and local TMDLs. The County is also required to meet an impervious surface treatment goal of 20% of the impervious surface not treated to the maximum extent practicable (MEP) by the end of the current 5-year permit term (December 17, 2019).

Howard County drafted a Countywide Implementation Strategy (CIS) in December 2015 to address the planning elements related to the restoration goals. The CIS was based on watershed assessments completed in 2015 for the Little Patuxent and Middle Patuxent watersheds. In order to fully meet the goals detailed in the CIS, the County initiated the Patapsco and Patuxent watershed assessments in 2016.

The main regulatory objective of the watershed assessments is to meet the County's MS4 NPDES permit requirements for Restoration Plans and Total Maximum Daily Loads per permit condition III.E.1.a-b – Watershed Assessments. The County must complete assessments by the end of the permit term in December 2019. According to the permit, the assessment shall include determination of water quality conditions, visual watershed inspection, rank of problems, prioritization of improvement projects, and will specify load reduction benchmarks and deadlines.

MDE considers the MS4 Permit for Howard County to be the entire county with the exception of lands which have their own NPDES stormwater permits, including federal lands, state highway lands, and other state lands, which are shown in gray in Figure 1. NPDES regulated industrial facilities are also excluded from the County's permit coverage. MDE notes that the inclusion of private and non-urban land in the MS4 permit is based on the rationale that stormwater management for private property in Maryland is locally administered for plan approval, inspection, and enforcement, and that these facilities

are inherently a part of a locality's storm drain system. The County's stormwater waste load allocation (SW-WLA) responsibilities are only for those areas included in the MS4 area.

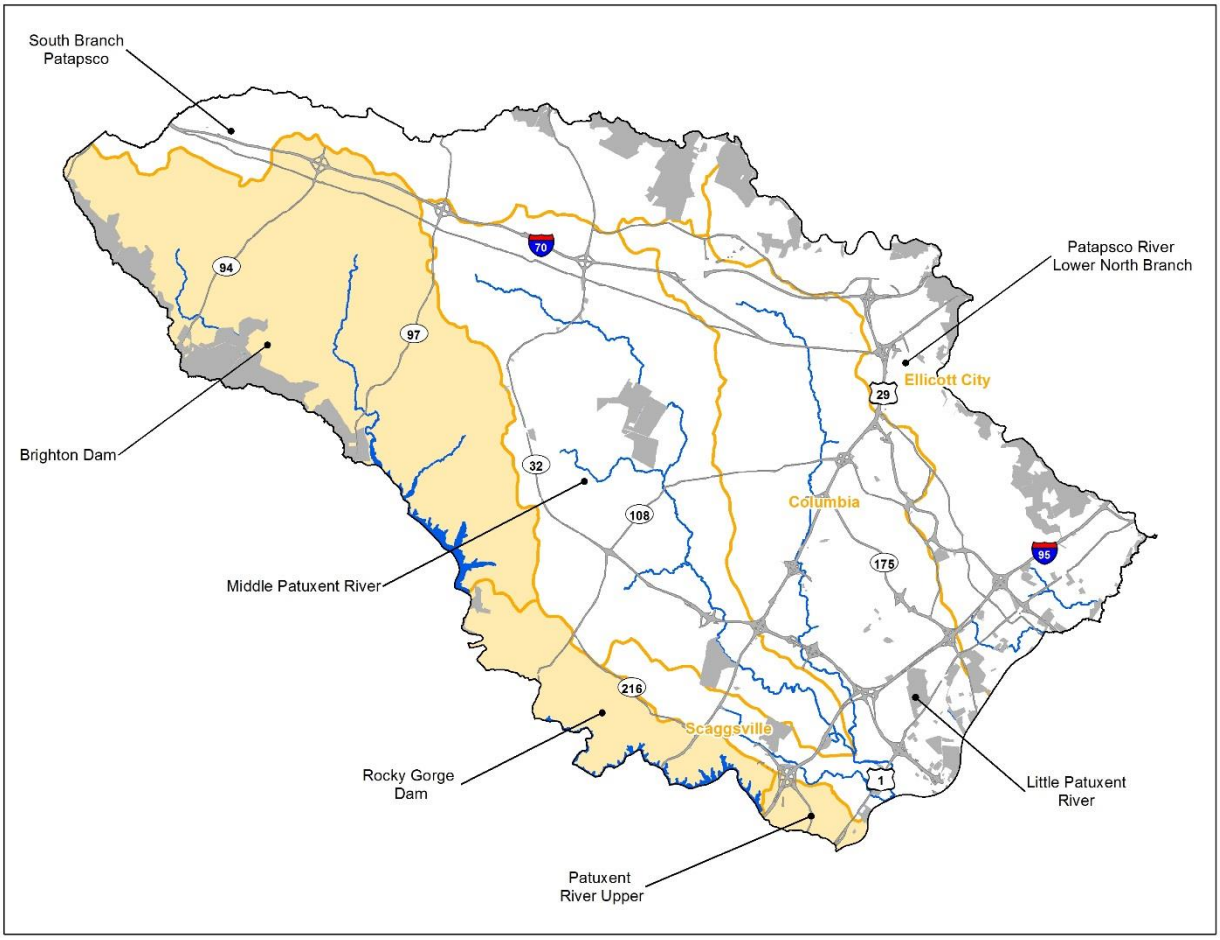

Figure 1. Major watersheds of Howard County and non-County MS4 permit areas in gray.

1.3 Report Structure

The report structure is consistent with the previous watershed assessment reports (Versar, 2016a and Versar, 2016b). The following seven sections outline the process used to identify, assess, and prioritize restoration opportunities in the Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds.

Section 1: Introduction provides context for the project and describes the regulatory drivers for the watershed assessments and pollutant reduction planning, as well as the overall structure of this report.

Section 2: Assessment of Current Watershed Conditions provides information about the physical characteristics such as impervious cover, existing stormwater BMPs, and assessments of stream biotic health. This section also provides descriptions of the five types of potential restoration opportunities considered in this study.

Section 3: Desktop Analysis explains the process used to synthesize and analyze past data in order to select sites for field investigation.

Section 4: Field Assessments describes the field work methodology, calibration, and QA/QC employed by consultant teams conducting the fieldwork within the geographic scope of this study. Assessment data, including the desktop revisits of previously assessed sites and public input/feedback, are reported for each of the five types of potential restoration opportunities in the study area are depicted spatially and in tabular form.

Section 5: Restoration Project Ranking and Prioritization sequences the steps and results of scoring and ranking individual potential restoration opportunities among all the individual opportunities of that type. Further, this chapter details the scoring and comparative ranking of individual opportunities across all five types of potential restoration for prioritization. By identifying the high priority opportunities, this process produced a more limited set of candidates for development of Concept Plans, which are included as four-page summaries in Appendix G.

Section 6: Pollutant Load Modeling reports the calculations of potential pollutant loading reductions for the recommended projects. Pollutant loads for nitrogen, phosphorus, and sediment were modeled at the planning level for the Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds.

Section 7: References documents other works cited throughout the report.

1.4 Previous Studies

Two previous studies conducted within the Patuxent River watershed were integrated into this study. Data from these studies were made available to KCI to aid in initial site selection, to avoid redundancy, and to incorporate recommended projects into the prioritization and concept plan selection process.

- Howard County Dry Pond and Extended Detention Pond Retrofits Summary Report (Versar, 2013a)

This study identified and prioritized dry ponds and extended detention stormwater management ponds to consider for retrofit in order to provide and/or enhance water quality control. This study included ponds throughout the entire County and resulted in 53 conceptual designs.

- Howard County Low Impact Development (LID) Retrofits and Tree Planting Summary Report (Versar, 2013b)

This study identified opportunities for LID practices on Howard County-owned properties, including Howard County Public School System sites. The study also identified potential tree planting sites. Thirty-four sites were identified as potential candidates for LID implementation and 32 sites were selected for potential tree planting opportunities throughout the County.

1.5 Regulatory Context

Under the Federal Clean Water Act (CWA), the State of Maryland is required to assess and report on the quality of waters throughout the state. Where Maryland's water quality standards are not fully met, Section 303(d) of the CWA requires the state to list these water bodies as impaired waters. States are then required to estimate the maximum allowable pollutant load, or TMDL, that the listed water body can receive and still meet water quality standards.

1.5.1 Howard County MS4 Permit

Section 402(p) of the CWA required the EPA to add MS4 discharges to the NPDES permit program. In 2002, EPA directed permit writers to include WLA requirements in NPDES permits, including those for MS4 discharges. Howard County is one of five medium jurisdictions in Maryland that is regulated by a NPDES MS4 Discharge Permit (Section 402(p) of the Water Quality Act of 1987 and NPDES Permit Application Regulations for Storm Water Discharges of November 16, 1990). Howard County's first permit went into effect on April 17, 1995 and the County received its fourth permit on December 18, 2014 (11-DP-3318, MD0068322). This fourth permit includes the following new requirements related to Restoration Plans, impervious surface treatment, and TMDLs among others.

Under Howard County's current MS4 permit (Permit Number 11-DP-3318, MD0068322, issued December 18, 2014), the County is required to develop Watershed Assessments and Restoration Plans to address the pollutant reductions required by the approved TMDLs. The County has developed a Countywide Implementation Strategy (CIS, KCI, 2017b) that demonstrates ways to meet the TMDL SW-WLAs and illustrates a strategy to treat 20% of impervious area currently not managed to the Maximum Extent Practicable (MEP).

Under the MS4 permit, the County is also required to provide watershed assessments for each watershed within the County, which address the following:

i. Determine current water quality conditions;
ii. Include the results of a visual watershed inspection;
iii. Identify and rank water quality problems;
iv. Prioritize all structural and nonstructural water quality improvement projects; and
v. Specify pollutant load reduction benchmarks and deadlines that demonstrate progress towards meeting all applicable stormwater WLAs.

1.5.2 Water Quality Impairments

All three watersheds are listed as impaired for various pollutants (MDE, 2015a), as of November 2016. The following statuses shown in Table 1 correspond to the following categories used by MDE to describe water quality impairment listings (MDE, 2015a):

- WQA – Category 2; waters meeting the standards for which they have been assessed based on a completed Water Quality Assessment (WQA)
- Insufficient data – Category 3; waters that have insufficient data or information to determine whether any water quality standard is being attained
- TMDL developed – Category 4a; waters that are still impaired but have a TMDL developed that establishes pollutant loading limits designed to bring the water body back into compliance.
- Impaired – Category 5; water bodies that may require a TMDL

Table 1. MDE Water Quality Impairment Listings and Status of Local Impairments and TMDLs in the Patuxent River Watershed

Impairment	Applicable Segment	Status	Approval Date
Nitrogen/Phosphorus	Patuxent R. Upper	WQA	February 2007
Escherichia coli	Patuxent R. Upper - lower segment	TMDL completed	August 2011
Escherichia coli	Patuxent R. Upper - upper segment	Insufficient data	
Mercury in Fish Tissue	Patuxent R. Upper	Impaired	
PCB in Fish Tissue	Patuxent R. Upper	Insufficient data	
Chlorides	Patuxent R. Upper	Impaired	
Sulfates	Patuxent R. Upper	Impaired	
Sediment	**Patuxent R. Upper**	**TMDL developed**	**September 2011**
Biological	Patuxent R. Upper	Impaired	
Phosphorus	**Patuxent R. Upper – Brighton**	**TMDL developed**	**November 2008**
Sediment	**Patuxent R. Upper – Brighton**	**TMDL developed**	**November 2008**
Biological	Patuxent R. Upper – Rocky Gorge	Impaired	
Mercury	Patuxent R. Upper – Rocky Gorge	Impaired	
Phosphorus	**Patuxent R. Upper – Rocky Gorge**	**TMDL developed**	**November 2008**

Final approved TMDLs within Howard County with either an individual or aggregate SW-WLA, shown in bold text

Source: Maryland's Final 2014 Integrated Report of Surface Water Quality (MDE, 2015a)

1.5.3 Local Total Maximum Daily Loads (TMDLs)

This section provides a brief overview of the TMDLs assigned to the Patuxent watershed. Refer to Howard County's restoration plan, the CIS (KCI, 2017b) for a more detailed description of the TMDLs, derivation of the County's specific targets, and the plan to address the requirements. Howard County has several watersheds where an EPA-approved quantitative assessment study (the TMDL) has established pollutant loading limits for waterbodies. These loading limits represent a maximum amount of a pollutant that the water body can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant (e.g., point sources or nonpoint sources). Pollutant loads from point and nonpoint sources must be reduced by implementing a variety of control measures. Responsibility for TMDL reductions is divided among various contributing jurisdictions within the area draining to the water body. The TMDL loading targets, or allocations, are also divided among the pollution source categories, which in this case includes non-point sources (termed load allocation or LA) and point sources (termed waste load allocation or WLA). The WLA consists of loads attributable to regulated process water or wastewater treatment and to regulated stormwater. For the purposes of the TMDL and consistent with implementation of the NPDES MS4 permit, stormwater runoff from MS4 areas is considered a point source contribution.

There are currently three final approved TMDLs within Howard County with either an individual or aggregate SW-WLA for Brighton Dam and Rocky Gorge Dam (MDE, 2008), and Patuxent River Upper (MDE 2011), shown in Table 2 and Figure 2. There is a bacteria TMDL completed for the lower segment of the Patuxent River Upper (approved August 2011), but it does not have a SW-WLA assigned to the Howard County MS4 source sector and is therefore not included here.

Table 2. Local TMDL SW-WLAs and Location Reductions

Watershed Name	Patuxent River Upper	Rocky Gorge Reservoir	Triadelphia Reservoir (Brighton Dam)[6]
Watershed Number	2131104	2131107	2131108
Baseline Year	2005	2000	2000
Pollutant	Sediment	Phosphorus	Phosphorus
Unit[1]	EOS-lbs/yr	EOS-lbs/yr	EOS-lbs/yr
Reduction %[2]	11.40%	15%	15%
Baseline Loads[3]	145,902	861	2,654
Load Reductions[4]	**16,633**	**129**	**398**
SW-WLA[5]	129,269	732	2,256

1) An EOS load is the amount of a pollutant load that is transported from a source to the nearest stream annually.

2) Published Reduction % from the MDE TMDL Data Center SW-WLAs for County Storm Sewer Systems in Howard County.

3) Baseline loads modeled in BayFAST using County BMPs installed prior to the TMDL baseline year on top of baseline land use background load. Additional load reductions from Howard County lakes installed prior to the baseline year and rooftop/non-rooftop disconnects were included outside of BayFAST.

4) Calibrated reductions calculated by applying the MDE published percent reduction to the BayFAST calibrated baseline loads.

5) Calibrated WLAs calculated by subtracting the calibrated reduction from the BayFAST calibrated baseline load.

6) The Triadelphia Reservoir (Brighton Dam) sediment TMDL requires 0% reduction with the assumption that meeting the phosphorus TMDL will result in the necessary sediment reductions (MDE, 2008). Therefore, the Triadelphia Reservoir sediment local TMDL is not addressed further here.

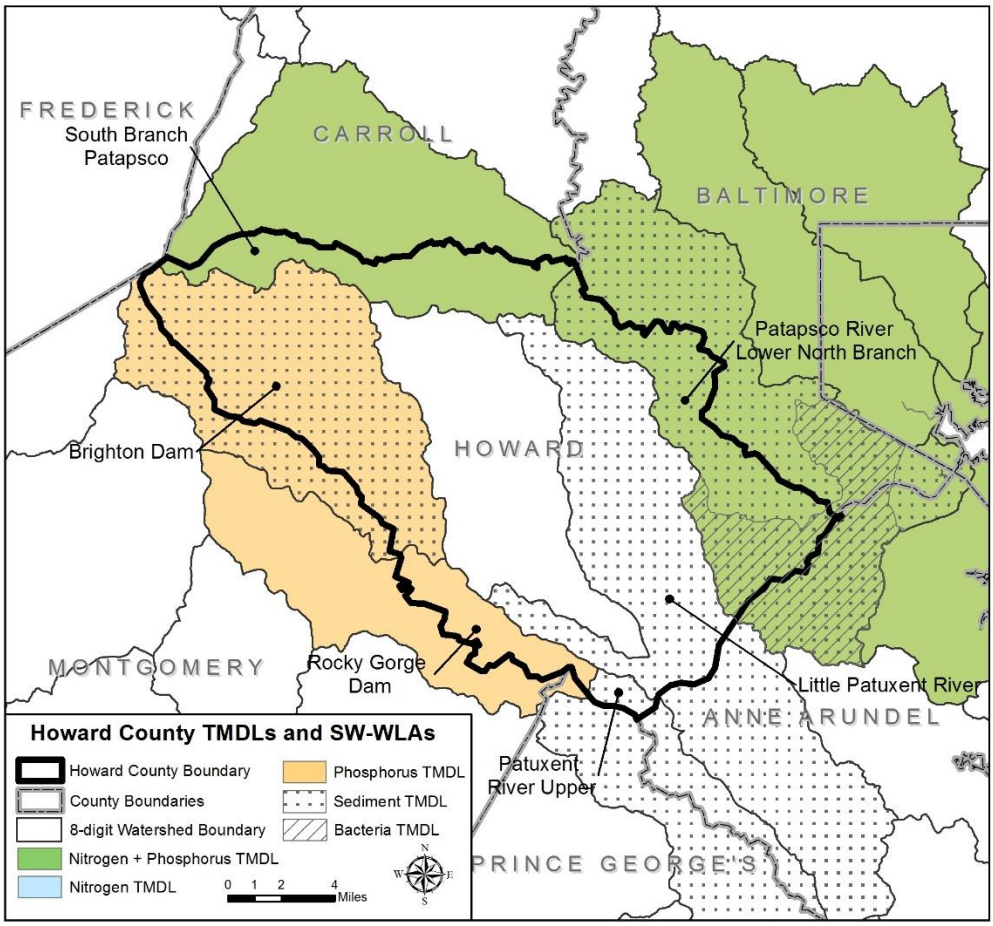

Figure 2. Howard County Local TMDLs with SW-WLAs.

1.5.4 Chesapeake Bay Total Maximum Daily Load (TMDL)

The Chesapeake Bay TMDL, established by the EPA (EPA, 2010), sets pollution limits for nitrogen, phosphorus, and sediment in the Chesapeake Bay watershed. Total limits set in the Bay TMDL for the states of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia are "185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year—a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment" (EPA, 2010). The TMDL also sets "rigorous accountability measures" for state compliance.

1.5.5 Impervious Surface Treatment Strategy

The County's MS4 permit is requiring compliance with the Chesapeake Bay TMDL through the use of the 20% impervious surface treatment strategy. As a requirement of section PART IV.E.2.a of the NPDES MS4 Discharge Permit issued by MDE to Howard County, the County must conduct an impervious area assessment to define the restoration efforts required under the permit to restore 20% of remaining Countywide baseline impervious acres not already restored to the MEP. The restoration is required to be complete by 2019, the end of the current permit term.

2. Assessment of Current Watershed Conditions

This section describes the current conditions of Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds (Figure 3), including information from geographic information system (GIS) data and existing stream monitoring efforts. GIS data were compiled from Howard County and other sources for use throughout the watershed assessment and planning process; see Appendix A for an inventory of GIS data gathered. The initial watershed characterization and desktop assessment step is described in this section. Subsequent sections detail the remaining steps of the project, for which GIS was integral: GIS screening analysis to select sites for field visits (Section 3), planning and conducting field investigations (Section 4), prioritization of restoration opportunities identified (Section 5), and development of concept plans (Section 5.4).

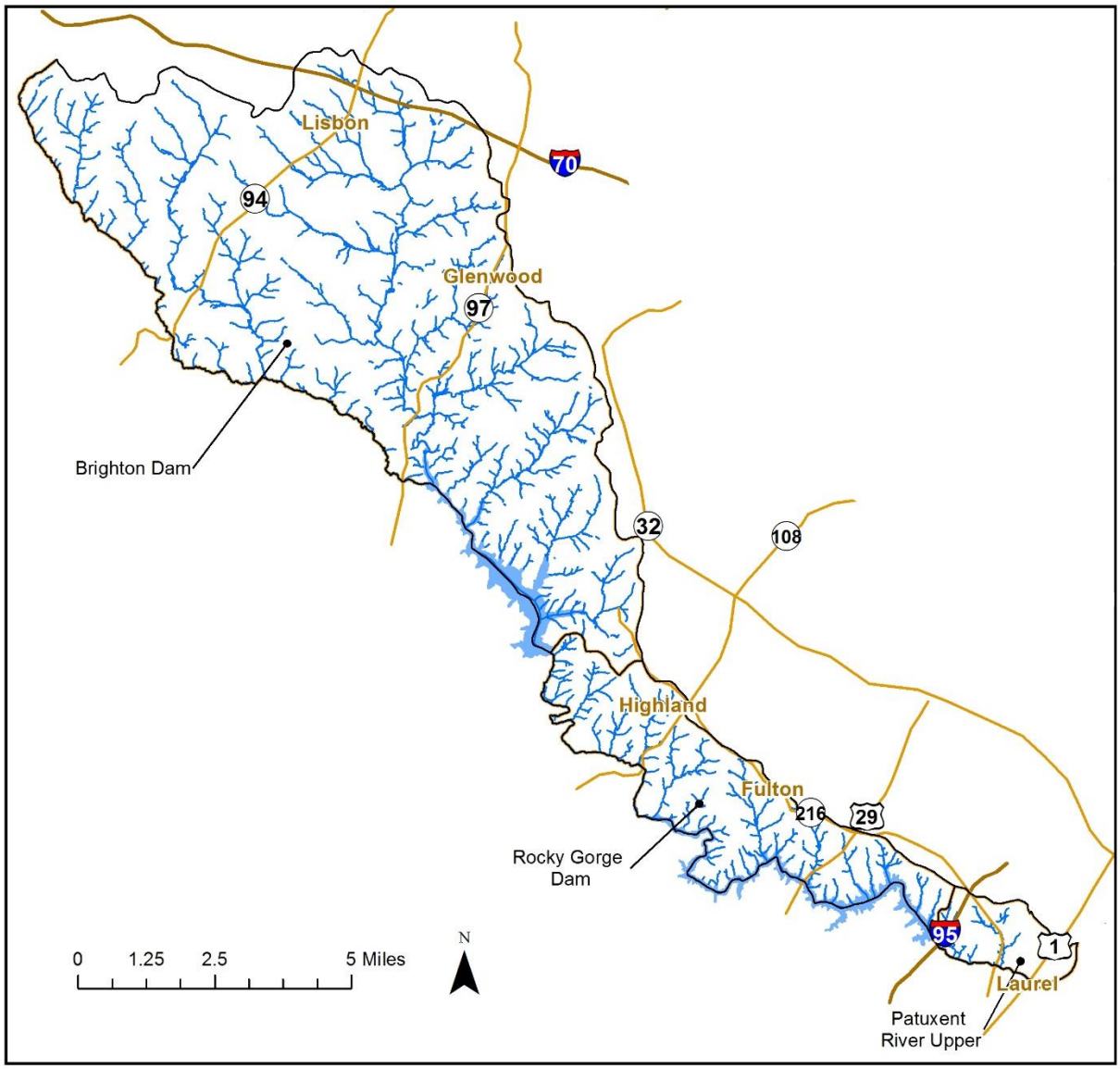

Figure 3.Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds in Howard County, Maryland

2.1 Impervious Surfaces

Studies have shown a correlation between the amount of impervious surface within a watershed and stream quality (e.g., Schueler et al. 2009). Impervious surfaces, including roads, parking areas, roofs, and other paved surfaces, prevent precipitation from naturally infiltrating the ground. This prohibits the natural filtration of pollutants and conveys concentrated, accelerated stormwater runoff directly to the stream system. Consequently, stormwater runoff from impervious surfaces can cause stream erosion and habitat degradation from the high energy flow. Furthermore, such runoff is likely more polluted than runoff generated from pervious areas.

Percent impervious cover is the most commonly used single measure of urban impacts to streams. Schueler (2008) defines the following general categories, using the Impervious Cover Model (Figure 4) describing the general relationship between the amount of impervious cover in a watershed and stream quality:

- Sensitive Streams: 2 - 10% impervious cover
- Impacted: 10 - 24%
- Damaged (Non-Supporting): 25 - 59%
- Severely Damaged (Urban Drainage): 60% or more

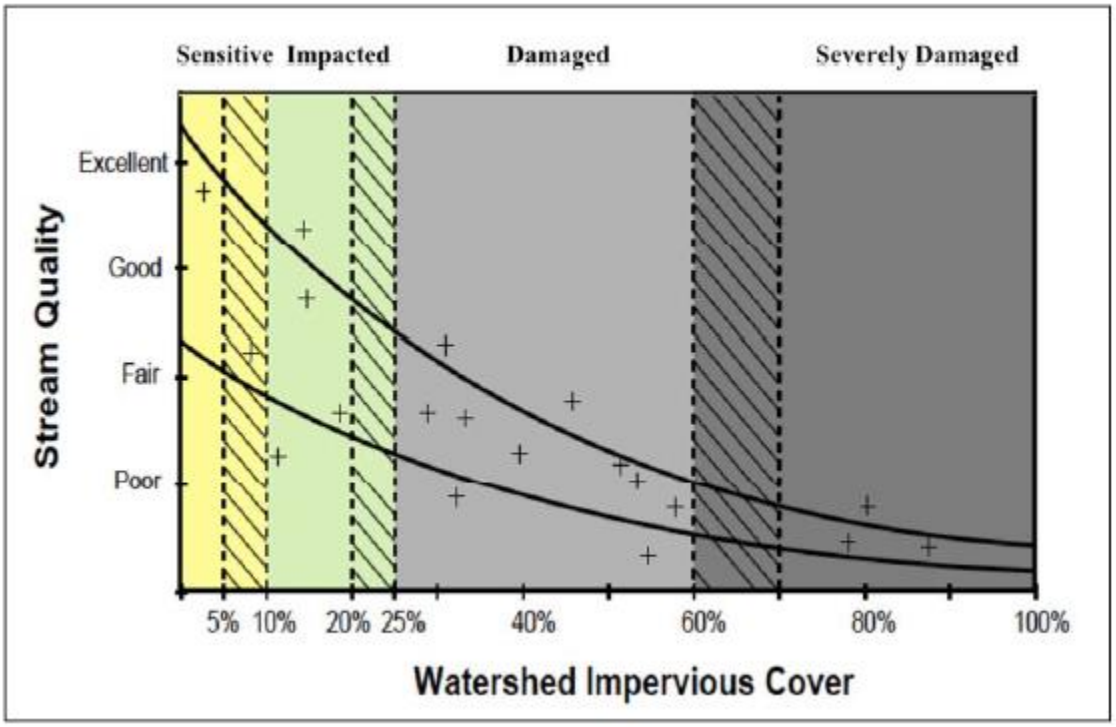

Figure 4. Impervious Cover Model (adapted from Schueler et al. 2009)

Howard County's impervious cover GIS data were used to map and quantify impervious cover within the Patuxent River Watershed (Figure 5). The impervious GIS layer, updated October 2, 2015, includes roads, parking lots, driveways, major buildings, bridge decks, sidewalks, pathways, and swimming pools. Table 3 outlines the impervious area of each watershed.

Table 3. Watershed Impervious Area

Watershed	Total Area (square miles)	Impervious Area (square miles)	Impervious Percent	Wooded Area (square miles)	Wooded Percent
Brighton Dam	57.7	2.9	5.0	15.3	26.5
Rocky Gorge Dam	12.5	0.9	7.2	4.3	34.4
Patuxent River Upper	2.7	0.7	25.9	0.7	25.9

While the Impervious Cover Model provides a general indication of stream conditions under varying degrees of impervious cover, it does not explicitly account for the effectiveness of BMPs that are in place to treat runoff from those impervious areas. Table 4 presents the number of stormwater BMPs (includes septic practices, tree planting, outfall stabilization, stream restoration and stormwater structures) and treated area in each watershed. Figure 6 shows impervious cover and areas treated by existing BMPs.

Table 4. Number of stormwater BMPs and treated area in each watershed

Watershed	Stormwater BMPs	Treated Area (acres)	Treated Area (square miles)
Brighton Dam	800	390.0	0.6
Rocky Gorge Dam	303	108.5	0.2
Patuxent River Upper	134	86.1	0.1

Howard County's current MS4 permit requires restoration of an additional 20% of impervious cover, countywide, not already restored to the MEP. Following MDE guidance (MDE, 2014b), impervious cover not restored to the MEP can be defined, in practice, as any impervious acres not draining to BMPs constructed after 2001. Beginning in 2002, Maryland regulations and local ordinances required BMPs to address a specific stormwater volume equivalent to providing water quality treatment to the MEP. Additional information pertaining to this requirement and planned implementation can be found in the County's restoration plan, Countywide Implementation Strategy (KCI, 2017b).

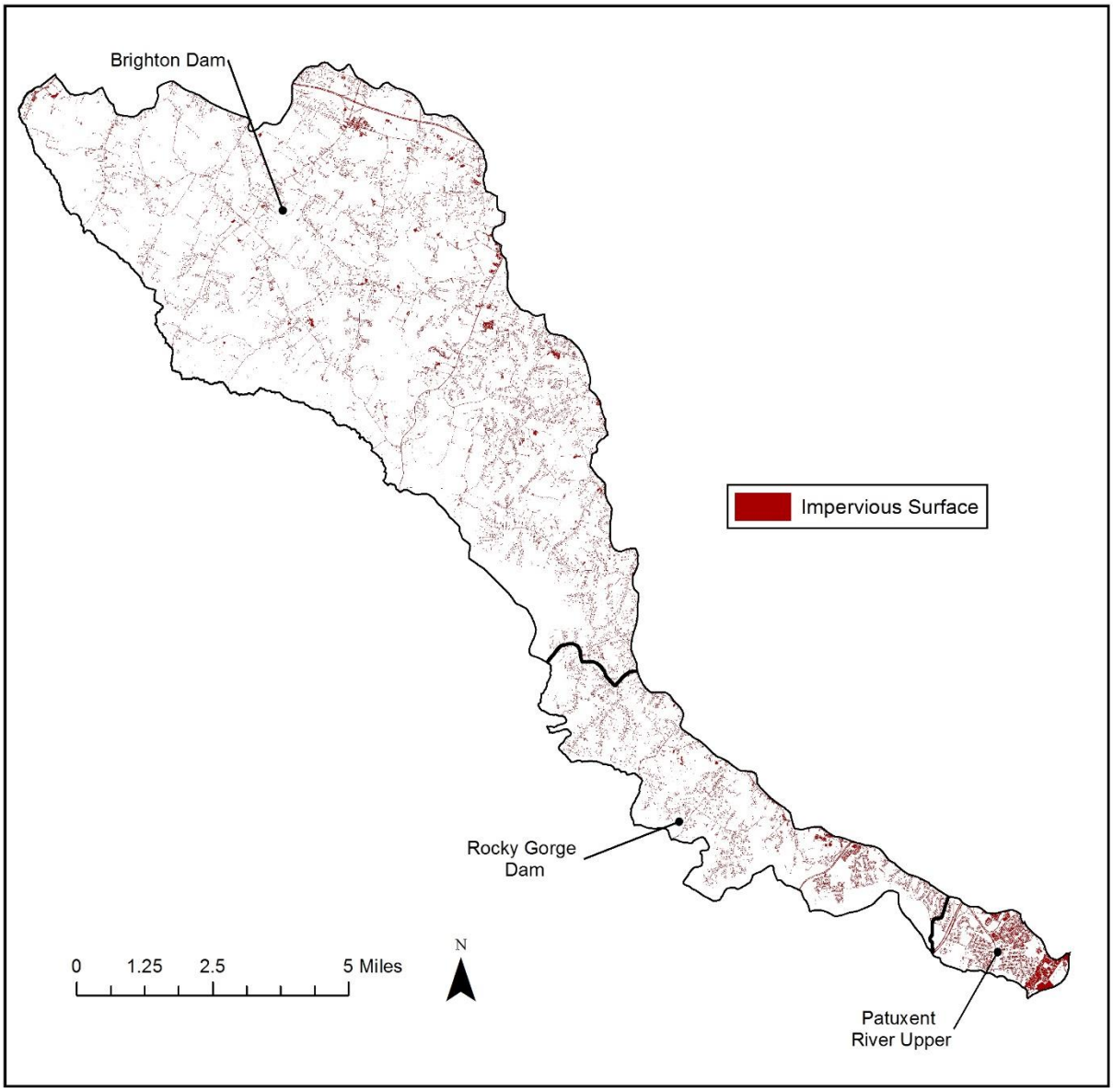

Figure 5. Impervious surfaces in Patuxent River watershed (Howard County 2015 impervious GIS data)

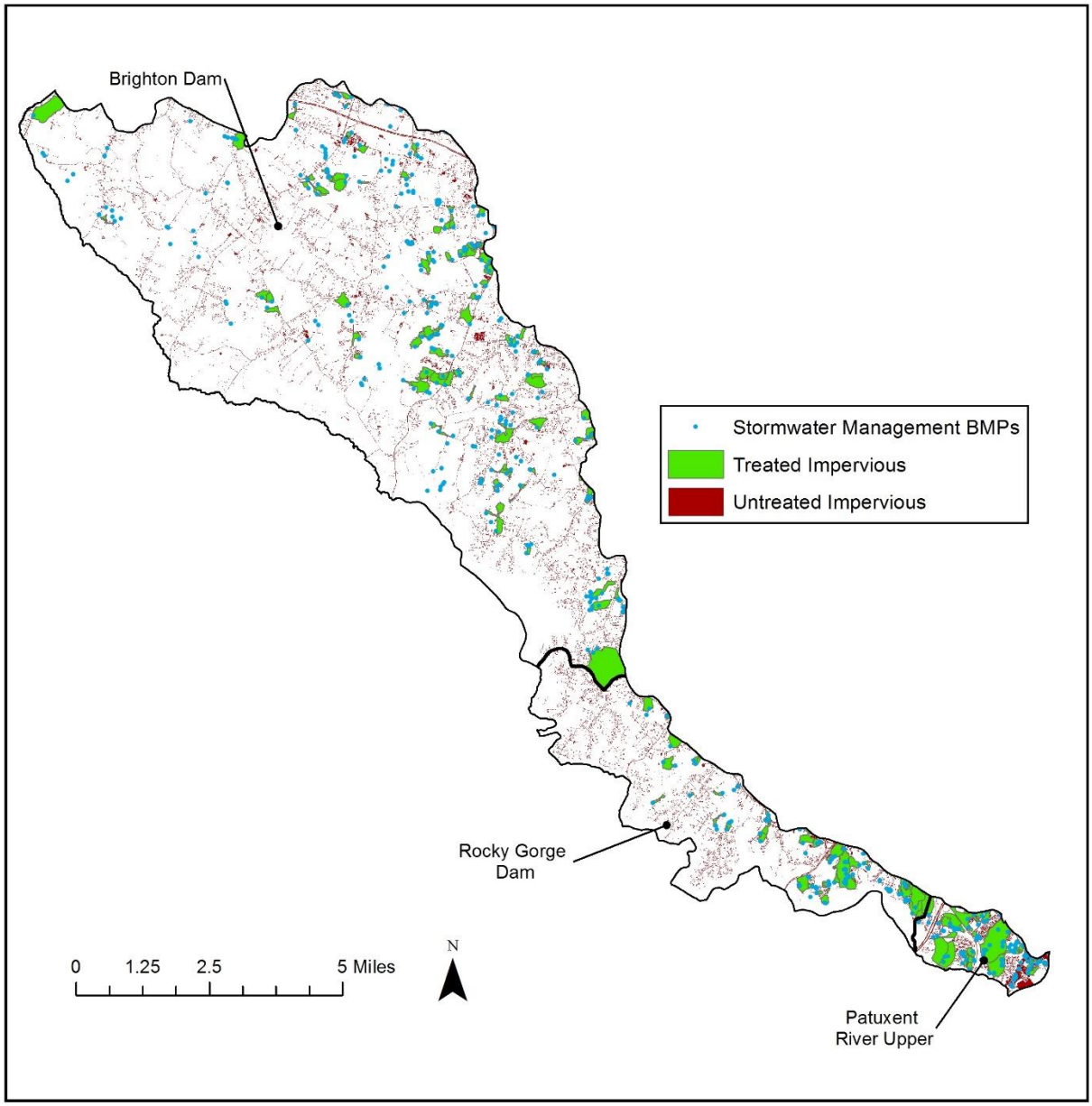

Figure 6. BMP Locations, Treated and Untreated Impervious Surfaces

2.2 Land Use

Land use within Patuxent River Watershed was derived from Maryland Department of Planning, 2010 data (Figure 7, Table 5). The three watersheds vary greatly in land use. Primary land uses in Brighton Dam are agriculture, urban, and forest. Rocky Gorge Dam is primarily urban, followed by forest. Over half of the area of the Patuxent River Upper watershed is urban, followed by forest. Residential is the primary land use under the "urban" category in all three of these watersheds.

Table 5. Land use of Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper

Watershed	Urban		Agriculture		Forest		Water		Other	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Brighton Dam	12,730.2	34.5	13,864.0	37.5	9,815.9	26.6	488.9	1.3	23.5	0.1
Rocky Gorge Dam	3,771.0	47.1	1,167.5	14.6	2,729.4	34.1	328.0	4.1	10.6	0.1
Patuxent River Upper	1,090.9	63.2	70.7	4.1	478.3	27.7	0.0	0.0	86.0	5.0

Future land use will be influenced by zoning (Figure 8). The vast majority of Brighton Dam watershed is designated rural residential with a few office/commercial zones. The northern portion of Rocky Gorge Dam watershed is similar, with majority rural residential zoning and a few office/commercial zones. The southern portion of Rocky Gorge Dam watershed is majority low density residential with a few mixed used zones. The Patuxent River Upper watershed is more mixed, with majority of the watershed zoned residential (mixed low, medium, and high density), along with portions of office/commercial, mixed use, industrial, and commercial/residential zoning.

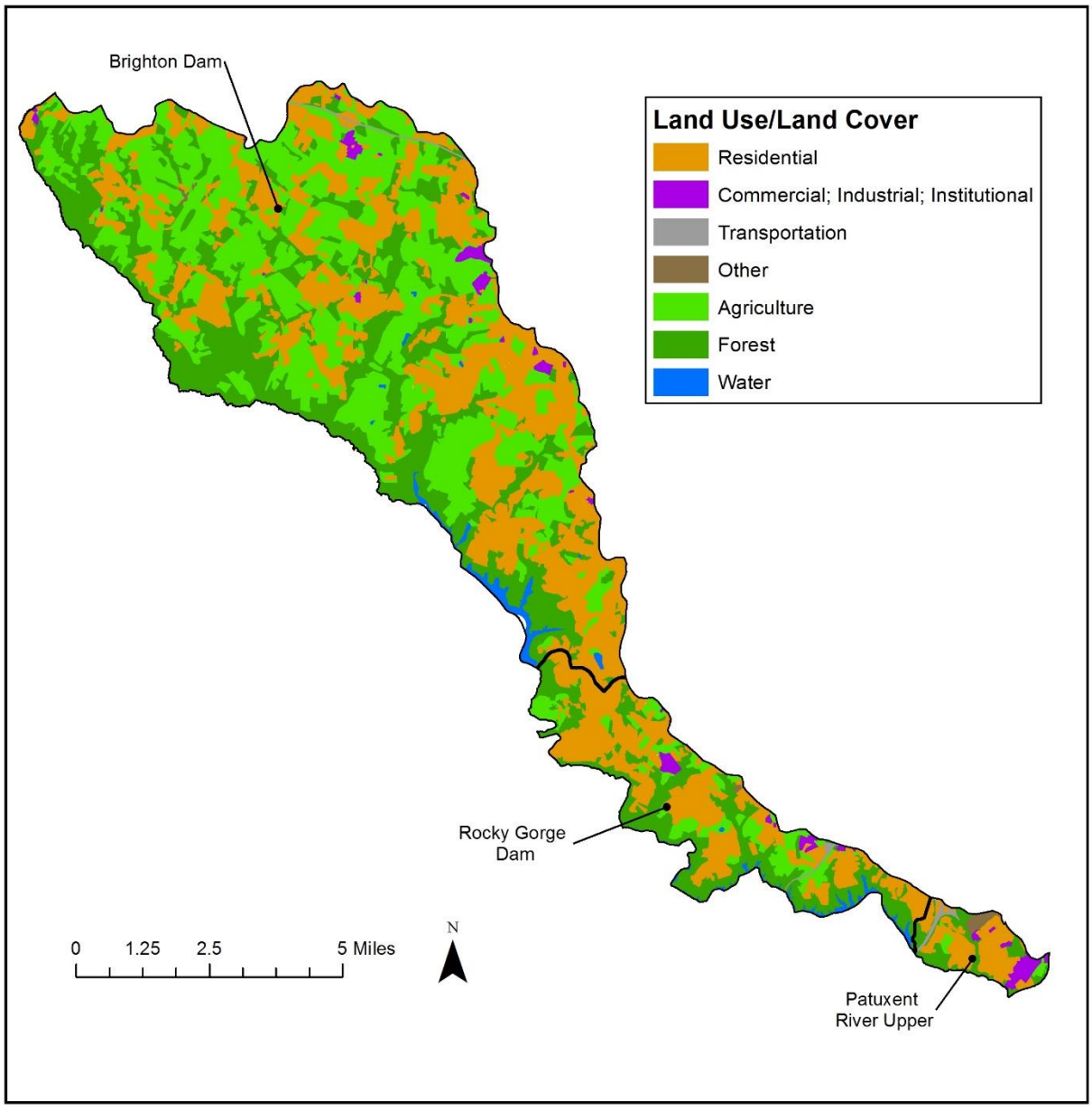

Figure 7. Land use in Patuxent River watershed.

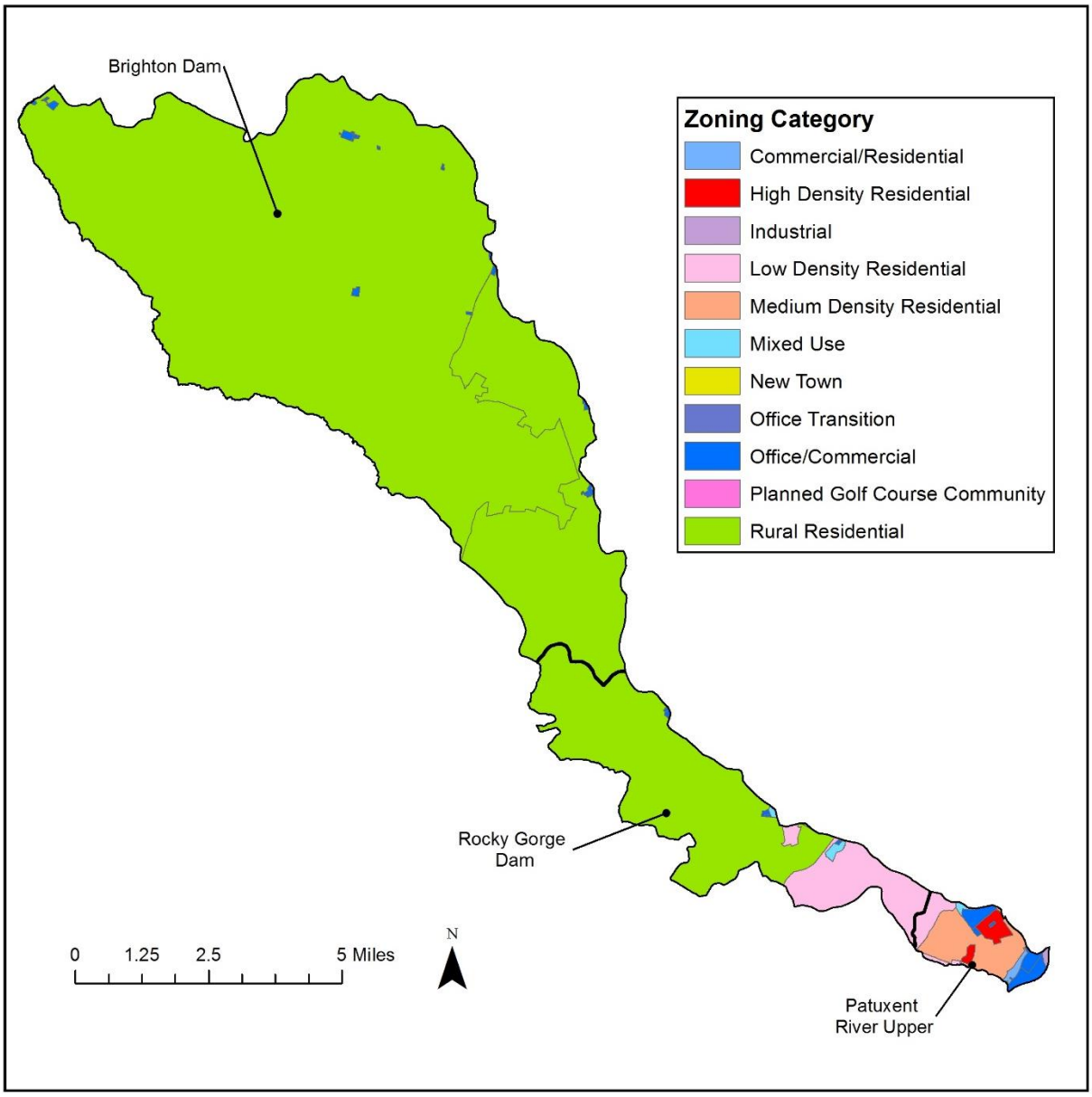

Figure 8. Zoning in the Patuxent River watershed

2.3 Soils

Soil conditions are important when evaluating how a watershed affects water quantity and quality in streams and rivers. Soil type and moisture conditions impact how land may be used and its potential for infiltration or various types of plants. Howard County's GIS soils layer was used for the soils data analysis and is a representation of the Howard County Soil Survey.

The Natural Resource Conservation Service (NRCS) classifies soils into four hydrologic soil groups based on runoff potential. Runoff potential refers to the tendency of soils to produce surface runoff; it is the opposite of infiltration capacity (i.e., the ability for the soil to absorb precipitation). Soils with high infiltration capacity will have low runoff potential, and vice versa. Infiltration rates are highly variable among soil types and are also influenced by disturbances to the soil profile (e.g., land development activities). For example, urbanization in watersheds with high infiltration rates (e.g., sands and gravels) will have a greater impact than urbanization in watersheds consisting mostly of silts and clays, which have low infiltration rates. Factors that affect infiltration rate include soil permeability (influenced mostly by texture and structure), slope, degree of soil saturation, and percentage of leaf litter cover. The four hydrologic soil groups are A, B, C, and D, where Group A soils generally have the lowest runoff potential and Group D soils have the greatest.

Brief descriptions of each hydrologic soil group are provided as follows. Further explanation of each can be found in the U.S. Department of Agriculture (USDA)/NRCS publication, Urban Hydrology for Small Watersheds, also called Technical Release 55 (USDA, 1986).

- Group A soils include sand, loamy sand, or sandy loam types. These soils have a high infiltration rate and low runoff potential even when thoroughly wet. These consist mainly of deep, well to excessively drained sands or gravel. These soils have a high rate of water transmission.
- Group B soils include silt loam or loam types. They have a moderate infiltration rate when thoroughly wet. These soils mainly consist of somewhat deep to deep, moderately well to well drained soils with moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- Group C soils are sandy clay loam. These soils have a low infiltration rate when thoroughly wet. These types of soils typically have a layer that hinders downward movement of water and soils with moderately fine or fine texture. These soils have a low rate of water transmission.
- Group D soils include clay loam, silty clay loam, sandy clay, silty clay, or clay types. These soils have a very low infiltration rate and high runoff potential when thoroughly wet. These consist mainly of clays with high swell potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

As shown in Figure 9, the majority of Brighton Dam and Rocky Gorge Dam watersheds fall into soil group B with moderate infiltration rates. Patuxent River Upper watershed has a much larger proportion of soil groups with higher runoff potential, in hydrologic groups C and D. The low infiltration rates of these soils mean that they are more susceptible to flooding and provide a poor porous medium for stormwater ponds and Environmental Site Design (ESD) opportunities, so opportunities should be considered carefully, using local-scale information.

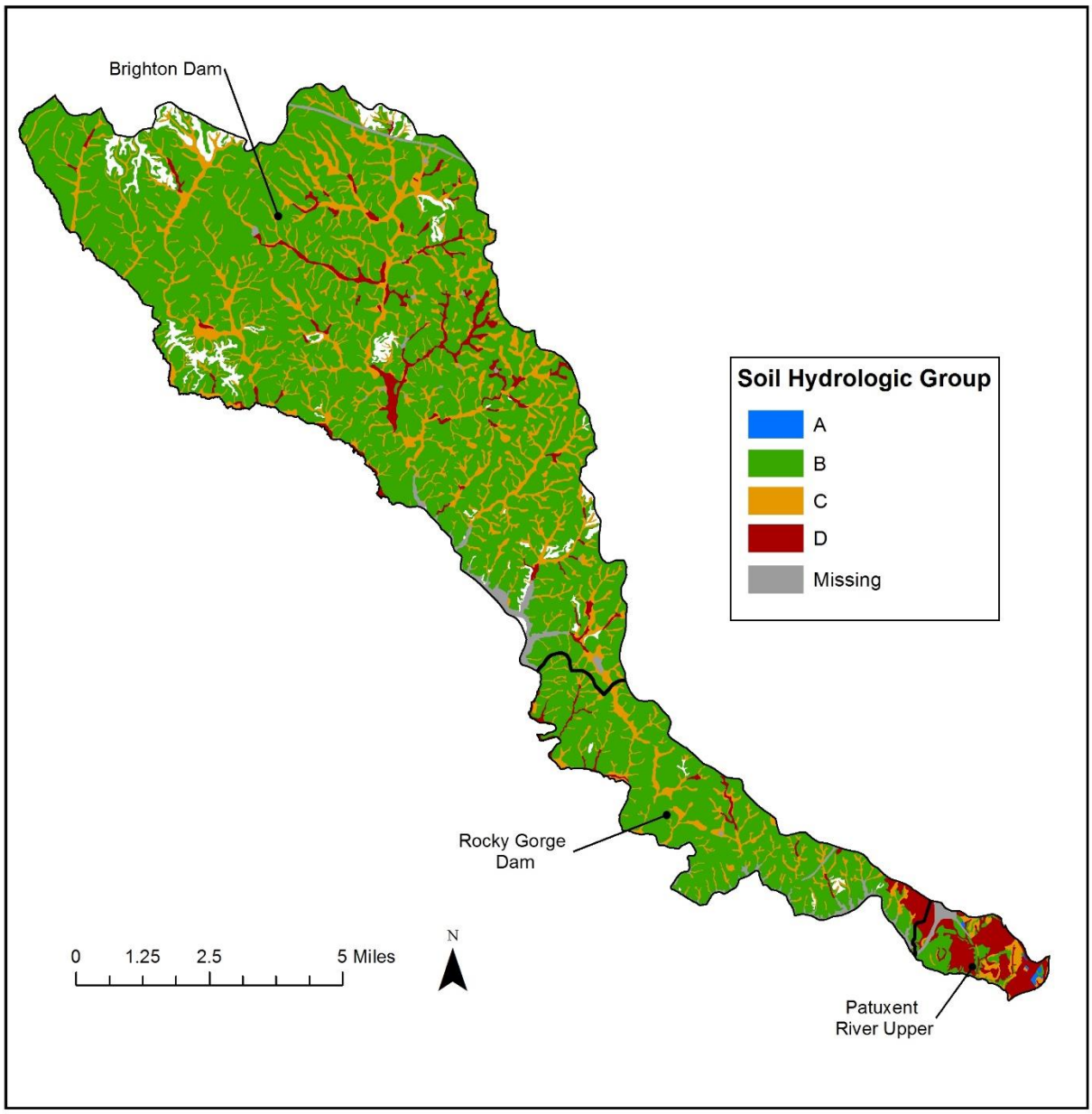

Figure 9. Soil hydrologic groups in Patuxent River watershed

2.4 Stream Condition

Howard County conducts biological monitoring at randomly selected stations in its Countywide monitoring program which began in 2001. In addition, the Maryland Department of Natural Resources (DNR) Maryland Biological Stream Survey (MBSS) has performed stream monitoring statewide since 1995, using similar monitoring methods as the County. Since 2000, the DNR Stream Waders volunteer program has performed benthic macroinvertebrate monitoring throughout the County. The results of all of these assessments are shown in Figure 10.

Of the 239 sites in Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds, 107 (48%) were in Good condition, 68 (30%) were in Fair condition, 33 (15%) were in Poor condition, and 15 (7%)

were in Very Poor condition. Brighton Dam had the most sites in Good condition, while Patuxent River Upper sites were mostly in Poor or Very Poor condition.

Stream habitat condition was also evaluated by Howard County and MBSS using the MBSS Physical Habitat Index (PHI) for habitat assessment. Of the 50 sites assessed (Figure 11), 11 sites (22%) were rated as minimally degraded (the highest scoring category), 28 (56%) were rated as partially degraded, 6 (12%) were rated as degraded, and 5 (10%) were rated as severely degraded. These scores indicate that many streams in the Patuxent River watershed show evidence of habitat degradation.

While stream conditions vary across the county, degradation is more prevalent in the heavily developed urban areas. This reflects the history of urban and suburban development prior to effective stormwater management regulations. Watershed condition is generally better in the more rural parts of the county, but stream degradation still occurs in these areas as a result of large lot development and agricultural impacts. By reducing the adverse effects of stormwater runoff throughout the county, the process of watershed assessment, restoration planning, and implementation of prioritized BMPs should improve the water quality condition in the Patuxent River Watershed over time.

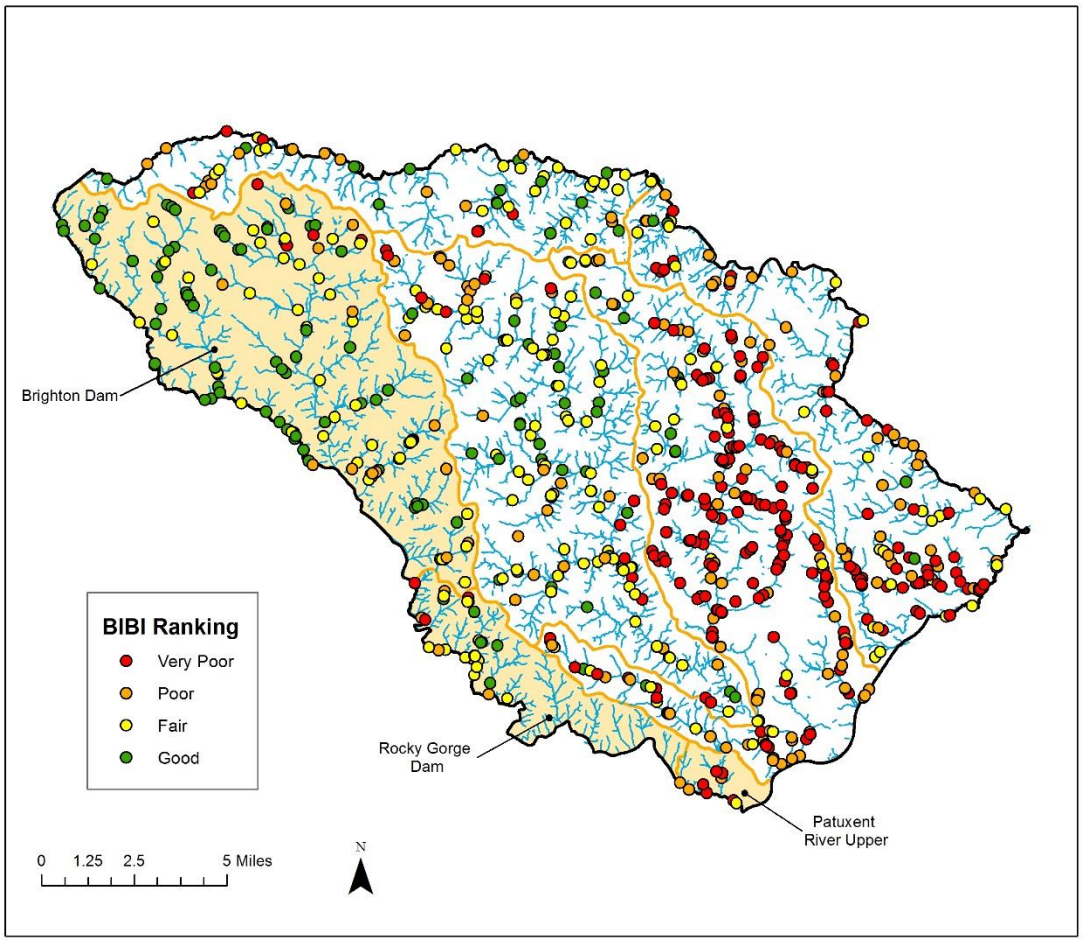

Figure 10. Benthic Index of Biotic Integrity ratings at sites assessed by Howard County, MBSS and Stream Waders 1995-2016

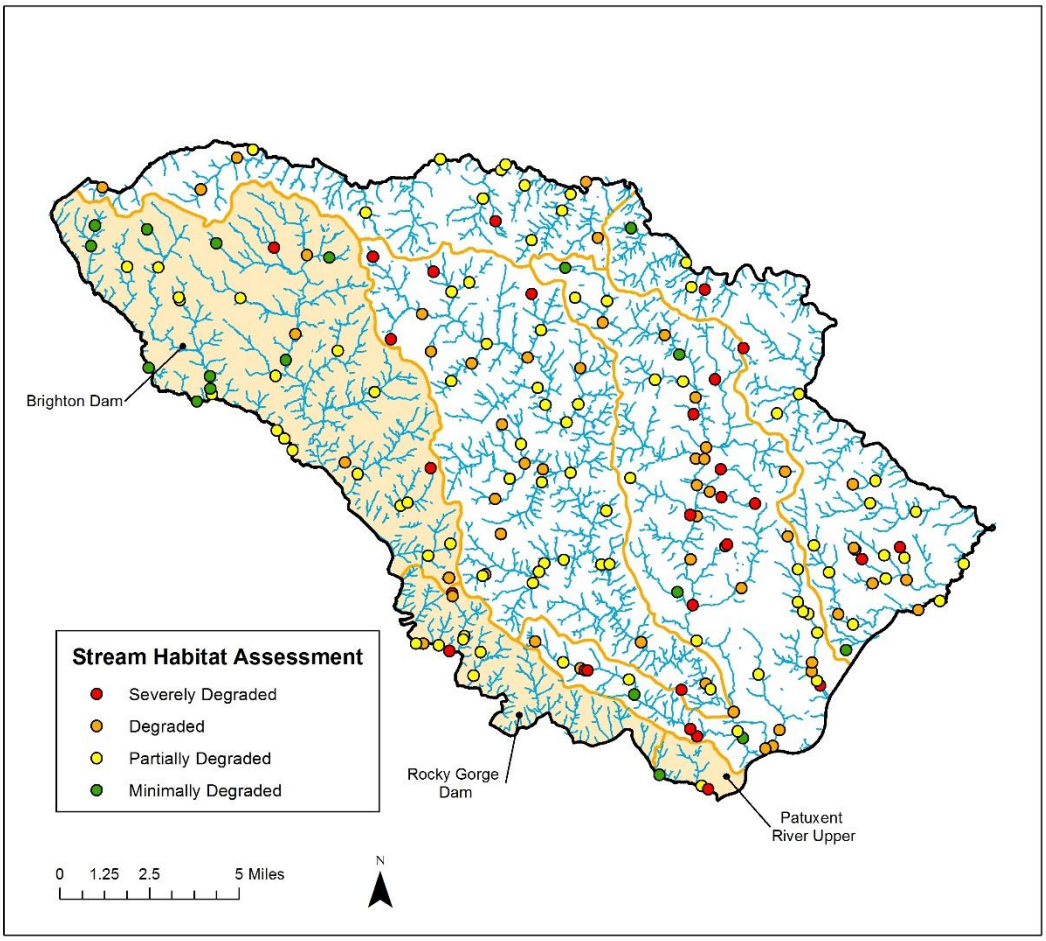

Figure 11. Habitat Assessments based on Physical Habitat Index (PHI) protocol at sites monitored by Howard County and MBSS, 1995-2016

2.5 Patuxent Reservoirs

The watersheds of two reservoirs on the Patuxent River, Triadelphia and Rocky Gorge, are mostly within Howard and Montgomery Counties. These reservoirs are significant water supply sources for the Washington D.C. metropolitan area and both are impaired by nutrients and have TMDLs established. The Patuxent Reservoirs Watershed Protection Group released the *2013 Annual Report of the Technical Advisory Committee* (Patuxent Reservoirs Watershed Protection Group, 2013) which summarizes current conditions of the watersheds, recent accomplishments, and identifies a work plan and funding needs to improve water quality in the reservoirs.

2.6 Best Management Practices: Opportunities for Retrofit and Restoration

The same five types of retrofit and restoration opportunities were considered for the current watershed assessment as the previous watershed assessments (Versar, 2016a and 2016b): (1) upgrading and retrofitting existing BMPs, (2) proposing new BMPs, (3) planting trees, (4) restoring streams, and (5) stabilizing storm drain outfalls. These structural practices will be combined with non-structural programmatic practices (e.g. street sweeping, septic system upgrades) that the County is implementing as part of its overall strategy. The following describes these structural practices in more detail.

2.6.1 BMP Conversions

Howard County has implemented BMPs and other watershed management practices since the 1980s. The initial focus of stormwater management was detention of large flows to reduce flooding using dry ponds and extended detention dry ponds. Conversion of these facilities to wet ponds and wetlands that meet current water quality volume treatment requirements and provide greater pollutant removal efficiencies is a cost effective restoration practice. These conversion types include:

- Extended detention wet pond/wetlands, shallow wetlands
- Bioretention
- Non-bioretention filtering practices
- Infiltration practices
- Swales
- Addition of pre-treatment or post-treatment BMPs within existing dry or wet pond boundaries
- New BMP retrofits outside of existing dry or wet pond boundaries but which would drain into an existing pond or capture and treat stormwater just outside of the existing pond (e.g. step pool conveyance).

Stormwater pond conversions can include the following general options for the re-design of existing stormwater ponds to provide additional water quantity control or water quality treatment:

- Increasing storage capacity by additional excavation
- Providing water quality treatment features at facilities that currently have only water quantity control, if the space is available. Examples include: micropools, sediment forebays, or constructed stormwater wetlands.
- Modifying or replacing existing outlet controls to reduce the discharge rate from the stormwater management facility.
- Where soil types are appropriate, adding infiltration (sometime referred to as exfiltration) features to promote groundwater recharge and improve pollutant removal.
- Where water quality flows can be split or separated from larger events, vegetated areas with engineered soils and underdrain, referred to as bioretention, can sometimes be retrofit into an existing pond as pretreatment or post treatment and yield a significant increase in pollutant removal efficiency.
- Installing proprietary settling, filtering or hydrodynamic devices in parking lots or other areas with a large percentage of impervious area to trap sediments, trash and petroleum products before they flow into a pond. These tend to have low pollutant removal efficiencies but can be good options in the highly urban context, particularly where subterranean treatment is the only option.

2.6.2 New BMPs

New BMP practices include retrofitting untreated impervious with new stormwater BMP facilities. This can include locations that currently have no stormwater quantity or quality controls or where existing BMPs are inadequate and where space is available for a new BMP. New BMP practices include:

- Extended detention wet ponds/wetlands, shallow wetlands
- Bioretention
- Non-bioretention filtering practices

- Infiltration practices
- Swales
- Replacement of impervious cover with pervious pavement
- Impervious surface removal
- Rain gardens

2.6.3 Tree Planting

Reforestation opportunities at stream buffers or in upland areas provide ancillary benefits of enhancing wildlife and amenity values, as well as reducing runoff from interception and uptake/transpiration of precipitation, providing soil stability, heat island reduction, and wildlife habitat benefits. Riparian forest buffers are typically at least 35 feet on each side of the stream and provide benefits such as filtering sediments and pollutants from stormwater runoff, moderating water temperatures in streams, and providing shelter and food to both terrestrial and stream organisms. Upland tree plantings provide many of the same benefits along with increasing wildlife habitat and aesthetics.

2.6.4 Stream Restoration

Stream restoration is used to improve the ecosystem condition in degraded streams by restoring the natural hydrology and landscape of a stream and by enhancing habitat and water quality. Streams damaged by erosive flows, excess sedimentation, and disruptive human activities are often not capable of re-establishing a stable form. Preferred techniques to repair these damaged or degraded streams are based on mimicking natural stream channels and the range of natural variability exhibited by nearby stable streams. Termed natural stream channel design, such repairs focus on establishing natural stream channel shape, size, and habitat features. Restoration can range from minor repairs to bank stability restoration to complete reconstruction of the stream channel. Stream restoration also provides significant ancillary benefits through habitat enhancement and improved ecosystem services.

2.6.5 Outfall Stabilization

Outfall stabilization includes the restoration of degraded ephemeral and intermittent outfall channels through stabilization techniques which include:

- *Step Pool Stormwater Conveyances / Regenerative Stormwater Conveyances* are open-channel conveyance systems that convert surface stormwater flow to shallow ground water flow through surface pools and subsurface sand seepage filters (Anne Arundel County, 2012). These practices can be used to stabilize degraded ephemeral and intermittent channels while also providing water quality treatment for the contributing drainage area, allowing for pollutant removal opportunities that do not exist with traditional outfall stabilization techniques. Specific site conditions will dictate whether these practices are appropriate. Pollutant reductions for regenerative stormwater conveyances will be credited using the Expert Panel's Protocol 4, as described in Section 6.1.1.
- *Other Stabilization Practices*. Where step pool conveyances are not feasible, simpler outfall channelization practices such as riprap or drop structures may be implemented to reduce erosion.

3. Desktop Analysis and Field Site Selection

Potential retrofit and restoration sites for field investigation were selected through a desktop analysis using a suite of GIS data and data compiled from previous studies. Specific methods for each BMP type are described in the following sections. In general, areas within non-County NPDES MS4 stormwater regulation were not investigated, including State property.

3.1 Conducting Desktop Analysis- Methods

3.1.1 BMP Conversion Assessments

The County's stormwater BMP facility database was used, which includes BMP types and BMP drainage area polygons, to identify BMPs that could be converted to a design with increased pollutant removal efficiencies. The desktop analysis was conducted with the most complete BMP database update available at the time, in December 2015. Facilities that were identified as being either a dry pond or dry extended detention pond that did not comply with current water quality volume treatment criteria of treating 1 inch of rainfall (MDE, 2014b) were selected. Facilities that had been identified and assessed in previous County assessment efforts and studies were not included in the selection for field assessment.

During a two day review of all sites selected via the GIS desktop analysis, Howard County Stormwater Management and KCI staff reviewed each potential project site and removed sites where conditions were known to be not conducive for a project. The County also added sites that citizens had brought to the County's attention. Desktop assessments were reserved for sites of interest that had been previously visited during two recent County studies conducted to identify retrofit and restoration opportunities: Howard County Dry Pond and Extended Detention Pond Retrofits Summary Report (Versar, 2013a) and the Howard County Low Impact Development (LID) Retrofits and Tree Planting Summary Report (Versar, 2013b). These desktop assessments were included to put all previously studied sites into the same frame of reference, so that previously identified opportunities could be ranked and evaluated alongside the new opportunities identified during this Watershed Assessment.

3.1.2 New BMP Assessments

Prior to 1982, when the State's first Stormwater Management law was passed, there were no requirements for quantity or quality control of urban runoff. This means that when land development occurred before this law's enactment, there were very few BMPs built to control the runoff from new impervious surfaces. Controlling runoff from impervious surfaces in areas of older development presents unique challenges – there must be adequate open space available for a new BMP and the open space must be in the correct landscape location for receiving impervious runoff (or costly changes need to be made to site grading or stormwater infrastructure to re-direct runoff to the available open space). Because of this, when selecting assessment sites for new BMPs, efforts were made to limit assessments to areas where implementation of new practices would allow for treatment of areas of significant impervious surface.

The County's latest planimetric GIS layers (including roads, buildings, parking lots, driveways and major sidewalks) were combined to identify where there were contiguous blocks of impervious surface. These blocks of impervious were then overlaid with the drainage areas treated by current or planned BMPs; the potential pool of candidates was limited to those areas not treated by an existing or planned BMP, as per the County's BMP and Water Quality Improvement Projects data. Older or underutilized properties were prioritized. Sites that were previously identified during other studies were not included

for field assessment. Sites with poor access, or projects that would cause major interruptions to business operations were also eliminated. A list and geodatabase of candidate sites were prepared for presentation to Howard County staff during a site-by-site review of opportunities selected by the GIS desktop analysis.

3.1.3 Tree Planting Assessments

Howard County GIS data were used to identify parcels that are good candidates for tree planting projects. The County's forest conversation easement GIS layer was used in conjunction with recent aerial imagery to identify easements that appeared to either not be planted, or to not be currently forested as some sites may have been planted initially but were unsuccessful. County owned properties (open space, parks, schools) were prioritized by identifying all public and County-owned properties and locating areas on aerial photography that appeared to be open space. Additionally, a search using aerial imagery and the stream layer was conducted to find sites on private property in need of a riparian buffer or buffer enhancement. Larger sites were prioritized over sites on smaller parcels. Sites that had been previously planted (coded FPU in County BMP database) were excluded. Sites that had been identified in previous studies were also excluded, however some sites were retained as a desktop assessment site, so that they could be ranked and evaluated alongside the new opportunities identified during this Watershed Assessment.

During a comprehensive review of sites selected by the GIS desktop analysis, Howard County Stormwater Management Division staff had a chance to remove sites where conditions were known to be not conducive for a tree planting project. As an additional step following this meeting, staff of the Howard County Department of Recreation and Parks and Howard County Soil Conservation District were also provided with maps and given the opportunity to review the candidate sites and remove/add sites based on their local knowledge of the sites. Additionally, sites on school properties were sent to the Howard County Public Schools Grounds Services Manager for any additional input.

3.1.4 Stream Restoration Assessments

Howard County GIS data were used to isolate stream segments within the watershed where environmental problems are known to exist. Specific GIS data were used to identify stream segments containing known problems, particularly where erosion had been observed, such that sites would be good candidates for further investigation of restoration potential. Bank stability scores collected during annual Countywide biological monitoring surveys conducted every spring (years 2012-2015) were used to flag potential sites. Sites with fair to low bank stability scores were identified as potential assessment sites. During the desktop analysis, streams on County-owned properties were prioritized, as were longer segments of potential impairment. Using the most recent aerial imagery, a visual search for streams with minimal or deficient buffers were identified, and those streams were selected for investigation.

During a two-day review of sites selected by the GIS desktop analysis, staff from Howard County's Stormwater Management Division had a chance to remove sites where stream restoration work was already completed or planned, or sites where conditions were known to be not conducive for a restoration project. The County staff also had a chance to add sites that citizens had brought to the County's attention that had not made the initial list of candidates. Additionally, maps of sites on agricultural use properties were sent to Howard County Soil Conservation District for their review.

3.1.5 Outfall Stabilization Assessments

GIS data from previous watershed studies, BMP inspections, and Illicit Discharge Detection and Elimination (IDDE) investigations were used to identify an initial pool of outfall stabilization candidates. The GIS data were used to select outfalls that had been previously identified as having an erosion issue. Data used for outfall selection includes Howard County IDDE data (2000-2014) and BMP inspections (2014-2016). Outfalls with IDDE erosion scores of moderate or severe were selected. BMP inspection notes were investigated for BMPs with outfall ratings of 3 or 4 to identify sites with erosion issues, rather than general maintenance requirements.

Outfalls were removed from the initial pool of candidates if they were associated with an outfall stabilization project identified in a previous study or were within Howard County's Water Quality Improvement Project database as a planned or completed project.

Several of the candidate outfalls were close enough to another candidate outfall that it was possible that they were the same outfall surveyed during multiple studies or over multiple IDDE investigations. All obvious duplicate outfalls were removed prior to the merging of candidate outfall GIS layers from previous studies, but the duplication of several proximate outfalls could not be verified due to a lack of a unique identifier and inconsistencies with surveyed outfalls matching the location of outfalls and pipes contained within the County's stormwater infrastructure GIS layers. These situations were individually investigated and assumptions were made based on all available GIS data. These assumptions were verified during the field investigation and exact pipe locations and quantities were recorded.

3.2 Desktop Analysis Summary- Results

Table 6 and Table 7 show the final breakdown of sites selected for field and desktop assessments. The final number of sites that were actually assessed, which are presented in Section 4, do not match the numbers shown in these tables for two reasons. First, in addition to the sites selected through the desktop analysis, field teams had the ability to add new sites that they found in the field, increasing the number of assessed sites. Second, some of the sites selected through the desktop analysis were not able to be visited due to issues such as property owner constraints and sites not being found, decreasing the number of assessed sites. Explanations of why sites could not be assessed can be found in the consultant field reports located in Appendix E.

Table 6. Number of sites selected for field assessments

Assessment Type	Unit	Number of Sites (or Stream Miles)		
		Brighton Dam	Rocky Gorge Dam	Patuxent River Upper
BMP Conversion	Number of sites	8	1	3
New BMP	Number of sites	8	1	0
Tree Planting	Number of sites	3	3	10
Stream Restoration	Stream miles	13.5	3.2	12.8
Outfall Stabilization	Number of sites	3	0	13

Table 7. Number of sites selected for desktop assessments

Assessment Type	Number of Sites		
	Brighton Dam	Rocky Gorge Dam	Patuxent River Upper
BMP Conversion	1	1	1

4. Field Assessments

Field assessments were conducted in 2016 to gather data on existing conditions in the Patuxent River watershed and to recommend sites with potential restoration and stormwater retrofit opportunities. Teams from two consultant groups were assigned portions of the Patuxent River watershed to assess. Brighton Dam and Rocky Gorge Dam watersheds were assessed by Straughan Environmental, Inc., and Patuxent River Upper watershed was assessed by Biohabitats. Additional desktop assessments were performed by Straughan Environmental, Inc.

4.1 Field Methods and Calibration

4.1.1 Field Protocols

Howard County Watershed Assessment field protocols were developed by Versar prior to the Little and Middle Patuxent River watershed assessments, in consultation with Howard County Stormwater Management Division and the other three consultant teams. Only minor changes to field protocols were made for the current watershed assessment study. Data collection was customized for each of the five BMP types and focused on (1) assessing current conditions and (2) identifying and describing restoration opportunities.

Specific protocols for each type in many instances drew from existing methodologies, but with customization to ensure that data collected in the field met the needs for this project. Custom data collection protocols were developed to document the following types of assessments and recommendations.

- Conversion of existing stormwater BMPs - methods were derived from the Center for Watershed Protection's Retrofit Reconnaissance Investigation (RRI) protocol, from the Urban Subwatershed Restoration Manual 3 (CWP 2007);
- Establishment of new stormwater BMPs for impervious surfaces not currently treated –similar to BMP conversions, methods were derived from RRI (CWP 2007);
- Tree planting - methods were drawn from Pervious Area Assessments (PAA), Unified Subwatershed and Site Reconnaissance, Manual 11 (CWP 2005) and Urban Reforestation Site Assessment (URSA), Urban Watershed Forestry Manual, Part 3: Urban Tree Planting Guide (CWP 2006);
- Stream restoration - methods were a combination of Stream Corridor Assessment (SCA, Yetman 2001) for characterizing erosion and other stream features, EPA's Rapid Bioassessment Protocol (RBP, Barbour et al. 1999) for habitat assessment, Rosgen (1996, 2001) methods for Bank Erosion Hazard Index (BEHI) and other geomorphic indicators; and
- Outfall stabilization - methods were primarily derived from the SCA protocols (SCA, Yetman 2001).

A complete field packet was distributed to each of the consultant teams to ensure that assessments were being conducted in a consistent manner. The packet included guidance on naming sites added in the field, a list of sites with special notes that field crews were to read prior to assessing the sites, a field assessment decision flow chart, field names and domains for field assessment layers, Rapid Bioassessment Protocol habitat scoring sheets, and Bank Erosion Hazard Index (BEHI) diagrams. A complete copy of the packet can be found in Appendix C.

4.1.2 Electronic Data Collection

Field assessment data were collected with mobile tablet devices through the ESRI ArcCollector application. Digital photographs were taken at each assessment site and appended to the database. The electronic collection of data allowed for data to be entered directly into a geodatabase in the field and removed the step of having to manually enter data from paper datasheets in the office. ESRI Web Maps that were linked to the field assessment geodatabases were accessed from desktop computers to complete desktop assessment data entries, and to edit the field data. An ArcCollector Field Data Collection Instructions packet was developed and distributed to each of the consultant teams to be used as a reference guide while working with the geodatabases and the associated background data layers.

4.1.3 Calibration of Field Teams

Prior to beginning data collection, two field assessment training and calibration days were held to ensure that field personnel from each of the consultant teams were familiar with the methods being used to collect field data and to create a consistent perspective among all consultant personnel for recording field observations. The first training and calibration day covered BMP Conversion, New BMP, and Tree Planting field assessment protocols, and was held on March 22, 2016. The second day covered Stream Restoration and Outfall Stabilization field assessment protocols, and was held on March 24, 2016. Each of the training days consisted of a review, discussion, and revisions to field assessment protocols, review of data download, collection, and upload procedures with the tablets and the ArcCollector application. Brief visits to representative field sites for each of the five assessment types were also conducted.

4.1.4 Landowner Permissions

Once the final list of field sites was completed, the GIS parcel layer was used to identify all properties containing field sites. Property ownership data was populated for these properties and was used to send notification letters to request property permission. The following steps were taken to refine the mailing list:

- For public property (e.g., county-owned parklands, schools), County staff confirmed that sites were accessible and no letter was sent.
- School system personnel were contacted separately and the Howard County Public Schools Assistant Manager of Grounds Services was present during the field investigations. Field staff were also instructed to visit the school office, upon arrival at each school site, in order to present identification and sign in.
- Parcels containing more than one site were reduced to a single entry, to avoid duplicate mailings.
- For multiple-tenant commercial properties, a single letter was sent for the whole unit.
- Multi-owner or publicly accessible facilities (e.g., a commercial complex that would be readily accessible from a parking lot) were removed from the mailing list.

- Sites on agricultural properties were reviewed by the Soil Conservation District staff, who helped identify appropriate sites to visit, prior to letters being sent.

Howard County Stormwater Management Division staff developed a letter to send to property owners (see Appendix D). County staff sent out letters and field staff were instructed to wait an initial period of two weeks after letters were sent before beginning field work on private properties, to allow time for responses to be received by the County.

A web-based map was developed by the project team for County staff to use in recording permission responses and kept up-to-date as responses were received. Data fields were added to the data for each parcel to capture permission status (Granted, Notify Prior to Accessing, or Denied), comments, and contact name, address, and phone/email information. The map was color-coded to reflect parcel permission status. All information was readily available to field crews through the web map and ArcCollector application.

4.1.5 Field and Desktop Data Collection

The four field teams collected data during the period of March through May 2016. Teams communicated with KCI and County staff as needed to answer questions that arose about BMP data, site access, or other issues. Data were collected using field tablets, by working locally (with daily backups) or by collecting data live, on-line, and saving directly to the server.

In addition to the field assessments, three of the consultant teams (Biohabitats, KCI, and Straughan) conducted desktop reviews of sites that were visited during the Howard County Dry Pond and Extended Detention Pond Retrofits Summary Report (Versar, 2013a) and the Howard County Low Impact Development (LID) Retrofits and Tree Planting Summary Report (Versar, 2013b). Desktop assessments consisted of BMP Conversion and New BMP sites. Data for desktop assessment sites were entered using the same data system along with field data, based on information available from prior studies and, in a few cases, a brief field visit.

4.1.6 Field Summary Reports

At the conclusion of the field visits, the consultant teams were asked to prepare a field summary report, summarizing field and desktop assessments completed, including the following information:

- Summary of the number of field assessments completed, by type;
- If there were sites that could not be assessed in the field, a summary of primary reasons;
- Comments about data or assumptions made;
- Summary of the number of recommendations made at field sites, with initial field rating of restoration potential (high, medium, or low);
- General comments about the types of recommendations made;
- List of sites reported to Howard County for follow-up because of suspected illicit discharges, safety concerns, or other reasons;
- Other comments/explanations related to data collected; and
- Summary of sites evaluated via desktop assessments.

Consultant team Field Summary Reports are included in Appendix E.

4.1.7 Field Data Quality Assurance/Quality Control

At the completion of the field and desktop assessments, all of the data for a given area were copied from the ESRI ArcGIS Server and sent to each of the consultant teams in the form of a file geodatabase. Each team had an opportunity to make any additions or edits to the geodatabases before they were sent to KCI for Quality Assurance/Quality Control (QA/QC). Once the file geodatabases were received, KCI reviewed each and checked for logical data (e.g., checking for stream bed particle size distributions that do not sum to 100%), use of correct site IDs, matching assessment and recommendation data, and overall completeness. Once the QA/QC process was complete, all of the file geodatabases were merged into a single personal geodatabase that could be used for the prioritization analysis.

4.2 Summary – Patuxent River Watershed Field and Desktop Site Assessments

Table 8, Table 9, and Table 10 present the number of BMP conversion, new BMP, tree planting, stream restoration, and outfall stabilization field and desktop assessments conducted in each watershed. Further details are presented below, organized by BMP type.

Locations of assessments for BMP Conversion, New BMPs, Stream Restoration, Tree Planting, and Outfall Stabilization based on field and desktop assessments are shown in Figure 12 and Figure 13.

BMP Conversion Assessments

All BMP facilities evaluated for conversion potential were existing dry ponds or extended detention dry ponds (Figure 14).

New BMP Assessments

The majority of areas evaluated in Brighton Dam and Rocky Gorge Dam watersheds were schools and small commercial parking lots (Figure 15). The Patuxent River Upper watershed had one new BMP assessment which was an industrial/commercial area with large buildings and parking areas.

Tree Planting Assessments

The majority of areas evaluated in the three watersheds were areas with absent or inadequate riparian buffers (Figure 16) and several tree planting assessments were conducted in riparian areas that were identified while conducting the stream restoration assessments.

Stream Restoration Assessments

Areas of erosion were identified and considered for stream restoration projects (Figure 17).

Outfall Stabilization Assessments

The majority of outfall stabilization assessments were located in the Patuxent River Upper watershed due to its higher density of impervious surfaces and stormwater infrastructure. Outfall sizes ranged from 12 to 36 inches. Photos of typical outfalls assessed are presented in Figure 18.

Table 8. Summary of Assessments in the Brighton Dam watershed

Type	Unit	Field Assessments	Desktop Assessments
BMP Conversion	Number of sites	8	1
New BMP	Number of sites	8	3
Stream Restoration	Stream miles	2.9	
Tree Planting	Number of sites	22	
Outfall Stabilization	Number of sites	4	
	Total Assessments	**42 sites + 2.9 stream miles**	**4 sites**

Table 9. Summary of Assessments in the Rocky Gorge Dam watershed

Type	Unit	Field Assessments	Desktop Assessments
BMP Conversion	Number of sites	2	1
New BMP	Number of sites	1	
Stream Restoration	Stream miles	1.4	
Tree Planting	Number of sites	8	
Outfall Stabilization	Number of sites	0	
	Total Assessments	**11 sites + 1.4 stream miles**	**1 site**

Table 10. Summary of Assessments in the Patuxent River Upper watershed

Type	Unit	Field Assessments	Desktop Assessments
BMP Conversion	Number of sites	3	1
New BMP	Number of sites	1	
Stream Restoration	Stream miles	3.2	
Tree Planting	Number of sites	2	
Outfall Stabilization	Number of sites	9	
	Total Assessments	**15 sites + 3.2 stream miles**	**1 site**

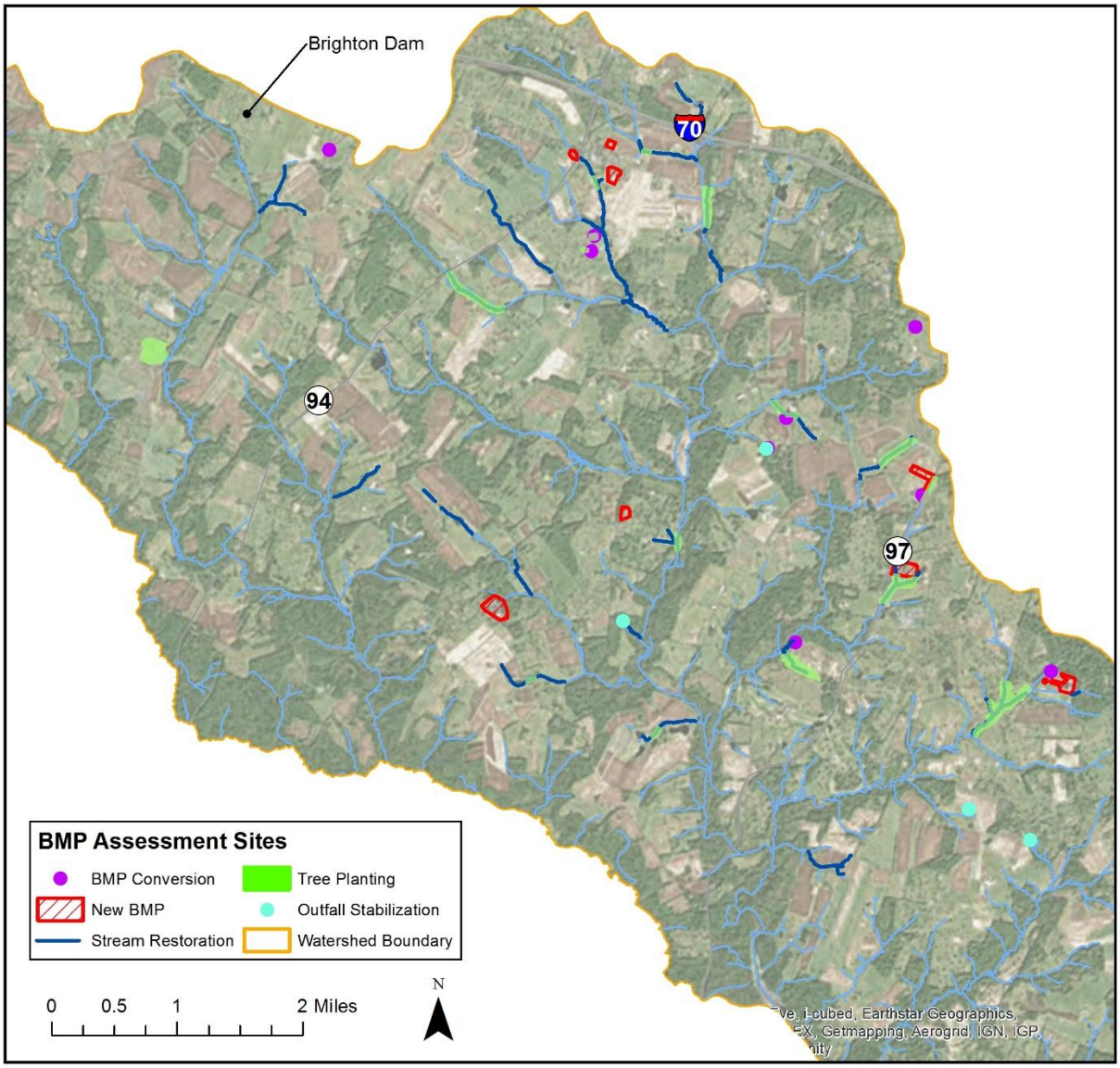

Figure 12. Locations of assessments, northern portion of study area

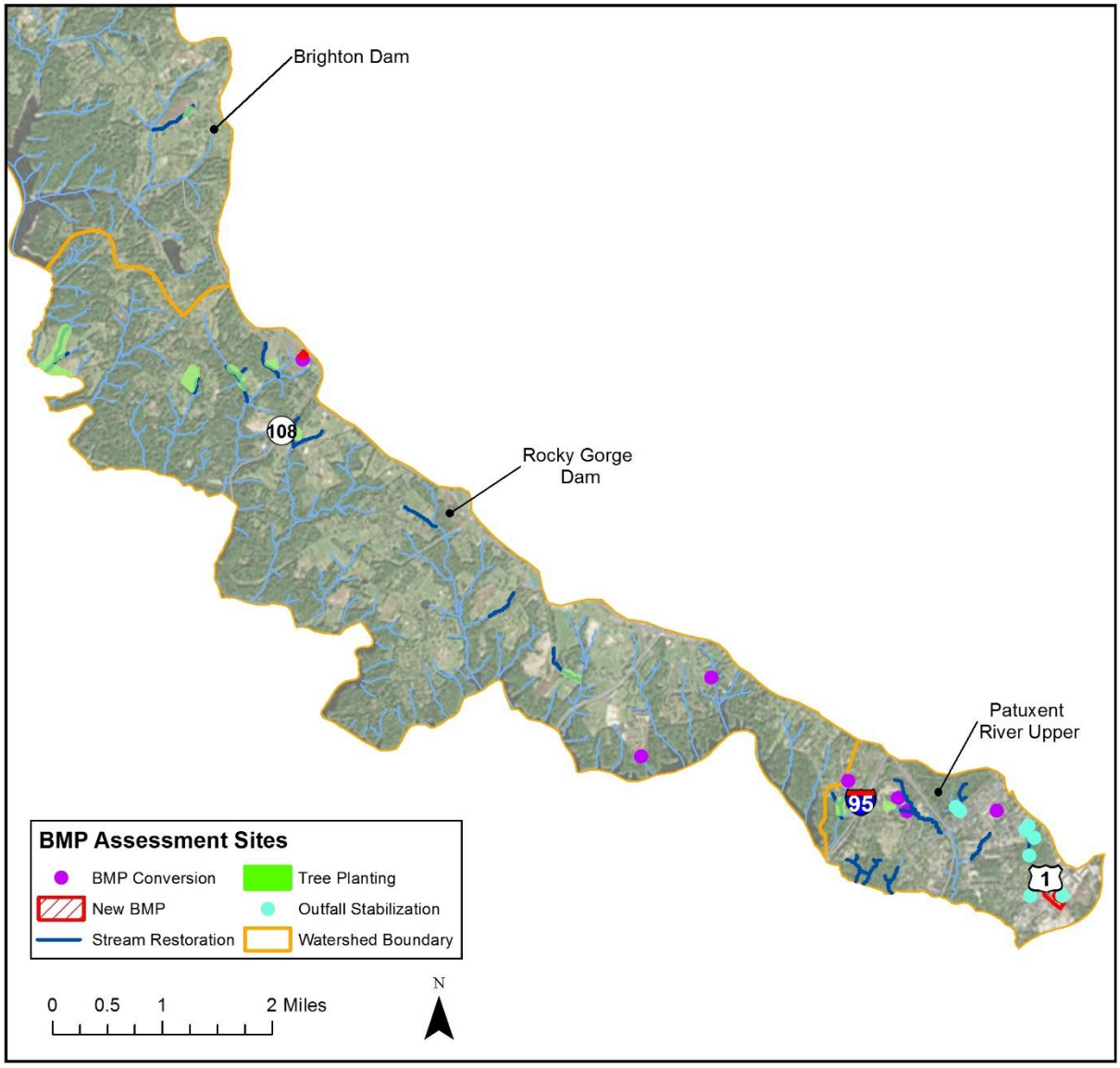

Figure 13. Locations of assessments, southern portion of study area

Figure 14. Typical BMP conversion recommendation sites

Figure 15. Typical new BMP recommendation sites

Figure 16. Typical tree planting recommendation sites

Figure 17. Typical stream restoration recommendation sites

Figure 18. Typical outfall stabilization recommendation sites

4.3 Summary – Patuxent River Watershed Restoration and Retrofit Recommendations

Locations of recommendations for BMP Conversion, New BMPs, Stream Restoration, Tree Planting, and Outfall Stabilization made based on field and desktop assessments are shown in Figure 19 and Figure 20. For all recommendations made, field crews assigned an initial assessment of restoration potential, rating the recommendation as High, Medium, or Low potential, based on field observations. Table 11, Table 12, and Table 13 summarize the total number and restoration potential ratings for all recommendations made within Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds, respectively.

Table 11. Summary of Recommendations in the Brighton Dam watershed

Type	Number of Recommendations	High Potential Sites	Medium Potential Sites	Low Potential Sites
Field Recommendations				
BMP Conversion	8	4	4	0
New BMP	24	7	11	6
Tree Planting	26	15	11	0
Stream Restoration	17	3	9	5
Outfall Stabilization	3	0	2	1
Total Field Recommendations	**78**	**29**	**37**	**12**
Desktop Recommendations				
BMP Conversion	1	1	0	0
New BMP	3	0	3	0
Tree Planting	0	0	0	0
Stream Restoration	0	0	0	0
Outfall Stabilization	0	0	0	0
Total Desktop Recommendations	**4**	**1**	**3**	**0**
Total Recommendations	**82**	**30**	**40**	**12**

Table 12. Summary of Recommendations in the Rocky Gorge Dam watershed

Type	Number of Recommendations	High Potential Sites	Medium Potential Sites	Low Potential Sites
Field Recommendations				
BMP Conversion	2	0	2	0
New BMP	2	0	1	1
Tree Planting	8	6	2	0
Stream Restoration	8	1	4	3
Outfall Stabilization	0	0	0	0
Total Field Recommendations	**20**	**7**	**9**	**4**
Desktop Recommendations				
BMP Conversion	1	0	1	0
New BMP	0	0	0	0
Tree Planting	0	0	0	0
Stream Restoration	0	0	0	0
Outfall Stabilization	0	0	0	0
Total Desktop Recommendations	**1**	**0**	**1**	**0**
Total Recommendations	**21**	**7**	**10**	**4**

Table 13. Summary of Recommendations in the Patuxent River Upper watershed

Type	Number of Recommendations	High Potential Sites	Medium Potential Sites	Low Potential Sites
Field Recommendations				
BMP Conversion	3	0	2	1
New BMP	4	0	0	4
Tree Planting	1	0	1	0
Stream Restoration	5	2	1	2
Outfall Stabilization	6	2	2	2
Total Field Recommendations	**19**	**4**	**6**	**9**
Desktop Recommendations				
BMP Conversion	1	0	0	1
New BMP	0	0	0	0
Tree Planting	0	0	0	0
Stream Restoration	0	0	0	0
Outfall Stabilization	0	0	0	0
Total Desktop Recommendations	**1**	**0**	**0**	**1**
Total Recommendations	**20**	**4**	**6**	**10**

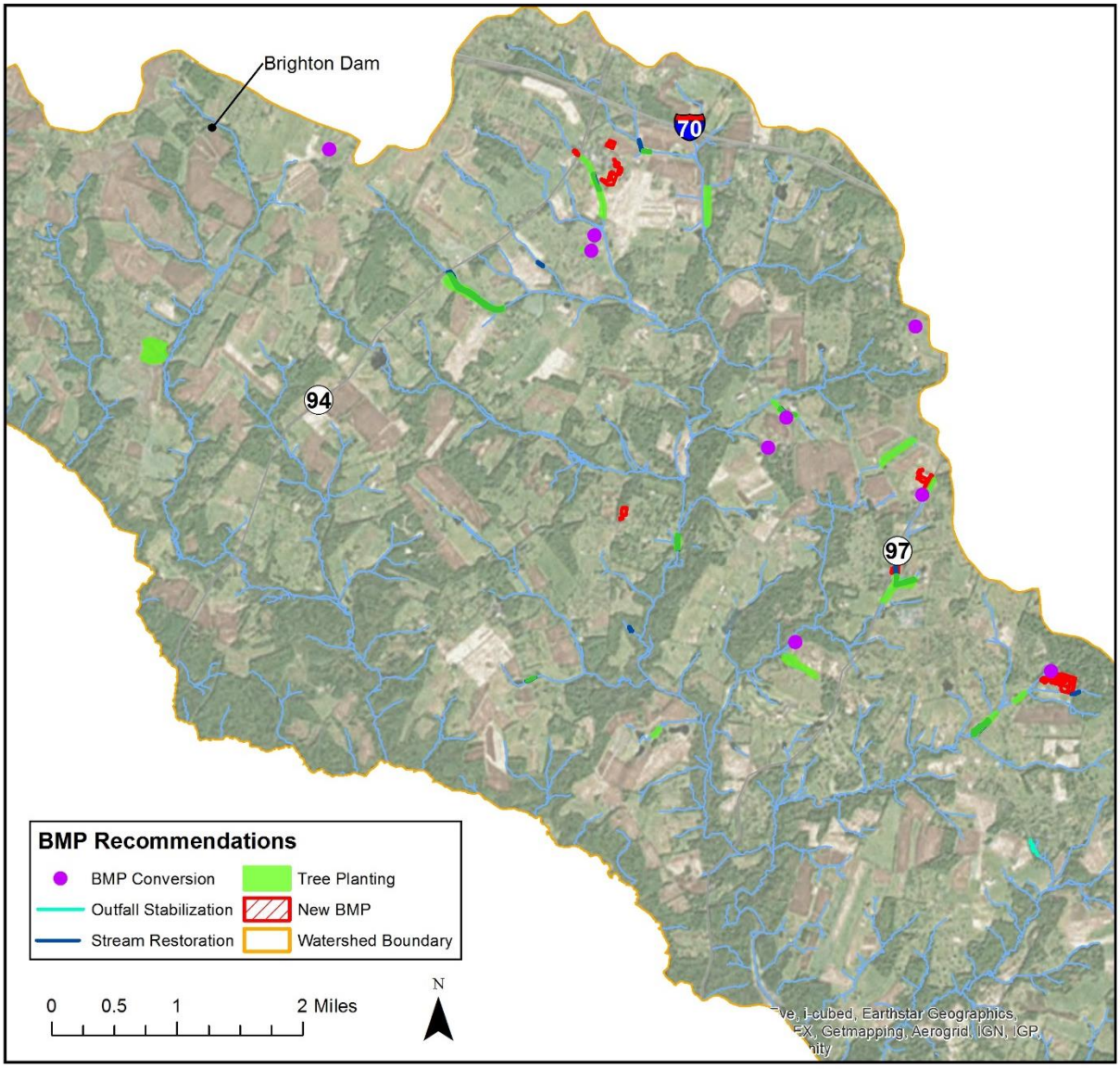

Figure 19. Locations of recommendations, northern portion of study area

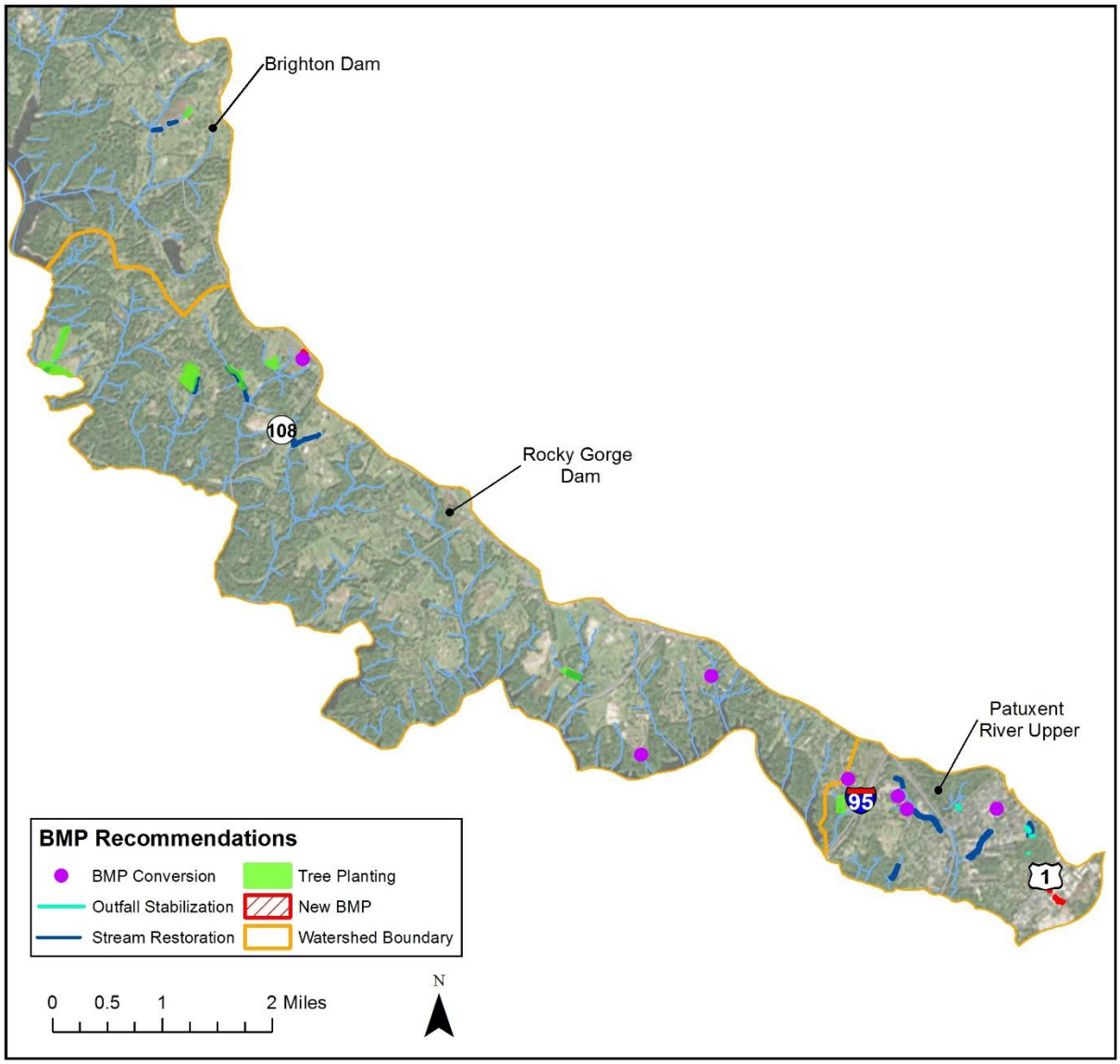

Figure 20. Locations of recommendations, southern portion of study area

4.3.1 Recommendations

Table 11, Table 12, and Table 13 summarize the total number and restoration potential ratings for all recommendations made within Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds, respectively.

Proposed BMP conversion options include extended detention, wet pond, created wetland, and bioretention. Multiple conversion options were identified at the majority of the assessed sites.

The most common new BMP types recommended were bioretention, filtering practice other than bioretention, infiltration, swale, and impervious surface removal. Multiple new BMP facility types were recommended at most of the assessed sites.

Tree planting areas ranged in size from 0.25 to 14 acres. The total area of all proposed tree planting projects in the three watersheds is approximately 130 acres.

In general, stream reaches recommended for restoration contained either one (or multiple) instance(s) of severe bank erosion, consistent minor to moderate bank erosion, or threatened infrastructure (e.g. exposed utility pipes, road embankment, etc.).

SPSC was recommended at majority of the proposed outfall stabilization projects, followed by rip rap stabilization, and drop structure.

4.4 Public Input and Feedback (Additional Sites)

Field assessment results were presented during a set of public meetings that were held by Howard County Stormwater Management Division in June 2016. During the meetings, citizens had the opportunity to review assessment findings and recommendations developed to date, and to bring issues to the attention of the County that could be investigated. Meetings included a County presentation of background information, an overview of the watershed assessment process, and highlights of findings to date. During an interactive discussion period, County and consultant team staff were available to talk with participants about particular sites or concerns. Large map display posters and data tablets were available for viewing field assessment data and recommendations. As a result of the citizen input, additional sites were identified for field assessment.

5. Restoration Project Ranking and Prioritization

5.1 Ranking Methods- Overview

The sites recommended during the assessments were ranked and prioritized to determine the best opportunities for implementation, beginning with concept plan development. During the various field assessments, crews determined which locations were best suited for potential projects, as reported in Section 4. In all, 390 potential projects were identified. The large list of possible projects generated, as well as the multiple goals this watershed assessment aims to address (e.g., impervious surface treatment, pollutant reductions, etc.), makes it challenging to select the best projects for implementation. To address this challenge, a standardized method was developed for comparing, ranking, and prioritizing projects during the previous watershed study, the Little and Middle Patuxent Rivers (Versar, 2016a and 2016b), and this same method was used again with only minor changes. The method relies on a combination of field data, the known costs and benefits of various BMP types, and GIS analyses. The prioritization process combined projects from all subwatersheds within the 2016 study

areas (Brighton Dam, Patapsco Lower North Branch, South Branch Patapsco, Patuxent River Upper, and Rocky Gorge Dam).

Potential projects were ranked in two different ways, the details of which will be discussed in the following sections. Potential projects identified in all watersheds were combined into one prioritization process. First, each potential project was ranked against all other projects of the same type. This will allow Howard County, for example, to target grant funding that must be applied to forest canopy improvement to the areas in the watershed that were identified as having the best tree planting opportunities. This type of ranking also allows for the incorporation of more specialized ranking factors. For example, the length and severity of erosion at an outfall is a useful way to compare stabilization projects, but would not apply to rankings that also include tree planting sites or locations for new BMP installations.

Second, all potential projects were pooled together and every potential project was ranked against each other. In this way, the County can compare the relative costs and benefits of the complete project list. This list can help to determine those projects which have the highest potential value and should be taken to the next design stage, as well as aid in modeling scenarios to determine which combination of projects will help to meet TMDL and other goals, and at what cost.

Ranking factors included the amount of impervious area restoration that would be achieved by the project (Table 14) and other benefits and constraints. There were some factors that were generally applicable across all project types (see details noted as level "A" in Table 15 through Table 19). Level "A" factors were divided into four main categories:

- Permit contribution – how a project will help towards the County meeting the impervious surface restoration requirements in its NPDES MS4 permit, as well as its TMDL goals
- Biological uplift – if a project will provide additional benefits, such as building onto existing green infrastructure or protecting wetlands
- Programmatic benefit – if a project has value beyond its primary functional purpose, such as visible demonstration projects or public education
- Feasibility – estimation of the ease or difficulty of project implementation, including public versus private ownership, site accessibility, or whether a repair is already required at a site providing an opportunity to minimize costs by upgrading the facility during the course of other required construction activities

Each factor was scored according to various criteria (see Tables in Section 5.2 and 5.3). The sum of all the factor scores was used to rank each project, with higher total scores representing higher priority projects. A table of all projects, with scores, is found in Appendix F.

5.2 Impervious Area Credits

For all opportunities identified, the potential benefits in terms of impervious area restoration credit were calculated in accordance with MDE's accounting guidance (MDE, 2014b). For stormwater BMPs, according to MDE criteria the target is treatment of the water quality volume (WQv), typically associated with the 1-inch rainfall event. When the practice is able to provide treatment for the full WQv, full impervious area credit is given based the total impervious area within the BMP drainage area. When less than 1 inch of rainfall is treated, impervious area treatment credit is based on the proportion of the full WQv treated. For alternative BMPs such as tree plantings and stream restoration, impervious acre

equivalents were calculated based on factors provided by MDE (2014b), as summarized in Table 14. Impervious acre credits (and impervious acre equivalents, for alternative BMPs) are used to plan for and estimate progress toward meeting the 20% impervious area restoration requirement in Howard County's MS4 Permit (MDE 2014a).

Table 14. Impervious acre credits for alternative BMPs (from MDE, 2014b)

BMP	Notes	Impervious Acre Equivalent
Reforestation on Pervious Urban	Survival rate of 100 trees/acre or greater; at least 50% of trees have two-inch diameter or greater (4.5 feet above ground).	0.38 acre credit / acre reforested
Impervious Urban to Pervious	Remove pavement and provide vegetative cover for 95% of area.	0.75 acre credit / acre revegetated
Impervious Urban to Forest	Survival rate of 100 trees/acre or greater; at least 50% of trees have two-inch diameter or greater (4.5 feet above ground).	1.00 acre credit / acre reforested
Regenerative Step Pool Storm Conveyance (SPSC)	Located in dry or ephemeral channels; impervious area credit is based on runoff depth treated. When less than 1 inch of rainfall is treated, a proportion of credit is taken.	1.00 acre credit / impervious acre treated, based on treating 1 inch of rainfall.
Stream Restoration	Planning level estimate	0.01 acre credit / linear foot restored
Outfall Stabilization	Stabilization or repair of localized areas of erosion below a storm drain outfall; max credit is two acres per project (200 ft of stabilization).	0.01 acre credit / linear foot restored

5.3 Ranking and Prioritization Within Project Types

5.3.1 BMP Conversion and New BMP

The similar nature of these two project categories led to them sharing a set of ranking criteria (Table 15), though they were ranked separately. Prior to scoring and ranking, some projects were eliminated from the candidate pool. Pond conversion candidates that seemed to be naturally converting to a wetland facility were not included in the ranking, as it was unlikely that the County would want to disturb an area that was already providing additional water quality benefits. Howard County intends to focus on projects that would have larger-scale benefits, and so new BMP projects that were determined to address less than 2 acres of impervious surface were also removed from the ranking.

Table 15.Ranking factors, criteria, and scoring for BMP conversion and new BMP projects

	Factor	Criteria	Score
A. Factors for all site types			
1. Permit contribution			
1.a.	Acres of impervious treatment	> 10 acres	20
		5-10 acres	15
		1-5 acres	10
		< 1 acre	5
1.b.	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	181-260	10
		101-180	6
		0-100	3
1.c	Cost per acre of impervious treatment	< $50,000	10
		$50,000 - $100,000	8
		$100,000 - $200,000	5
		> $200,000	2
2. Biological uplift			
2.a	BMP in a subwatershed with 45-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0
2.b	BMP is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	5
		No	0
3. Programmatic benefit			
3.a	Site has educational value and/or is visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3
4. Feasibility			
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	10
		Some	6
		Many	3
4.c	Adverse impacts to nearby trees	Minimal	10
		Moderate	6
		Significant	3
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Pond/infrastructure already in need of repair	Yes	15
4.f	Field assessment – high potential for restoration/retrofit	Yes	5

5.3.2 Tree Planting

In the case of tree plantings, there were a few minor variations from the standard factor scoring. In the case of structural and pond BMPs, there are many different types, allowing for a wide range of pollutant reduction efficiencies per drainage acre and costs per unit treatment across different projects. In the case of tree planting projects, these values would be the same across all projects; for this reason factors 1.b and 1.c were not scored (Table 16). Additionally, for tree planting projects, where the impact to surrounding trees would not be a concern, the level of site preparation required for planting was substituted as a factor (see 4.c in Table 16).

Table 16.Ranking factors, criteria, and scoring for tree planting projects

	Factor	Criteria	Score
A. Factors for all site types			
1. Permit contribution			
1.a.	Impervious Acre Equivalent	> 2 acres	20
		0.75 - 2 acres	15
		0.38 – 0.75 acres	10
		< 0.38 acres	5
1.b.	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	N/A – same for all sites	
1.c	Cost per acre of impervious treatment	N/A – same for all sites	
2. Biological uplift			
2.a	Planting in a subwatershed with 45-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0
2.b	Planting is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	10
		No	0
2.c	Planting is within 100 feet of wetlands	Yes	5
		No	0
3. Programmatic benefit			
3.a	Site has educational value and/or is visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3
4. Feasibility			
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	10
		Some	6
		Many	3
4.c	Site preparation required before planting	None	10
		Minimal	8
		Moderate	5
		Extensive	2

	Factor	Criteria	Score
A. Factors for all site types			
1. Permit contribution			
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Infrastructure in need of repair	N/A	
4.f	Field assessment – high potential for restoration/retrofit	Yes	5

5.3.3 Outfall Stabilization

Outfall stabilization projects, for the purposes of ranking, were divided into broad categories: traditional stabilizations (e.g., riprap) and step pool stormwater conveyances (SPSC, or regenerative stormwater conveyances, RSC). These two methods of stabilization vary greatly from one another in both cost and benefit and were thus used to help differentiate the projects in scoring (Table 17). Beyond the standard level "A" ranking factors, an additional level "B" factor was included, in order to characterize the length and severity of erosion each project would address.

Table 17. Ranking factors, criteria, and scoring for outfall stabilization projects

	Factor	Criteria	Score
A. Factors for all site types			
1. Permit contribution			
1.a.	Impervious Acre Equivalent	1.5 - 2 acres	20
		1 – 1.5 acres	15
		0.5 - 1 acres	10
		< 0.5 acres	5
1.b.	Pollutant load reduction factor (Note: standard outfall stabilizations receive no pollution reduction credits)	SPSC	10
		All other types	0
1.c	Cost per acre of impervious treatment (Note: Riprap is the less expensive option and receives more points)	Riprap	10
		SPSC	3
		All other types	0
2. Biological uplift			
2.a	Stabilization in a subwatershed with 45%-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0
2.b	Stabilization is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	5
		No	0
2.c	Stabilization is within 100 feet of wetlands	Yes	5
		No	0
3. Programmatic benefit			
3.a	Site has educational value/visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3
4. Feasibility			

	Factor	Criteria	Score
A. Factors for all site types			
1. Permit contribution			
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	10
		Some	6
		Many	3
4.c	Adverse impacts to nearby trees	Minimal	10
		Moderate	6
		Significant	3
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Outfall/infrastructure already in need of repair	Yes	15
4.f	Field assessment – high potential for restoration/retrofit	Yes	5
B. Erosion factor			
1	Length and severity of erosion (Length of erosion in feet x erosion severity rating)	> 1,000	15
		500 – 1,000	10
		< 500	5

5.3.4 Stream Restoration

As noted for the tree planting project ranking, pollutant reduction efficiencies and costs per unit treatment are the same among all stream restoration projects, and therefore 1.b and 1.c were not scored (Table 18). Beyond the standard level "A" ranking factors, two additional levels of factors were incorporated into the stream restoration prioritization. A level "B" factor was included, similar to that used for the outfall stabilization ranking, which characterizes the length and severity of erosion each project would be able to address. Three level "C" factors were also included, which address factors unique to streams, such as habitat quality and other problems identified during stream corridor assessments.

Table 18. Ranking factors, criteria, and scoring for stream restoration projects

	Factor	Criteria	Score
A. Factors for all site types			
1. Permit contribution			
1.a.	Impervious Acre Equivalent	> 9 acres	20
		6 – 9 acres	15
		3 – 6 acres	10
		< 3 acres	5
1.b.	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	N/A – same for all sites	
1.c	Cost per acre of impervious treatment	N/A – same for all sites	

	Factor	Criteria	Score
A. Factors for all site types			
1. Permit contribution			
2. Biological uplift			
2.a	Restoration in a subwatershed with 45%-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0
2.b	Restoration is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	5
		No	0
2.c	Restoration is within 100 feet of wetlands	Yes	5
		No	0
3. Programmatic benefit			
3.a	Site has educational value/visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3
4. Feasibility			
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	5
		Some	3
		Many	1
4.c	Adverse impacts to nearby trees	Minimal	10
		Moderate	6
		Significant	3
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Already in need of repair	N/A	
4.f	Field assessment – high potential for restoration/retrofit	Yes	5
B. Erosion factor			
1	Length and severity of erosion (Length of erosion in feet x erosion severity rating)	>8,400	15
		4,200-8,400	10
		<4,200	5
C. Stream condition factors			
1	Average BEHI score (length-weighted) along reach	46 - 50	10
		40 - 45	8
		30 - 39	6
		20 - 29	4
		< 20	2
2	Average Habitat Assessment score (length-weighted) within a reach rated site as non-supporting or only partially supporting aquatic biota	Yes	5
3	Number of other problems along reach (exposed	Other problems > 2	10

	Factor	Criteria	Score
A.	**Factors for all site types**		
1.	*Permit contribution*		
	pipes, eroded pipe outfalls, unusual conditions, etc.)		

5.4 Ranking and Prioritization across All Project Types

To develop a fair comparison of all projects, factors were limited to those that were common to all project types (level "A"), as shown in Table 19. Due to minor variations in the number of factors used for the different project types (e.g., factor 4.e, which determines if repairs are already recommended at an existing facility, only applied to outfalls and BMP conversions) the sum of individual scores for categories 2 through 4 were converted to a proportion so that each project was judged based on highest possible score for its own project type. After looking at the final ranked list of all projects, the highest ranking projects were selected based on the goals established in the Howard County Countywide Implementation Strategy for each watershed.

Table 19. Ranking factors, criteria, and scoring used for ranking all projects and selecting project concept plans.

	Factor	Criteria	Score
A.	**Factors for all site types**		
1.	*Permit contribution*		
1.a.	Acres of impervious treatment/ Impervious Acre Equivalent	> 10 acres	10
		5 – 10 acres	8
		3 – 5 acres	5
		1 – 3 acres	4
		< 1 acre	2
1.b.	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	201 - 260	10
		151 - 200	6
		1 - 150	3
		0	0
1.c	Cost per acre of impervious treatment	< $50,000	10
		$50,000 - $100,000	8
		$100,000 - $200,000	5
		> $200,000	2
2.	*Biological uplift*		
3.	*Programmatic benefit*		
4.	*Feasibility*		
2.a – c 3.a – c 4.a – f	Sum of scores, as a proportion of total possible points (Note: Total possible points is dependent of type of site	> 0.8	10
		0.6 – 0.8	8
		0.4 – 0.6	6
		0.2 – 0.4	4
		0.01 – 0.2	2
		0	0

5.5 Concept Plans

After the County approved the results of the ranking, a four-page concept plan was developed for each of the highest ranked projects (Table 20) with the same template used for the concept plans for the Little and Middle Patuxent River watershed assessments (Versar, 2016a and 2016b). In the process of developing concepts, a few sites were identified as not feasible projects and concepts for those projects were not completed. A total of 35 concepts were completed. These concept plans include:

- Location information (including a site locator map),
- Existing site conditions (including photos),
- Details of the proposed project (including a concept design drawing),
- Implementation information, such as utility constraints and other nearby projects,
- Potential impervious treatment and pollutant reduction credits, and
- Cost estimate.

Each concept plan provides a complete picture of the potential project, including costs and benefits. They may be used by the County to communicate with the public about a particular project, to apply for a grant for funds to move forward with project implementation, or to aid in the allocation of funds during the County's budget process. The complete set of concept plans is available in Appendix G.

Table 20. Number of projects, by type, developed for concept plans in Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds

Project Type	Number of Concept Plans Developed		
	Brighton Dam	Rocky Gorge Dam	Patuxent River Upper
BMP Conversion	4		2
New BMP	7		1
Tree Planting	1	2	
Outfall Stabilization	1		3
Stream Restoration	6	4	4
Total	**19**	**6**	**10**

6. Pollutant Load Modeling and Impervious Restoration

Potential pollutant load reductions and impervious surface credits were calculated for the stormwater projects for which concept plans were developed. The calculations are based on the level of design and analysis completed, which at this stage is a concept design. Load reduction and impervious credit results for each project will likely change as the projects move through full design and construction.

6.1 Modeling Approach

6.1.1 Pollutant Load Reductions

Pollutant load reductions for planned stormwater projects (i.e., new BMPs and BMP conversions) were calculated using revised removal rate curve equations for runoff reduction (RR) and stormwater treatment (ST) practices prepared by Chesapeake Stormwater Network (Schueler and Lane, 2015). Reductions are calculated based on rainfall treatment, whether noted in project concepts or as an assumption of 1-inch treatment, and removal efficiencies per RR and ST practice (Table 21). Following

MDE guidelines, additional credit is given when the rainfall depth treated exceeds 1 inch, with a maximum of 2.6 inches credited (MDE, 2014b).

To determine the water quality volume (WQv) required at each retrofit site, procedures from MDE 2000 Maryland Stormwater Design Manual were used including the following equation:

Load reductions for planned outfall stabilization projects with the use of SPSC are also calculated using ST practice removal rate reductions based on the rainfall treatment of each site. Planned outfall stabilization projects without SPSC are not credited with load reductions.

Table 21. Runoff Reduction and Stormwater Treatment Practices Removal Rate Reductions

Practice	Rainfall Treatment	Nitrogen Reduction	Phosphorus Reduction	Sediment Reduction
Runoff Reduction (RR)	1”	60%	70%	75%
Stormwater Treatment (ST)	1”	35%	55%	70%

Nitrogen, phosphorus, and sediment load reductions from planned tree planting and stream restoration projects were calculated with estimated removal efficiencies per acre and pounds reduced per linear foot, respectively, from *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2014b; Table 22).

To claim the tree planting credit, a survival of 100 trees per acre or greater is necessary with at least 50% of the trees having a diameter at breast height (DBH) of 2 inches or greater (DNR, 2009).

It is noted that the proposed stream restoration projects use MDE’s revised interim reduction rates for planning purposes; however selected and implemented projects will ultimately use the Chesapeake Bay Program’s (CBP) methods to calculate pollutant removal. The CBP Expert Panel to Define Removal Rates for Individual Stream Restoration Projects (Schueler and Stack, 2014) has defined these rates, which are acceptable for watershed planning purposes (for further details, see Section 6.7). However, recognizing that every stream restoration project is unique with respect to its design, stream order, landscape position and function, the Panel developed four protocols for determining pollutant reduction credits for individual projects, once site-specific design details are known. These protocols are as follows (from Schueler and Stack, 2014):

- Protocol 1: Credit for Prevented Sediment during Storm Flow. This protocol provides an annual mass nutrient and sediment reduction credit for qualifying stream restoration practices that prevent channel or bank erosion that would otherwise be delivered downstream from an actively enlarging or incising urban stream.
- Protocol 2: Credit for Instream and Riparian Nutrient Processing during Base Flow. This protocol provides an annual mass nitrogen reduction credit for qualifying projects that include design features to promote denitrification during base flow within the stream channel through hyporheic exchange within the riparian corridor.
- Protocol 3: Credit for Floodplain Reconnection Volume. This protocol provides an annual mass sediment and nutrient reduction credit for qualifying projects that reconnect stream channels to their floodplain over a wide range of storm events.

- Protocol 4: Credit for Dry Channel Regenerative Stormwater Conveyance (RSC) as an Upland Stormwater Retrofit. This protocol provides an annual nutrient and sediment reduction rate for the contributing drainage area to a qualifying dry channel RSC project. The rate is determined by the degree of stormwater treatment provided in the upland area using the retrofit rate adjustor curves developed by the Stormwater Retrofit Expert Panel.

An individual stream restoration project may qualify for credit under one or more of the protocols, depending on its design and overall restoration approach.

Table 22. Efficiencies and Load Reductions for Tree Planting and Stream Restoration Projects

BMP	Unit	Nitrogen Reduction	Phosphorus Reduction	Sediment Reduction
Reforestation on Pervious Urban	Efficiency per acre	66%	77%	57%
Stream Restoration	Lbs Reduced/Linear ft	0.075	0.068	45

6.1.2 Impervious Restoration

Impervious acre equivalences from *Accounting for Stormwater Wasteload Allocations and Impervious Ares Treated* (MDE, 2014b) were used to calculate impervious credit from planned projects. Impervious acre equivalences, by project type, are presented in Table 23, below. Appendix H includes pollutant load reductions and impervious credit for each concept plan potential project.

Table 23. Impervious Acre Equivalent for Structural and Non-Structural BMPs

BMP	Treatment Unit	Impervious Acre Equivalent*
New BMPs	WQv (provided)/WQv (required)	1.00
BMP Conversion	WQv (provided)/WQv (required)	1.00
Outfall Stabilization	WQv (provided)/WQv (required)	0.01
Step Pool Storm Conveyance (SPSC)	WQv (provided)/WQv (required)	1.00
Stream Restoration	Linear foot	0.01
Tree Plantings	Acres planted	0.38

*Assuming full 1-inch rainfall treatment, full WQv is provided. Acres of impervious in BMP drainage area is multiplied by the equivalent acres to determine credited acres

6.2 Summary of Pollutant Loading Reductions and Impervious Restoration

Nitrogen, phosphorus, and sediment load reductions and impervious credit for concept plan potential projects within the Brighton Dam, Patuxent River Upper, and Rocky Gorge Dam watersheds are presented in Table 24.

Table 24. Pollutant Load Reductions and Impervious Credit

	Number of Projects	Impervious Credit	Estimated Load Reductions		
			TN-EOS lbs	TP-EOS lbs	TSS-EOS lbs
Brighton Dam	19	84	1,055	425	290,387
BMP Conversion	4	20	491	36	31,228
New BMP	7	3	39	4	2,992
Stream Restoration	6	56	417	378	250,425
Tree Planting	1	1	24	1	379
Outfall Stabilization - SPSC	1	3	84	6	5,363
Patuxent River Upper	10	70	572	354	231,215
BMP Conversion	2	14	140	16	8,630
New BMP	1	2	25	3	1,337
Stream Restoration	4	49	364	330	218,250
Outfall Stabilization - SPSC	3	6	43	5	2,998
Rocky Gorge Dam	6	46	411	274	182,811
Stream Restoration	4	40	298	270	178,830
Tree Planting	2	7	113	4	3,981
Total	**35**	**200**	**2,038**	**1,053**	**704,413**

6.3 Summary of Cost Estimates

Estimated total cost of concept plan potential projects within the Brighton Dam, Patuxent River Upper, and Rocky Gorge Dam watersheds are presented in Table 25. The County's restoration plan, Countywide Implementation Strategy (KCI, 2017b), presents the cost of the projects selected for implementation based on the goals outlined in the plan.

Table 25. Estimated Total Cost of Concept Plan Projects

	Number of Projects	Total Cost
Brighton Dam	19	$10,290,909
BMP Conversion	4	$2,444,662
New BMP	7	$1,870,083
Stream Restoration	6	$5,400,005
Tree Planting	1	$162,760
Outfall Stabilization - SPSC	1	$413,400
Patuxent River Upper	10	$7,637,156
BMP Conversion	2	$1,414,563
New BMP	1	$413,543
Stream Restoration	4	$4,137,250
Outfall Stabilization - SPSC	3	$1,671,800

	Number of Projects	Total Cost
Rocky Gorge Dam	6	$5,150,197
Stream Restoration	4	$4,408,677
Tree Planting	2	$741,520
Total	**35**	**$23,078,263**

6.4 Proposed Implementation Timeframe

Project schedules and implementation milestones are discussed in detail in Section 7 Implementation Schedule and Milestones of the County's restoration plan, Countywide Implementation Strategy (KCI, 2017b).

6.5 Conclusion

Howard County is required to conduct watershed assessments for each watershed within the County under the MS4 permit (Permit Number 11-DP-3318, MD0068322, issued December 18, 2014) to identify specific restoration opportunities to provide greater treatment of stormwater runoff from impervious areas and to reduce pollutant loads associated with urban runoff. The Little and Middle Patuxent watershed assessments were completed in 2015, and the remaining watersheds, including Brighton Dam, Rocky Gorge Dam, and Patuxent River Upper watersheds summarized in this report, and South Branch Patapsco and Patapsco Lower North Branch (KCI, 2017a) have been completed, thus satisfying the permit requirement.

The watershed assessments evaluate current conditions and recommend watershed restoration opportunities. Implementation of these projects will assist the County in meeting its 20% impervious restoration goal by December 2019 and Total Maximum Daily Load (TMDL) targets established for phosphorus and sediment in the Patuxent River watersheds.

The results of the assessment support the completion of Howard County's Countywide Implementation Strategy (CIS) (KCI, 2017b) being completed concurrently with this Patuxent River assessment. The CIS presents the County's overall plan to meet its regulatory impervious restoration and TMDL goals, The CIS includes the practices outlined in this assessment, in addition to other programs designed to treat the subject pollutants including street sweeping, septic programs, and educational activities. Restoration targets, current progress, planned milestones, cost estimates, and tracking and evaluation mechanisms are all detailed in the CIS.

The County will continue to evaluate implementation progress, costs, and program success on an on-going basis with reporting to MDE on at least an annual basis on NPDES and TMDL compliance with the County's annual NPDES report.

7. References

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APPENDIX A: INVENTORY OF GIS DATA

Analysis data sets:

Data Set	Date	Data Source	File Name
8-digit watershed	2005	MDE	md8digit18may2005aggregated.shp
Current aerial photography	Unknown	ESRI Basemap	N/A
Impervious areas	2015	County	HoCo_Impervious
Land use	2010	Maryland Department of Planning	MDP_LULC_2010.shp
Property	2016	County	Property.shp
Zoning	2016	County	Zoning.shp
Forest Conservation areas	2016, assumed	County	ForestConservationEasement.shp
Natural resource areas	2016, assumed	County	NaturalResourceOpenSpace.shp
County parks	2016, assumed	County	CountyParks.shp
Storm drain pipes	2015	County	final_pipes.shp
Storm drain inlets	2015	County	final_inlet.shp
Storm drain oulets	2015	County	final_outlet.shp
Public water system	2015	County	Water_lines_master.shp
Public sewer system	2015	County	Sewer_lines_master.shp
Streams		County	Stream_CenterlineLine.shp
Drainage complaints (frequent flooding)	2016	County	SWM Complaints.mdb
MS4 Boundary	2016	Updates from McCormick Taylor	MD_NPDES_regulated_urban_stormwater_source_sectors_updated_v10.shp, Impervious_2016.gdb
Howard County biological monitoring program data	2016	Versar	HoCoCountywideSites_sp83m.shp
MBSS IBI Scores	2016	MD DNR	MBSSCSV.xls, WadersCSV.xls
2ft Contour lines	2011	County	Multiple tiles: contours_tile_1(-50).shp
BMPs	2015	KCI	TableB_points
Potential BMP and Stream restoration projects	2015	County	FY16 Projects Query.xls
DNR Wetlands Inventory	2005	MD DNR	DNR_wetlands.shp
Green Infrastructure	2012	Howard's GI Plan	Cooridors_All_Merged.shp
Tier II Streams and Catchments	2012	MDE	Stream_TierII.shp TierII_Catchments_2012.shp
Howard County IDDE Geodatabases	2000-2010, 2011-2014	County	IDDE2000thru2010.shp IDDE2011thru2014.shp
Road Centerlines	2016	County	centerln.shp

APPENDIX B: DESCRIPTIONS OF BMP TYPES

Appendix B: Stormwater Treatment BMP Definitions

BMP definitions are taken from the Maryland Assessment and Scenario Tool (MAST) guidance as provided on mastonline.org and edited, with the exception of regenerative step pool conveyance (RSC) which is provided by Anne Arundel County (2012) and outfall stabilization, described in the August 2014 MDE guidance entitled Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated. Names in "()" next to BMP types are the MAST BMP Short Name. Not all BMPs considered here have been recognized by MAST and therefore may not have an official MAST-designated Short Name.

Wet Ponds and Wetlands (WetPondWetland)

A wet pond and stormwater treatment wetland are water impoundment structures that intercept stormwater runoff then release it to the receiving stream or stormsewer system at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached nutrients/toxics. Until recently, these practices were designed specifically to meet water quantity, not water quality objectives. There is little or no vegetation living within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal.

Bioretention

Bioretention/raingardens - A/B soils, no underdrain (BioRetNoUDAB)

An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These excavated, planted areas are installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components consisting of the engineered media, topsoil, mulch, and vegetation, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP has no underdrain and is in A or B soil which assumes that all water will infiltrate into the subsoils.

Bioretention/raingardens - A/B soils, underdrain (BioRetUDAB)

An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP has an underdrain and is in A or B soil, in order to more carefully control dewatering of the system.

Bioretention/raingardens - C/D soils, underdrain (BioRetUDCD)

An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP is in C or D soil and has an underdrain in order to more assure dewatering of the system in timely fashion in these poorly draining soils.

Non-Bioretention Filtering Practices

Urban Filtering Practices (Filter)

These are practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity (CEC) achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.

Urban Filter Strip Runoff Reduction (UrbFilterRR)

Urban filter strips are stable areas with vegetated cover on flat or gently sloping land. Runoff entering the filter strip must be in the form of sheet-flow and must enter at a non-erosive rate for the site-specific soil conditions. A 0.4 design ratio of filter strip length to impervious flow length is recommended for runoff reduction urban filter strips. These filter strips allow for infiltration into subsoils and therefore significant pollutant removal compared to Urban Filter Strip Storm Water Treatment.

Urban Filter Strip Storm Water Treatment (UrbFilterST)

Urban filter strips are stable areas with vegetated cover on flat or gently sloping land. Runoff entering the filter strip must be in the form of sheet-flow and must enter at a non-erosive rate for the site-specific soil conditions. A 0.2 design ratio of filter strip length to impervious flow length is recommended for stormwater treatment urban filter strips. These filter strips do not allow for infiltration of subsoils and therefore only allow for reductions in sediment load.

Regenerative Step Pool Storm Conveyance (SPSC)

Regenerative Step Pool Storm Conveyance (SPSC) practices developed by Anne Arundel County Department of Public Works, Bureau of Engineering, have been used for retrofitting unstable and degraded stormwater conveyance channels in steep conveyance circumstances. SPSC systems are open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow. These systems safely convey, attenuate, and treat the quality of storm flow. These structures utilize a series of constructed shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/woodchip mix filter bed media. The physical characteristics of the SPSC channel are best characterized by the Rosgen A or B stream classification types, where “bedform occurs as a step/pool, cascading channel which often stores large amounts of sediment in the pools associated with debris dams” (Rosgen, 1996). The pretreatment, recharge, and water quality sizing criteria closely follow the State of Maryland’s criteria for a typical stormwater filtering device. These structures feature surface / subsurface runoff storage seams and an energy dissipation design that is aimed at attenuating the flow to a desired level through energy and hydraulic power equivalency principles.

Vegetated Channels

Vegetated Open Channels - A/B soils, no underdrain (VegOpChanNoUDAB)

Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, and includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils. This BMP has no underdrain, allowing for infiltration into subsoils; however, because the system is within A or B soil infiltration is better than in a similar channel in C or D soils and allows for higher pollutant removal rates.

Vegetated Open Channels - C/D soils, no underdrain (VegOpChanNoUDCD)

Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils. This BMP has no underdrain, allowing for infiltration into subsoils; however, C or D soils have lower infiltration rates and therefore lower pollutant removal rates relative to vegetated open channels in A or B soils.

Bioswale (BioSwale)

With a bioswale the load is reduced because, unlike other open channel designs, there is now treatment through the soil. A bioswale is designed to function as a bioretention area and therefore has much higher pollutant removal rates compared to the vegetated open channels in A/B and C/D soils.

Infiltration Practices

An infiltration practice generally is a depression to form an infiltration basin where sediment is trapped and water infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil (A/B soils). They are not constructed on poor soils, such as C and D soil types. Engineers are required to test the soil before approved to build is issued. To receive credit over the longer term, jurisdictions must conduct yearly inspections to determine if the basin or trench is still infiltrating runoff.

Urban Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain (InfiltWithSV)

A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Sand provides additional surface area for more complete filtration and vegetation provides root system uptake and additional biological activity for more complete pollutant processing.

Urban Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain (Infiltration)

A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Sand or vegetation are not included in these system.

Impervious Surface Reduction (ImpSurRed)

Reducing impervious surfaces to promote infiltration and percolation of runoff storm water by removing pavement and providing vegetative cover for 95% of the area that was previously impervious surface. MDE 2014 guidance offers 0.75 impervious acre equivalent credit for every acre of impervious cover removed and replaced with vegetation.

Urban Stream Restoration (UrbStrmRest)

Stream restoration is a change to the stream corridor that improves the stream ecosystem by restoring the natural hydrology and landscape of a stream, and helps improve habitat and water quality conditions in degraded streams. Credit is provided in the form of 0.01 impervious reduction equivalents of 0.01 acre per linear foot of outfall stabilization.

Urban Tree Planting (UrbanTreePlant)

Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting. Credit given is 0.38 impervious equivalent removed per acre planted with a survival rate of 100 trees/acre or greater and where at least 50% of trees have two-inch diameter or greater when measured at 4.5 ft. above ground level. (MDE 2014)

Urban Forest Buffers (ForestBufUrban)

An urban forest buffer is area of trees at least 35 feet wide on one side of a stream, usually accompanied by trees, shrubs, and other vegetation that is adjacent to a body of water. The riparian area is managed to maintain the integrity of stream channels and shorelines, to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals.

Outfall stabilization

Outfall stabilization or repair of localized areas of erosion below a storm drain outfall will received a maximum credit is 2 acres per project as per MAST. Credit is provided in the form of 0.01 impervious reduction equivalents of 0.01 acre per linear foot of outfall stabilization. No direct pollutant reduction credits are appropriated.

CITATIONS

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MAST 2015. Maryland Assessment and Scenario Tool. http://www.mastonline.org/

MDE 2014. Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated. Guidance for National Pollutant Discharge Elimination System Stormwater Permits. August 2014.

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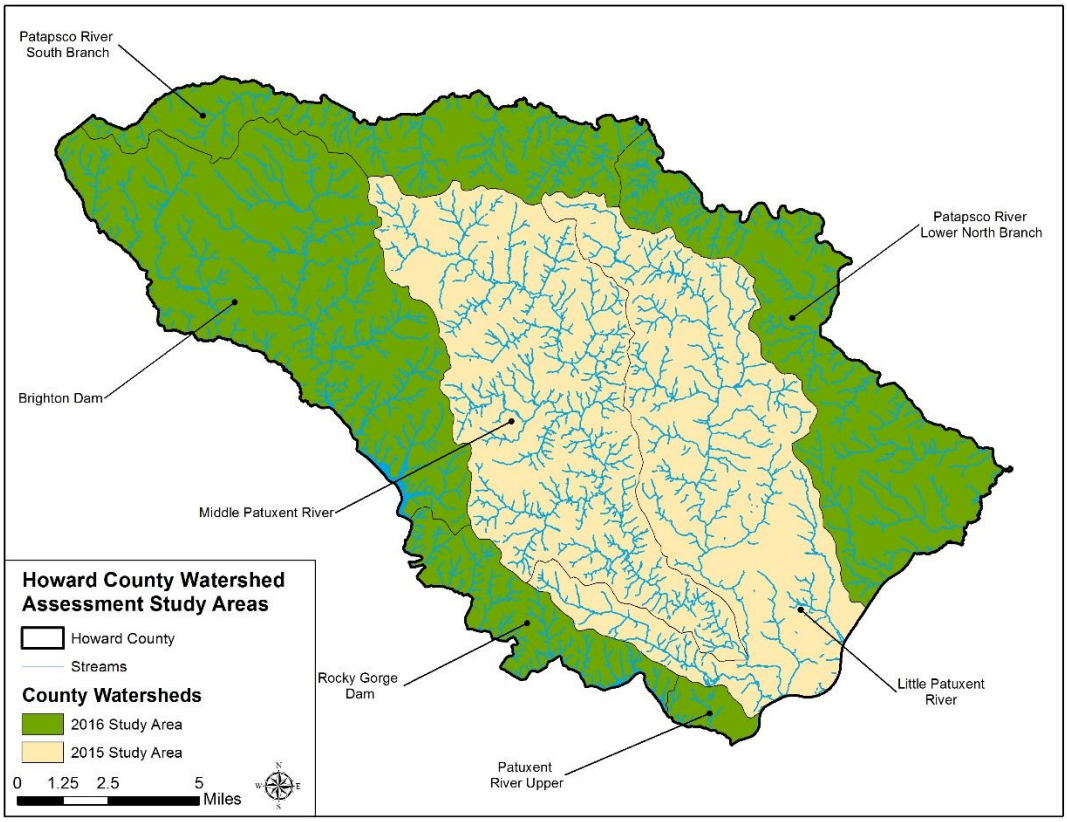
APPENDIX C: FIELD PROTOCOLS AND DATA COLLECTION GUIDE

Field Protocols and Data Collection Guide

Howard County Watershed Assessments 2016

Patapsco River Lower North Branch
Patuxent River Upper
Rocky Gorge Dam
Brighton Dam
Patapsco River South Branch



Prepared for
Howard County Watershed Management Program
Howard County Department of Public Works
Bureau of Environmental Services
Stormwater Management Division

Prepared by
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Sparks, MD 21152

March 29, 2016

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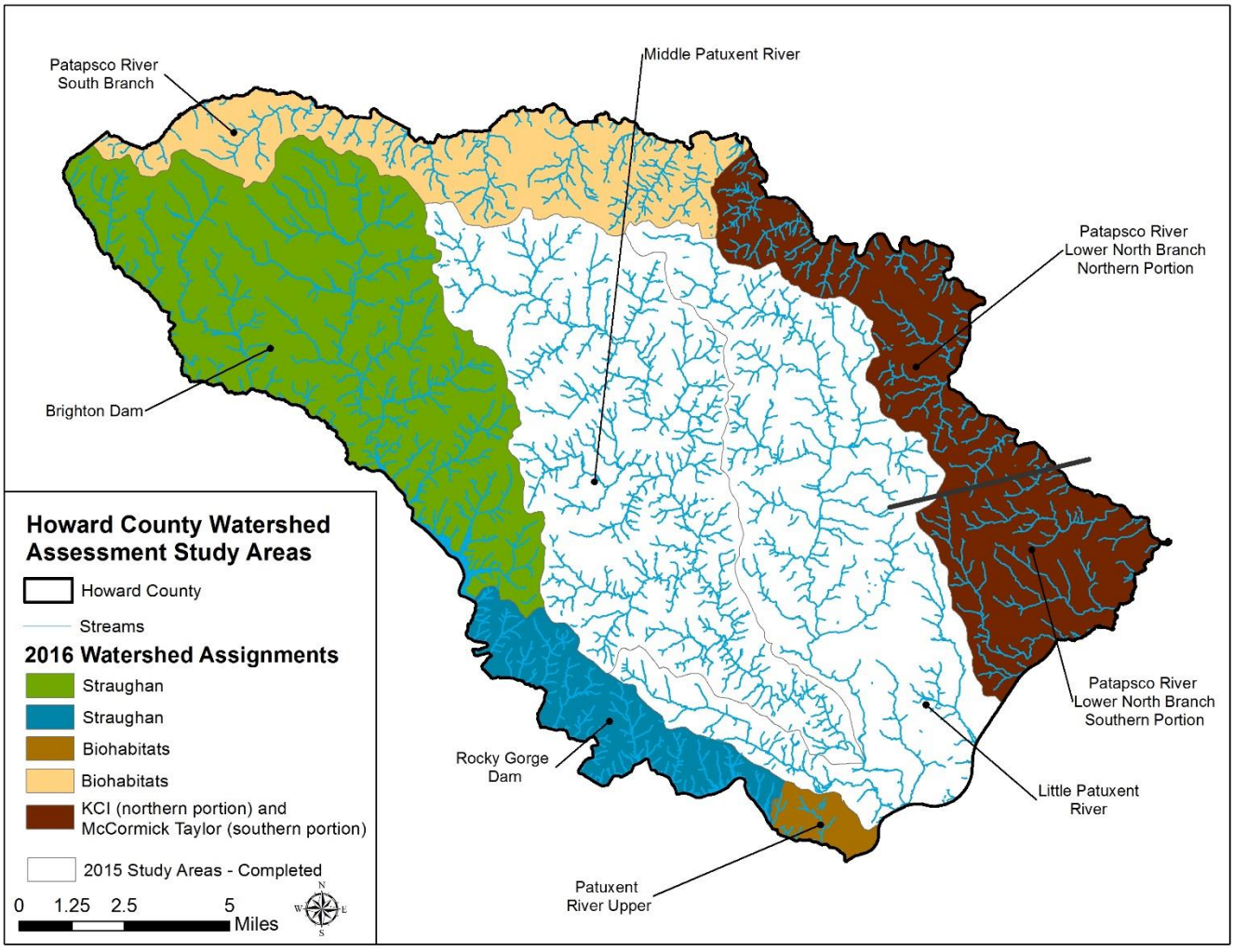
Howard County Watershed Assessments in 2016

Study Areas and Consultant Assignments for Field Assessments

March 29, 2016

Watershed Assessment Study Area	Consultant for Field Assessments
Patapsco River Lower North Branch (LNB)- southern portion	McCormick Taylor
Patapsco River Lower North Branch (LNB)- northern portion	KCI
Patuxent River Upper (PRU)	Biohabitats
Rocky Gorge Dam (RGD)	Straughan
Brighton Dam (BRD)	Straughan
Patapsco River South Branch (SBP)	Biohabitats



Howard County Watershed Assessments Site Naming Conventions

March 29, 2016

Purpose: to name all field sites so they are readily recognizable by their location, site type, and unique identifier.

1. Standard site names

AAA-SS-Fxxx (Example LNB-SR-F501)

AAA = Study Area (which will also point us to which consultant team collected the data, should there be any questions)

- LNB = Patapsco River Lower North Branch
- PRU = Patuxent River Upper
- RGD = Rocky Gorge Dam
- BRD = Brighton Dam
- SBP = Patapsco River South Branch

SS = Site type for the 5 types of opportunities

- BC = BMP Conversion (to upgrade existing stormwater BMP)
- NB = New BMP for currently untreated areas
- TP = Tree Planting
- OF = Outfall Stabilization
- SR = Stream Restoration

F = Field or desktop assessment

- F = Field assessment
- D = Desktop assessment (sites that will be evaluated based on past data)

xxx = 3-digit number that will be unique identifier within each type of opportunity (001, 002, etc.). These will be assigned as described in the following table. To avoid duplication, use the following guidance for any new site names added in the field:

Field Site numbering convention		
Consultant	**Series starting with:**	**Study Area and Site Type (pre-assigned v. added in the field)**
Straughan	101	BRD pre-assigned sites
	151	BRD sites added in the field
Straughan	201	RGD pre-assigned sites
	251	RGD sites added in the field
Biohabitats	301	PRU pre-assigned sites
	351	PRU sites added in the field
Biohabitats	401	SBP pre-assigned sites
	451	SBP sites added in the field
McCormick Taylor	501	LNB pre-assigned sites
	551	LNB sites added in the field
KCI	601	LNB pre-assigned sites
	651	LNB sites added in the field

Desktop Site numbering convention		
Consultant	**Numbers:**	**Study Area and Site Type (pre-assigned v. added in the field)**
Straughan	001-015	ALL Watersheds pre-assigned sites
McCormick Taylor	020-032	ALL Watersheds pre-assigned sites
KCI	040-073	ALL Watersheds pre-assigned sites

2. For specific types of data, there will be additional codes added:

AAA-SS-FxxxL (Example LNB-BC-F505A)

L = Letter for multiple recommendations/options (BMP conversion or new BMP Assessment) or reaches (Stream Restoration Assessment) within a site

- A = First recommendation/option or reach
- B = Second recommendation/option or reach
- C = Third recommendation/option or reach, etc.

2a. For BMP opportunities, there may be a need to keep track of multiple recommendations/options for the same site. Append A, B, C as needed to distinguish separate options.

- Example: LNB-BC-F505 has two options. Call them LNB-BC-F505A and LNB-BC-F505B

2b. For stream reaches, the first reach break along a reach will be named at the downstream end with the letter A. The upstream end will be named with the letter Z.

- Example: For stream reach LNB-SR-F501, the reach break at the downstream end will be called LNB-SR-F501A. A final reach break will be placed at the upstream end of the entire reach and be called LNB-SR-F501Z. No additional data is collected at F501Z.

If conditions vary within the reach, field crew should break the pre-selected stream restoration reach into two or more separate reaches if stream conditions warrant it.

- Example: if LNB-SR-F501 is broken into two reaches, the reach breaks at the bottom end of each will be named LNB-SR-F501A and LNB-SR-F501B. The reach break at the upstream end of Reach B will be marked LNB-SR-F501C, unless this is the final reach break, in which case it will be mark LNB-SR-F501Z.

2c. For stream assessment data, names will include additional digits as follows.

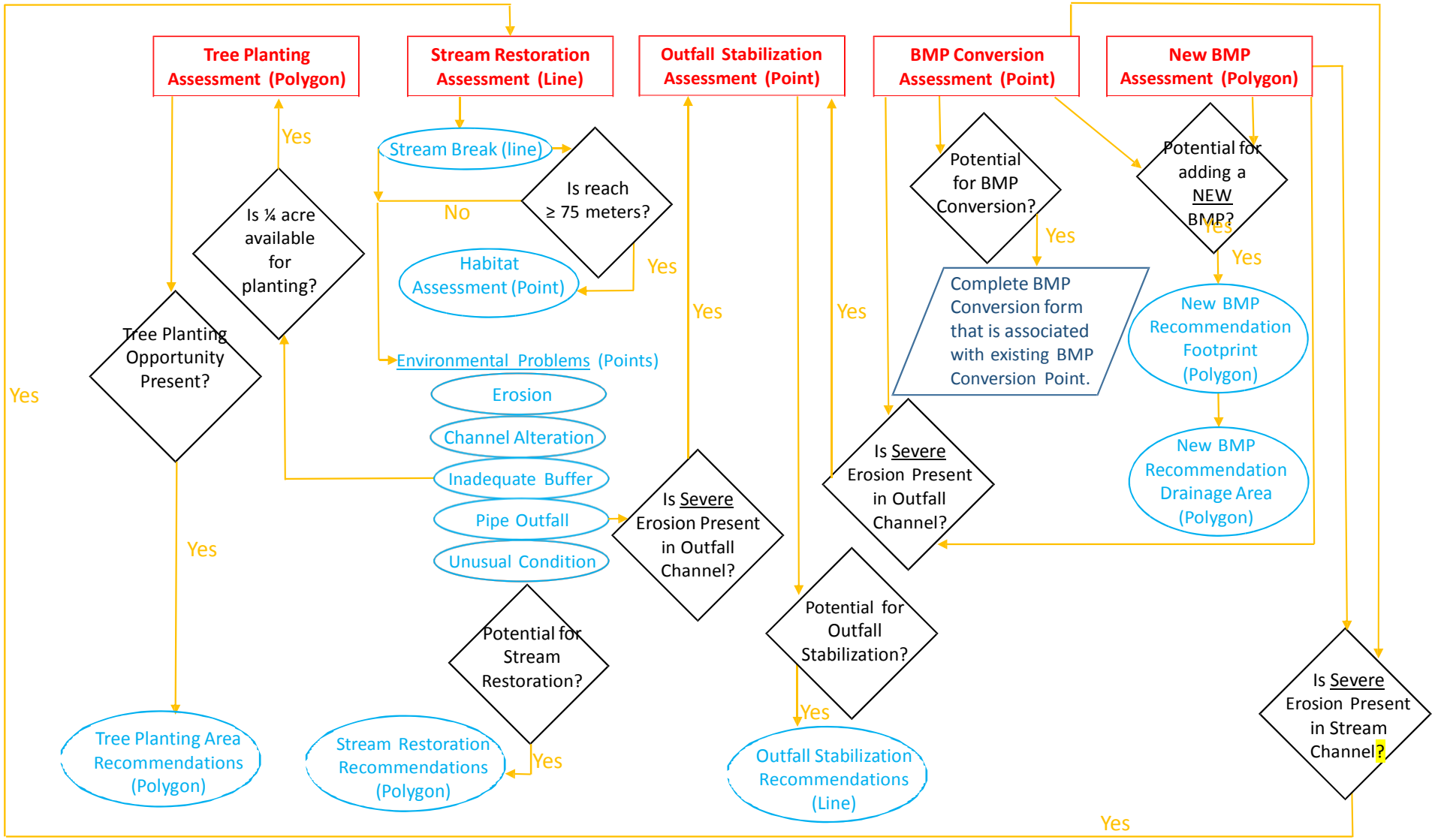
AAA-SS-FxxxL-TTyyy - For example at a stream restoration site (LNB-SR-F501A) with 3 erosion points, the erosion points would be recorded as LNB-SR-F501A-ES001, LNB-SR-F501A-ES002, LNB-SR-F501A-ES003]

TT = site type for specific stream data

- RE = Representative site - Habitat assessment
- ES = Erosion Site point
- CA = Channel Alteration point
- IB = Inadequate Buffer point
- EP = Exposed Pipe point
- UC = Unusual Condition or Comment
- PO = Pipe Outfall point
- XS = representative cross-section data

yyy = 3-digit number that will be unique identifier within each type of specific data (001, 002, etc.)

Howard County Field Assessment Decision Flow Chart



BMP Conversion Assessment

March 29, 2016

General Data Collection Instructions

- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Christine Lowe (cslowe@howardcountymd.gov Office 410-313-0522, or Cell 301-806-3597). Provide location, information about the problem observed, and a photograph.
- Locate site on map layer for BMP Conversion Assessment **(*point*)** and fill in data for the fields below.

Fields - BMP Conversion Assessment *(Point)*

Overall

- Site ID (pre-assigned, unique number. Example: LNB-BC-F501)
- Field Crew [initials]
- Create a site name [This will be considered the common name for the site. Example: name of school, business, or nearest road.]
- Can site be evaluated? (if no, do not fill out other data)
    - Yes
    - No, landowner did not grant access
    - No, fence or other barrier
    - No, BMP does not exist at present
    - No, another reason
- Other reason site cannot be evaluated (describe)
- Can existing BMP be converted? [Answer this question after assessing the site and constraints. Use CONSTRAINTS SECTION BELOW to document constraints.]
    - Yes
    - No
- Notes: Reason BMP cannot be converted

General Site Description – Existing Conditions

- BMP Structure ID of existing pond [pre-filled from GIS data]
- BMP type from database [e.g., Dry Pond or Extended Detention Dry Pond]
- Owner Name [pre-filled from GIS data]
- BMP Address [pre-filled from GIS data]
- Drainage Area of Existing BMP (ac) [pre-filled from GIS data]
- Impervious Area of Existing BMP Drainage Area (ac) [pre-filled from GIS data]
- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Ownership [In most cases, this should be evident in GIS parcel layer.]
    - County School
    - County Parks
    - County – other

    - Private
    - Other
    - Unknown
- Notes, if ownership other
- Existing Pond Type (as YOU see it in field)
    - Dry Pond
    - Wet Pond
    - Other
- Describe type, if Other
- Is pond type same as listed in County database?
    - Yes/no
- Is repair needed?
    - Yes/No
- Woody vegetation within woody free zone?
    - Yes/No
- Other information describing existing pond condition (describe) [Such as need for maintenance, invasive vegetation removal, under construction, etc.]
- Existing Drainage area land use (predominant type)
    - Residential – single family homes <1 ac lots
    - Residential – single family homes > 1 ac lots
    - Townhouses
    - Multi-Family
    - Institutional
    - Industrial (not necessarily related to 02-SW or 12-SW permits)
    - Commercial
    - Transport-Related
    - Park
    - Undeveloped
    - Other
- Other information related to land use type within existing drainage area (describe) [This is a super-hotspot, lots of floatables or pet/goose waste, or other major issue.]

Downstream or Outfall Condition

Note: sites with < 200 feet of erosion below outfall will be considered *outfall channels*. Sites with >200-300 feet of erosion below outfall will be considered for stream restoration and evaluated for *downstream condition*.)

- Condition of outfall channel
    - 0: No erosion
    - 1-3: Minor erosion. Less than 1 foot of eroded banks. Healing may be present.
    - 4-6: Moderate erosion. Eroded banks are 1-2 feet in height. Erosion looks relatively recent.
    - 7-10: Severe Erosion. Eroded banks are greater than 2 feet in height. Erosion typically recent/active. (Fill out Outfall Stabilization Evaluation form)
- Reason Condition of outfall channel could not be inspected
    - Not applicable - discharges directly into MS4
    - Not applicable – discharges directly into large perennial stream
    - Could not inspect outfall [If behind fence etc.]
- Length of outfall channel erosion (ft.)

- Condition of stream channel [extending beyond 200 feet from discharge point]
    - 1-3: Minor erosion. 2-3 feet in eroded bank height, not causing significant stream degradation. Showing signs of healing.
    - 4-6: Moderate erosion. 3-5 feet in eroded bank height. Relatively recent/raw.
    - 7-10: Severe Erosion. 5 ft or greater eroded bank height. Erosion typically recent/active. Obvious instream degradation. If threatening utilities or structures rate 9-10. (Fill in Stream Restoration Assessment Form)
- Reason Condition of stream channel could not be inspected
    - Not applicable [make N/A the default]
    - Too far to warrant inspection
- Length of stream erosion (ft.)
- Notes: Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance

<u>Candidate BMP Constraints</u>

- Property for Sale or Lease?
    - Yes/No
- Type (check all that apply)
    - Slope
    - Utilities
    - Structures
    - Space insufficient
    - Significant impact to trees
    - Specimen tree removal
    - Property Ownership
    - Access
    - Proximity to neighboring properties
    - Other adjacent landowner issues
    - Safety
    - Aesthetics
    - Other
- Other information on BMP project constraints or conflicts (describe)
- Impact to Existing Trees
    - Minimal
    - Moderate
    - Significant
- Ease of access
    - Easy
    - Moderate
    - Difficult
- Conflicts with Existing Utilities – Sewer
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Water
    - Yes

    - No
    - Possible
- Conflicts with Existing Utilities – Gas
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Cable
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Electric
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Electric to Streetlights
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Overhead Wires
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Other
    - Yes
    - No
    - Possible
- Other information on conflicts with existing utilities (describe)

[Whatever additional details you can think of which are relevant to conflicts which cannot be answered by YES or NO]

Potential Permitting Factors

- Dam Safety Permits Necessary [make "not probable" the default] (height of the pond measured from the upstream toe to the top of dam is more than 20 feet, or is a public road)
    - Probable
    - Not probable
- Impacts to Wetlands [make "not probable" the default]
    - Probable
    - Not probable
- Impacts to a Stream [make "not probable" the default]
    - Probable
    - Not probable
- Floodplain Fill [make "not probable" the default] (Will new BMP cause changes to floodplain elevation?)
    - Probable
    - Not probable
- Impacts to Specimen Trees (≥30 inch DBH)
    - Probable
    - Not probable
- Number of Specimen Trees Impacted (number)
- Other permitting or impact factors (describe)

Soils

- Evidence of poor infiltration [clays, fines]

    - Yes/No/Unknown
- Evidence of shallow bedrock
    - Yes/No/Unknown
- Evidence of high water table [gleying, saturation]
    - Yes/No/Unknown
- Notes on soils

Other Project Types

- Is Site a Candidate for Other Restoration Projects?
    - No
    - Yes, BMP conversion
    - Yes, Tree planting
    - Yes, Stream restoration
    - Yes, Outfall stabilization
- Other Types of Projects Appropriate Here (describe)

Recommendations Summary

Proposed BMP Conversion Recommendations

- Proposed Treatment Option within pond boundary (check all that apply)
    - Extended Detention
    - Wet Pond
    - Created Wetland
    - Bioretention
    - Step Pool Conveyance
    - Filtering Practice other than Bioretention
    - Infiltration (not recommended for hotspots)
    - Swale (engineered)
    - Other
- If other type, describe proposed treatment option
- Will new BMP drainage area be the same as existing drainage area?
    - Yes/No
- If no, describe area to be treated by newly converted BMP
- Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance. Give a short narrative of BMP conversion to be done, as would be given on the first page of construction drawings.
- Notes on BMP conversion proposed. [Space for anything more that could not fit above.]
- Initial Feasibility and Construction Considerations (describe)

  Summarize some of the above criteria such as utility conflicts, neighborhood aesthetics consideration, treatment trains, technical complexity such as need for flow splitters etc.
- BMP Conversion Potential [This is a quick evaluation of "convertibility", not the pollutant removal efficiency gains anticipated.]
    - High
    - Medium
    - Low

- Optional: Sketch the proposed BMP conversion and attach sketch as photo. Sketch elements may include existing head available, surface area, minimum depth of treatment, conveyance, inlet, outlet, utility lines / other constraints, flow lines, property lines

New BMP Assessment

March 29, 2016

General Data Collection Instructions

- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Christine Lowe (cslowe@howardcountymd.gov, Office 410-313-0522 or Cell 301-806-3597). Provide location, information about the problem observed, and a photograph.
- Locate site on map layer for New BMP Assessment **(*polygon*)** and fill in data for the fields below.

Fields – New BMP Assessment *(Polygon)*

Overall

- Site ID (pre-assigned, unique number. Example: LNB-NB-F501)
- Field Crew [initials]
- Create a site name [This will be considered the site's common name. Example: name of school, business, or nearest road.]
- Can site be evaluated? (if no, do not fill out other data)
    - Yes
    - No, landowner did not grant access
    - No, fence or other barrier
    - No, another reason
    - Other reason site cannot be evaluated (describe)
- Is a new BMP retrofit possible on this site? Answer this question after assessing the site and constraints. Use CONSTRAINTS SECTION BELOW to document constraints.
    - Yes
    - No, too many constraints

General Site Description – Existing Conditions

- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Site Area - acres [prefilled from GIS]
- Ownership [In most cases, this should be evident in GIS parcel layer]
    - County School
    - County Parks
    - County – other
    - Private
    - Other
    - Unknown
- Notes, if ownership other
- Existing Land Use in Site Vicinity [predominant type]
    - Residential – single family homes <1 ac lots
    - Residential – single family homes > 1 ac lots
    - Townhouses
    - Multi-Family

    - Institutional
    - Industrial (not necessarily related to 02-SW or 12-SW permits)
    - Commercial
    - Transport-Related
    - Park
    - Undeveloped
    - Other
- Additional information about the land use type within existing drainage area (describe)
- Adjacent Land Use (check all that apply)
    - Residential
    - Commercial
    - Institutional
    - Industrial
    - Transport-Related
    - Park
    - Undeveloped
    - Other
- Other information on adjacent land use (describe)
- Is repair/replacement of an existing structure needed? [example: older pipe or parking lot in need of replacement]
    - Yes/No
- Other information describing existing conditions (describe) such as need for maintenance, invasive vegetation removal.

Downstream or Outfall Condition

Note that sites with < 200 feet of erosion below outfall will be considered *outfall channels*. Sites with >200-300 feet of erosion below outfall will be considered for stream restoration and evaluated for *downstream condition*.

- Condition of outfall channel
    - 0: No erosion
    - 1-3: Minor erosion. Less than 1 foot of eroded banks. Healing may be present.
    - 4-6: Moderate erosion. Eroded banks are 1-2 feet in height. Erosion looks relatively recent.
    - 7-10: Severe Erosion. Eroded banks are greater than 2 feet in height. Erosion typically recent/active. [Fill out Outfall Stabilization Assessment form]
- Reason Condition of outfall channel could not be inspected
    - Not applicable – discharges directly into MS4
    - Not applicable – discharges directly into large perennial stream
    - Could not inspect outfall [If behind fence etc.]
- Length of outfall channel erosion (ft.)
- Condition of stream channel [extending beyond 200 feet from discharge point]
    - 0: No erosion
    - 1-3: Minor erosion. 2-3 feet in eroded bank height, not causing significant stream degradation. Showing signs of healing.
    - 4-6: Moderate erosion. 3-5 feet in eroded bank height. Relatively recent/raw.
    - 7-10: Severe Erosion. 5 ft or greater eroded bank height. Erosion typically recent/active. Obvious instream degradation. If threatening utilities or structures rate 9-10. [Fill in Stream Restoration Assessment Form]
- Reason Condition of stream channel could not be inspected

    - Not applicable
    - Too far away, no access, to warrant inspection
- Length of stream erosion (ft.)
- Notes: Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance

Candidate BMP Constraints

- Property for Sale or Lease?
    - Yes/No
- Constraint Type [check all that apply]
    - Slope
    - Utilities
    - Structures
    - Space insufficient
    - Significant impact to trees
    - Specimen tree removal
    - Property Ownership
    - Access
    - Proximity to neighboring properties
    - Other adjacent landowner issues
    - Safety
    - Aesthetics
    - Other
- Other information on BMP project constraints or conflicts (describe)

- Impact to Existing Trees
    - Minimal
    - Moderate
    - Significant
- Ease of access
    - Easy
    - Moderate
    - Difficult
- Conflicts with Existing Utilities – Sewer
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Water
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Gas
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Cable
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Electric
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Electric to Streetlights

    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Overhead Wires
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Other
    - Yes
    - No
    - Possible

- Other information on conflicts with existing utilities (describe)

Potential Permitting Factors

- Dam Safety Permits Necessary [make "not probable" the default] (height of the pond measured from the upstream toe to the top of dam is more than 20 feet)
    - Probable
    - Not probable
- Impacts to Wetlands [make "not probable" the default]
    - Probable
    - Not probable
- Impacts to a Stream [make "not probable" the default]
    - Probable
    - Not probable
- Floodplain Fill [make "not probable" the default] (Will new BMP cause changes to floodplain elevation?)
    - Probable
    - Not probable
- Impacts to Specimen Trees [≥30 inch DBH]
    - Probable
    - Not probable
- Number of Trees Impacted (number)
- Other permitting or impact factors (describe)

Soils

- Evidence of poor infiltration [clays, fines]
    - Yes/No/Unknown
- Evidence of shallow bedrock
    - Yes/No/Unknown
- Evidence of high water table [gleying, saturation]
    - Yes/No/Unknown
- Notes on soils

Other Project Types

- Is Site a Candidate for Other Restoration Projects?
    - No
    - Yes, BMP conversion
    - Yes, Tree planting
    - Yes, Stream restoration
    - Yes, Outfall stabilization
- Other Types of Projects Appropriate Here (describe)

Recommendations: New BMP (Polygon) and Drainage Area (DA) (Polygon) [This will be 2 polygons – one for the project footprint, one for the DA.]

- Draw footprint of proposed project – on tablet in layer called "Sketch – Proposed New BMP Footprint"
- Draw proposed Drainage Area in layer called "Sketch – Proposed New BMP – Drainage Area"
- Comments
- Drainage Area Estimate [No need to enter - will be calculated with hand drawn polygon.]

NEW BMP Recommendation Summary – complete the form in the layer "New BMP Recommendation Footprint" (polygon)"

- Site ID (Example: LNB-NB-F501A)
- Proposed Treatment Option (check all that apply)
  - Extended Detention
  - Wet Pond
  - Created Wetland
  - Bioretention
  - Step Pool Conveyance
  - Filtering Practice other than Bioretention
  - Infiltration
  - Swale
  - Green roof
  - Impervious surface removal
  - Impervious pavement replacement
  - Other
- If other proposed treatment, describe type.
- Demonstration/Education value?
  - Yes/no
- Notes: Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance.

  Give a short narrative of BMP to be built, as would be given on the first page of construction drawings
- Initial Feasibility and Construction Considerations (describe)

  Summarize some of the above criteria such as utility conflicts, neighborhood aesthetics consideration, technical complexity such as need for flow splitters etc.
- Other notes on new BMP proposed: [Space for anything more that could not fit above.]
- New Stormwater BMP – Retrofit Potential [This is quick evaluation of retrofitability / feasibility of constructing this BMP - not a ranking of quality of the BMP to remove pollutants]
  - High
  - Medium
  - Low

- Optional: Sketch the proposed BMP and attach sketch as photo. Sketch elements may include existing head available, surface area, minimum depth of treatment, conveyance, inlet, outlet, utility lines / other constraints, flow lines, property lines.

NEW BMP Recommendation Drainage Area – complete the form in the layer “New BMP Recommendation Drainage Area” (Polygon)”

- Site ID (Example: LNB-NB-F501A)
- Comments

Tree Planting

March 29, 2016

General Data Collection Instructions

- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Christine Lowe (cslowe@howardcountymd.gov, Office 410-313-0522 or Cell 301-806-3597). Provide location, information about the problem observed, and a photograph.
- Locate site on map layer for opportunity for Tree Planting Assessment **(*polygon*)** and fill in data for the fields below.

Fields – Tree Planting Assessment *(Polygon)*

Overall

- Site ID (pre-assigned or new ID, unique number. Example: LNB-TP-F501)
- Field Crew [Initials]
- Create a site name [This will be considered the common name of the site. Example: name of school, business, or nearest road.]
- Can site be evaluated? (if no, do not fill out other data)
  - Yes
  - No, landowner did not grant access
  - No, fence or other barrier
  - No, another reason
- Other reason site cannot be evaluated (describe)
- Is tree planting possible on this site? Answer this question after assessing the site and constraints. Use CONSTRAINTS SECTION BELOW to document constraints.
  - Yes
  - No, too many constraints
  - No, another reason (describe)
- Is tree planting opportunity at least 0.25 acres?
  - Yes/No

General Site Description

- Ownership [In most cases, this should be evident in GIS parcel layer.]
  - County School
  - County Parks
  - County – other
  - Private
  - Other
  - Unknown
- Notes, if ownership other
- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Parcel size: ____acre(s) [prefilled - from GIS]
- Access to site (check all that apply)

    - Foot access
    - Vehicle access
    - Heavy equipment access
- Current Management
    - School District
    - Charter School
    - Park
    - Tot Lot
    - Public Right-of-way
    - Private Right-of-way
    - Vacant land
    - Other

Climate

- Sunlight exposure
    - Full sun (6 hours or more of direct sun per day)
    - Part sun or filtered light (<6 hours per day)
    - Shade (<3 hours of direct sun per day)
- Microclimate features: High wind exposure (Yes/No)
- Microclimate features: Re-reflected heat load (Yes/No)
- Microclimate features: Other (describe)

Topography

- Any slopes >15% present in proposed planting area? (Yes/No)
- If yes, estimate slope
- Any low-lying areas present in proposed planting area? (Yes/No)
- If yes, notes on low lying area

Vegetation

- Current vegetative cover (estimate percent)
    - Mowed Turf _____% [1,2,3,4,5, 10, 15, 20, 25, 30 …100 by 5's]
    - Other Herbaceous _____% [as above]
    - Trees/Shrubs _____% [as above]
    - None (bare soil) _____% [as above]
- Note species to be preserved
- Are invasive species or noxious weeds present in proposed planting area? (Yes/No)
- % coverage by invasives in proposed planting area: _____
- List dominant types of invasive species in proposed planting area, if any _____
- Adjacent vegetative cover: is forest present? (Yes/No)
- If yes, note dominant forest species
- Are invasive species or noxious weeds present in adjacent vegetated area? (Yes/No)
- % coverage by invasives in adjacent area: _____
- List dominant types of invasive species in adjacent area, if any _____
- Is there heavy browsing by deer? (Yes/No)
- Is there beaver activity? (Yes/No)
- Evidence of previous tree planting? (Yes/No)
- Comment on success of previous tree planting, if evidence present
- Notes

Soils

- Soil texture
  - Clay
  - Loam
  - Sand
- Soil Compaction
  - None
  - Moderate
  - Severe
- Active or severe soil erosion? (Yes/No)
- Potential soil contamination? (Yes/No)
- Debris and rubble in soil? (Yes/No)
- Recent construction or other soil disturbance? (Yes/No)
- Other soil characteristics (describe)

Hydrology

- Site hydrology
  - Upland
  - Riparian
  - Both
- Stormwater runoff to planting site – bypasses site in pipe? (Yes/No)
- Stormwater runoff to planting site – Upslope drainage area outfalls to site? (Yes/No)
- Note diameter of pipe outfall, if present (inches)
- Stormwater runoff to planting site – Open channel directs flow across or around site? (Yes/No)
- Stormwater runoff to planting site – Shallow concentrated flow (for example, evidence of rills, gullies, sediment deposits)? (Yes/No)
- Stormwater runoff to planting site – Sheetflow? (Yes/No)
- Floodplain connection (riparian areas only) – bank height (ft)
- If riparian planting is proposed on both sides of stream, explain/describe differences in hydrology or flow path.

Potential Planting Conflicts or Constraints

- Space Limitations
  - Overhead wires? (Yes/No)
  - Height of overhead wires, if present (ft)
  - Pavement? (Yes/No)
  - Structures? (Yes/No)
  - Signs? (Yes/No)
  - Height of signs, if present (ft)
  - Lighting? (Yes/No)
  - Height of lighting, if present (ft)
  - Underground Utilities? (Yes/No)

    - Note type of underground utilities present
    - Other space limitations (describe)
- Other limiting factors or constraints
    - Trash dumping/debris (Yes/No)
    - If trash present, note type, volume (estimated number pickup truck loads) and source if known.
    - Deer, beaver, or other animal impacts (Yes/No)
    - Site mowed regularly (Yes/No)
    - Wetland present (Yes/No)
    - Insect infestation or disease (Yes/No)
    - Access (Yes/No)
    - Ownership (Yes/No)
    - Heavy pedestrian traffic (Yes/No)
- Other limiting factors/constraints (describe)
- Notes

Planting and Maintenance Logistics

- Site Access
    - Delivery Access for planting materials present? (Yes/No)
    - Temporary storage areas for soils, mulch, etc. present? (Yes/No)
    - Heavy equipment access? (Yes/No)
    - Volunteer parking area available? (Yes/No)
    - Nearby facilities for volunteers? (Yes/No)
- Water source
    - Rainfall only? (Yes/No)
    - Stormwater runoff? (Yes/No)
    - Hose hook-up nearby? (Yes/No)
    - Irrigation system in place? (Yes/No)
    - Overbank flow from river or stream? (Yes/No)
    - Fire hydrant nearby? (Yes/No)
- Other water source (describe)
- Estimated distance to nearest water source (ft)

TREE PLANTING RECOMMENDATIONS

Tree Planting Recommendation Summary – complete the form in the layer "Tree Planting Area Recommendations" [polygon]

Sketch footprint of proposed tree planting area – on tablet, outline area(s) to be planted

- Site ID (Example: LNB-TP-F501A)
- Site Preparation Required
    - High (e.g., clearing of dumpsite)
    - Medium (e.g., extensive clearing of invasives)
    - Low
    - None
- Type of site prep needed (describe)
- Potential Demonstration/Education Project? (Is site public/highly visited v. remote location?)
    - Yes/No/Maybe

- Notes: _____
- Tree Planting Areas - Restoration Potential [This is quick, overall evaluation of feasibility of tree planting at this site.]

    - High
    - Medium
    - Low

- Comments

- Optional: Sketch the proposed tree planting area and attach sketch as photo. Sketch elements may include:
    - Property boundary and features such as roads, streams, and adjacent land use/cover
    - Boundary and approximate dimensions of proposed planting area
    - Variations in sun exposure, microclimate, and topography within planting area
    - Current vegetative cover, location of trees to be preserved, and invasive species
    - Flow paths to planting area and contributing flow length
    - Above or below ground space limitations (e.g., utilities, structures)
    - Other limited factors such as trash dumping, pedestrian paths
    - Water source and access points
    - Scale bar and north arrow.

Stream Restoration Assessment

March 29, 2016

General Data Collection Instructions

- All reaches are assessed while walking upstream
- If there is a significant change in biological, physical or geomorphic conditions within a reach, then the field team has the ability to draw a Stream Reach Break Line to designate separate reaches.
- Each reach, including new reaches designated in the field, must have a habitat assessment point if reach is at least 75 meters long.
- If a portion of a reach cannot be assessed due to access or safety issues, then place a Reach Break Line at the point in the reach where the team can no longer walk upstream. Place a new Reach Break Line when the reach is assessable again.
- Right and left bank are determined while facing downstream.
- A minimum of two photos must be taken at each feature (point, line or polygon). First photo is taken looking upstream (or upslope in the case of outfalls), second photo is taken while looking downstream. Additional photos may be taken at the discretion of the field team.
- If it is immediately obvious that the site is not a good stream restoration candidate - only complete form up to the "Can/should site be evaluated" field and do not spend a significant amount of time walking the stream.
- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Christine Lowe (cslowe@howardcountymd.gov, Office 410-313-0522 or Cell 301-806-3597). Provide location, information about the problem observed, and a photograph.

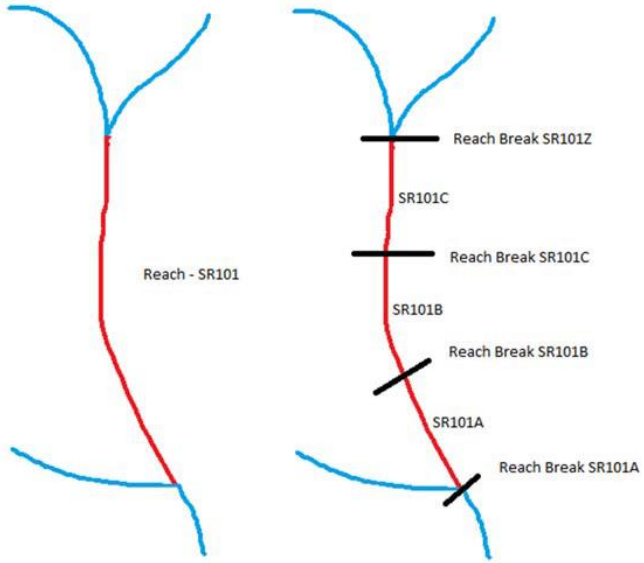
Stream Restoration Assessment Data Layers

Stream Restoration Assessment (line) – No editing; base layer with Site IDs. Check here for comments that may contain special notes for field crews.

Stream Reach Break Data *(line)*

Data Collection Instructions

Add a Stream Reach Break line at the beginning of a new stream reach assessment for either a pre-selected reach or a new reach within a pre-selected reach. This line signifies the downstream end of a new section of stream that is assessed. Each line will be perpendicular to and crossing the stream reach. Break line may be at or slightly below the downstream end of the stream reach. The last reach break will be labelled with Z to signify the upstream end of the study reach; do not fill in any other data for the "Z" reach.



Fill out all fields prior to assessing reach, except for the final field, Stream Restoration Opportunities Present, which you will complete after the assessment.

Fields

- Site ID of Stream Reach [fill in ID from the Stream Reach base layer, in which the number will be pre-assigned (e.g., LNB-SR-F001); add A for the first reach break. Add B, C, D, etc. for each additional break. Assign Z to the break at the end of reach.]
- Field Crew [Initials]
- Can/should site be evaluated? (if no, do not fill out other data)
    - Yes
    - No, landowner did not grant access
    - No, fence or other barrier
    - No, another reason
    - Site in good condition, no reason to assess
- Notes
- Create a site name [This wil be considered the common name for the site. Example: name of school, business, or nearest road.]
- Past Weather (24 hours) – yes/no for all [Fill out only once per day]
    - Clear
    - Cloudy
    - Trace of Rain
    - Rain
    - Snow
    - Extreme Cold [consistently < 32 degrees F]
    - Extreme Hot ([consistently > 80 degrees F])

    - Other
- Current Weather [Fill out only once per day unless weather changes throughout the day]
    - Same Options as above
- Stream Type – check one
    - Perennial
    - Intermittent
    - Ephemeral
    - Unknown
    - If stream type is unknown, explain
- Notes
- Stream Restoration Opportunities Present (Filled out after walking reach) [Note if opportunities present, then also fill in Stream Restoration Recommendations form.]
    - None
    - One
    - Several

Rapid Biology/Habitat Assessment Data *(Point)*

Data Collection Instructions

At least one Habitat Assessment point needs to be placed within each stream reach. If a reach is >1000 ft long, place a Stream Reach Break and collect another Habitat Assessment Point.

The assessment is conducted within a representative 75-meter reach. It is at the discretion of the field crew to choose a representative location for the 75-m reach assessment.

See example RBP data form for habitat parameter scoring guidance. For each RBP parameter, scale runs from 1 (worst condition) to 10 or 20 (best condition).

Fields

- Site ID (e.g. LNB-SR-F501A-RE001) [Fill in, using Stream Reach ID and adding RE###, RE for Representative Site]
- Stream Bed Particle Size (note percentage, estimate to the nearest 5%)
    - Clay
    - Silt
    - Sand
    - Gravel ○
    Cobble ○
    Boulder
    - Bedrock
    - Concrete
- Epifaunal Substrate/Available Cover (0-20 score)
- Embeddedness (0-20)
- Velocity/Depth Regime (0-20)
- Sediment Deposition (0-20)
- Channel Flow Status (0-20)
- Channel Alteration (0-20)
- Frequency of Riffles (or bends) (0-20)
- Bank Stability (Right) (0-10)
- Bank Stability (Left) (0-10)
- Vegetative Protection (Right) (0-10)
- Vegetative Protection (Left) (0-10)
- Riparian Vegetative Zone Width (Right) (0-10)
- Riparian Vegetative Zone Width (Left) (0-10)
- Percent Shading (estimate to nearest 10%, assuming leaf-on)
- Trash Rating (0-20)
- Notes

Erosion Site (*Point, placed at downstream end of erosion)*

Data Collection Instructions

Document all stream bank erosion that has an eroded surface of at least 2 feet high and 10 feet long. Shorter instances of erosion can be documented if the erosion is threatening a utility, property, or structure. Erosion points are placed at the downstream end of erosion. A new erosion point is placed on the map if the average height of erosion changes by more than 2-3 feet, or any of the erosion point parameters have a significant change. See BEHI diagram for guidance on collecting the applicable parameters. If there is erosion on both banks, record BEHI parameters for whichever bank is more extreme. If there are multiple areas of erosion that are vastly different in degree of erosion hazard, additional erosion points may be added if needed.

A gully associated with an outfall channel will be recorded as an erosion point. If the actual outfall is located, that will also be recorded, as a pipe outfall. If the erosion is a headcut, only the headcut fields need to be completed.

Fields

- Site ID (e.g. LNB-SR-F501A-ES001) [Fill in using Stream Reach ID and adding ES###, ES for Erosion Site]
- Type of Erosion (check all that apply)
    - Headcutting
    - Downcutting
    - Widening
    - Other
- Right Bank Length of Erosion (ft) - extending upstream of point, estimate or measure to the nearest 10 ft the length along bank
- Left Bank Length of Erosion (ft) - extending upstream of point, estimate or measure to the nearest 10 ft the length along bank
- Height of Erosion on Right Bank (ft) – to nearest 0.1 ft
- Height of Erosion on Left Bank (ft) – to nearest 0.1 ft
- Right Bank Total Height (ft) – to nearest 0.1 ft, measure from thalweg to top of bank
- Left Bank Total Height (ft) – to nearest 0.1 ft, measure from thalweg to top of bank
- Bankfull Depth (ft) – to nearest 0.1 ft, measure from thalweg to bankfull
- Note bankfull indicators
- Predominant Bank Material
    - Clay
    - Silt
    - Sand
    - Gravel
    - Cobble
    - Boulder
    - Bedrock
- Bank angle as degrees, Bank Erosion Potential category
    - 0 – 20 degrees, Very Low
    - 21 – 60 degrees, Low
    - 61 – 80 degrees, Moderate
    - 81 – 90 degrees, High
    - 90 – 119 degrees, Very High
    - >119 degrees, Extreme

- Root Density as percentage, Bank Erosion Potential category
  - 80 - 100% Very Low
  - 55 - 79% Low
  - 30 - 54% Moderate
  - 15 - 29% High
  - 5 – 14% Very High
  - <5% Extreme
- Root Depth as proportion of bank height, Bank Erosion Potential category
  - 0.90 – 1.0 Very Low
  - 0.50 – 0.89 Low
  - 0.30 - 0.49 Moderate
  - 0.15 – 0.29 High
  - 0.05 - 0.14 Very High
  - <0.05 Extreme
- Surface protection as percentage, Bank Erosion Potential category
  - 80 - 100% Very Low
  - 55 - 79% Low
  - 30 - 54% Moderate
  - 15 - 29% High
  - 10 – 14% Very High
  - <10% Extreme
- Near Bank Stress Rating [narrative category]
  - Very Low
  - Low
  - Moderate
  - High
  - Very High
  - Extreme
- Soil Stratification
  - None/Low
  - Medium
  - High
- Headcut height, ft, to the nearest 0.5 ft [if applicable]
- Headcut angle, degrees [if applicable]
  - 0 – 30 degrees ○
  - 31 - 60 degrees ○
  - 61 – 90 degrees
- Headcut length, ft [bottom to top; if applicable]
- Overall Erosion Severity Rating (1-10)
  - 1-3: Minor erosion. 2-3 feet in eroded bank height, not causing significant stream degradation. Showing signs of healing.
  - 4-6: Moderate erosion. 3-5 feet in eroded bank height. Relatively recent/raw.
  - 7-10: Severe Erosion. 5 ft or greater eroded bank height. Erosion typically recent/active. Obvious instream degradation. If threatening utilities or structures rate 9-10.
- Notes

Channel Alteration Site *(Point, placed at downstream end of channel alteration)*

Data Collection Instructions

Document instances of the channel bed, bank, or nearby floodplain being altered by placing a Channel Alteration point at the downstream extent of the alteration and completing the electronic form. Only document instances where the alteration is detrimental to the stream (e.g. concrete-lined channel) or needs to be fixed (e.g. failing bank stabilization project). Do not document stable utility line protection or successful stream restoration projects. Channel Alteration points are placed at the downstream end of erosion.

Fields

- Site ID (e.g. LNB-SR-F501A-CA001) [Fill in using Stream Reach ID and adding CA###, CA for Channel Alteration]
- Type
    - Concrete
    - Riprap
    - Gabion Basket
    - Earthen Channel
    - Channelization/Straightening
    - Other
- Alteration Length (ft) (extending upstream of point, estimate or measure to the nearest 10 ft)
- Alteration Width (ft) (Bed only)
- Alteration Location
    - Bed
    - Bank
    - Bed and Bank
    - Floodplain
- Signification vegetation in channel?
    - Yes, No, Unknown
- Signification Aggradation
    - Yes, No, Unknown
- Significant Degradation
    - Yes, No, Unknown
- Associated with a Road Crossing
    - Yes, No, Unknown
- Alteration Severity (1-10)
    - 1-3: Alteration is detrimental to the health of the stream, but alteration is relatively short and is not causing any current channel instability.
    - 4-6: Alteration is causing noticeable channel instability (e.g. channel starting to erode around riprap placed on bank or channelized stream banks slumping in stream) and should be corrected.
    - 7-10: Alteration is relatively long, causing significant channel instability/loss of habitat and should be corrected as soon as possible.
- Notes

Inadequate Buffer Site *(Point, placed at downstream end of inadequate buffer)*

Data Collection Instructions

Document non-natural areas with a minimum length along the stream (parallel to the channel) of 100 feet. A buffer will be considered adequate if it is tree-covered within 75 ft of the stream.

A more detailed assessment of the area can be completed with the Tree Planting Area form (polygon feature) if adequate space is available for planting (at least 0.25 acre).

Inadequate buffer points are placed at the downstream end of the inadequate buffer.

Fields

- Site ID (e.g. LNB-SR-F501A-IB001) [Fill in using Stream Reach ID and adding IB###, IB for Inadequate Buffer]
- Inadequate buffer length – Right (ft)
- Inadequate buffer length – Left (ft)
- Existing Buffer width – Right (ft) (to 150 ft maximum)
- Existing Buffer width – Left (ft) (to 150 ft maximum)
- Opportunity for tree planting project? (yes/no) – If Yes, fill out Tree Planting assessment form
- Notes

Pipe Outfall Site *(Point)*

Data Collection Instructions

Document all outfall pipes or channels that can be seen from the stream by placing an outfall point on the map. If the outfall is a pipe then place the point at the opening of the pipe, if the outfall is a channel then place the point at the termination of the formal conveyance (i.e. do not place point at end of erosional gully, this will be documented within the field form).

Use this form to record unmapped outfalls and problematic outfalls observed while conducting stream assessment. This is not intended to be a comprehensive inventory of outfalls.

Fields

- Site ID (e.g. LNB-SR-F501A-PO001) [Fill in using Stream Reach ID and adding PO###, PO for Pipe Outfall]
- Mapped outfall number, if available [MSLINK from GIS]
- Type of Outfall
    - Stormwater BMP Outfall
    - Stormwater Outfall, no BMP
    - BMP Overflow Channel / Spillway
    - Agricultural Drainage Pipe
    - Roof Drains (only record if there are major problems to address)
    - Sewage Plant
    - Unknown
    - Other
- Enclosed Pipe or Open Channel (choose one)
- Material
    - Earth Channel
    - Concrete Channel
    - Concrete Pipe
    - Smooth Metal Pipe
    - Corrugated Metal Pipe
    - Smooth Plastic Pipe
    - Corrugated Plastic Pipe
    - Unknown
    - Other
- Pipe Diameter [inside – inches]
- Location in relation to stream channel (choose one, facing downstream)
    - Right side
    - Left side
    - In-line with stream
- Evidence of dry weather flow (e.g. staining, excessive vegetation, oil sheen, etc.)?
    - Yes, No
- Is there a suspected illicit discharge that needs to be addressed?
    - Yes, No – If yes, notify Howard County
- Trash Rating (0-20, refer to RBP ratings)
- Evidence of Erosion below outfall?
    - Yes, No - If moderate or severe erosion is observed, fill out Outfall Stabilization Assessment form [point feature].
- Notes

Unusual Condition/Other *(Point)*

Data Collection Instructions

Document any unusual conditions found during the stream assessments. These may not necessarily be good indicators for targeting restoration sites, but these conditions may be leading to (or indicative of) instream degradation and are worth documenting for the County's use if the condition is severe. Place a new point on the map where the unusual condition is found.

Fields

- Site ID (e.g. LNB-SR-F501A-UC001) [Fill in using Stream Reach ID and adding UC###, UC for Unusual Condition]
- Near-stream construction with poor ESC (yes/no)
- Suspected illicit discharge (Contact County) (yes/no)
- Illegal Dumping (yes/no)
- Exposed Pipe (yes/no)
- Unusual Water Color (yes/no)
- Unusual Water Clarity (yes/no)
- Unusual Water Odor (yes/no)
- Excessive Algae (yes/no)
- Excessive Bacteria Indicators (yes/no)
- Severe Fish Blockage/Barrier (yes/no)
- Other (describe) (yes/no)
- Notes

Stream Restoration Recommendations *(Polygon)*

Data Collection Instructions

Use this feature to indicate the location and extent of one or many potential stream restoration projects within the assessed reach. Draw a polygon that includes the extent of stream length to be restored, including side tributaries if they are to be included in project.

Also, document the potential of adding one or many restoration projects in the Stream Reach Break line shapefile.

Fields

- Site ID (e.g., LNB-SR-F501A)
- Instream Restoration Potential
    - High
    - Medium
    - Low
- Restoration Length (ft) [will be calculated later in GIS]
- Percent of channel included in polygon in need of restoration
- Stream Restoration Project Constraints - Type
    - Utility
    - Roadway
    - Buildings
    - Other Structure
    - Ownership
    - Access
    - Significant Impact to Trees
    - Specimen Tree Removal
    - Wetland Impacts
    - Other
- Approximate length of project affected by constraint (ft)
- Impact to Existing Trees
    - Minimal
    - Moderate
    - Significant
- Ease of access
    - Easy
    - Moderate
    - Difficult
- Potential Demonstration/Educational Value? (yes/no)
- Notes

Outfall Stabilization Assessment (Point)

March 29, 2016

General Data Collection Instructions

- If any illicit discharges (any discharge after 3 days of dry time) or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Christine Lowe (cslowe@howardcountymd.gov, Office 410-313-0522 or Cell 301-806-3597). Provide location, information about the problem observed, and a photograph.

- Edit an existing (preselected) outfall stabilization point OR add a new outfall stabilization point. If adding a new point and the outfall is a pipe then place the point at the opening of the pipe. If the outfall is a channel then place the point at the termination of the formal conveyance (i.e. do not place point at end of erosional gully, this will be documented within the field form).

Fields – Outfall Stabilization Assessment (*Point)*

- Site ID (prefilled) (example: LNB-OF-F501). If site was a Pipe Outfall Site in Stream Restoration reach, use that outfall point site ID (example: SR-F501-PO103).
- Field Crew [Initials]
- Create a site name [This will be considered the common name of the site. Example: name of school, business, or nearest road.]
- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Can site be evaluated? (if no, do not fill out other data)
    - Yes
    - No, landowner did not grant access
    - No, fence or other barrier
    - No, another reason
- Point moved? (If point is in incorrect location, move the point and indicate here)
    - Yes
    - No
- Notes
- Past Weather (24 hours) – yes/no for all [Fill out only once per day]
    - Clear
    - Cloudy
    - Trace of Rain
    - Rain
    - Snow
    - Extreme Cold (consistently < 32 degrees F)
    - Extreme Hot (consistently > 80 degrees F)
    - Other
- Current Weather [Fill out only once per day unless weather changes throughout the day]
    - Same Options as above
- Outfall Pipe Height (inches)
- Outfall Pipe Width (inches)
- Outfall Pipe Shape
    - Round
    - Rectangular
    - Elliptical
- Outfall Type
    - Pipe only
    - Headwall/Endsection
- Is repair needed?
    - Yes/No

- Is sediment removal needed?
    - Yes/No
- Is there baseflow?
    - Yes/No
- Outfall Material
    - Earth Channel
    - Concrete Channel
    - Concrete Pipe
    - Smooth Metal Pipe
    - Corrugated Metal Pipe
    - Smooth Plastic Pipe
    - Corrugated Plastic Pipe
    - Unknown
    - Other
- Trash Rating (0-20, refer to RBP rating)
- Evidence of Erosion below outfall?
    - Yes, No
- Location of Erosion
    - Outfall Channel (yes/no)
    - Main Stream Channel (yes/no)
- Length of outfall channel erosion (ft)
- Length of stream channel erosion that is attributable to the outfall (ft)
- Distance from outfall to Stream Channel (ft)
- Height of pipe above channel bed (ft)
- Severity of outfall channel Erosion/degradation (1-10)
    - 1-3: Minor erosion. Less than 1 foot of eroded banks. Healing may be present.
    - 4-6: Moderate erosion. Eroded banks are 1-2 feet in height. Erosion looks relatively recent.
    - 7-10: Severe Erosion. Eroded banks are greater than 2 feet in height. Erosion is typically recent/active.
- Does this site have potential for outfall stabilization?
    - Yes (if yes, go to Outfall Stabilization Recommendation, add line, and fill out form)
    - No
- Does this site have potential for stream restoration?
    - Yes (if yes, go to Stream Restoration Assessment, beginning with Stream Reach Break Data and fill out forms, including Erosion Site form)
    - No
- Notes

Outfall Stabilization Recommendation *(Line)*

Data Collection Instructions

Add line to map and fill out the form below if "Yes" was answered for "potential for outfall stabilization". Draw line to indicate proposed location and length of outfall stabilization project. Note: portions of Outfall Stabilization projects that extend beyond 200-300 feet will be categorized as stream restoration projects.

Fields

- Site ID (e.g. LNB-OF-F501) (match Outfall Stabilization Assessment Site ID)
- Overall Outfall Stabilization Potential
    - High
    - Medium
    - Low
- Type of Outfall Stabilization Project
    - Rip Rap
    - Drop Structure
    - Regenerative Stormwater Conveyance
    - Other
- Describe Other type of stabilization
- Proposed project length (ft) (estimate to nearest 10 ft)
- Outfall Stabilization Project Constraints - Type
    - Utility
    - Roadway
    - Buildings
    - Other Structure
    - Ownership
    - Access
    - Draining a hotspot
    - Significant impact to trees
    - Specimen tree removal
    - Wetland Impacts
    - Other
- Approximate length of project affected by constraint (ft)
- Impact to Existing Trees
    - Minimal
    - Moderate
    - Significant
- Ease of access
    - Easy
    - Moderate
    - Difficult
- Potential Demonstration/Educational Value? (yes/no)
- Note

APPENDIX D: LANDOWNER NOTIFICATION LETTER

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS
6751 Columbia Gateway Drive, Suite 514 ■ Columbia Maryland 21046 ■ 410-313-6444

Mark DeLuca, P.E., Deputy Director
Chief, Bureau of Environmental Services
mdeluca@howardcountymd.gov

FAX 410-313-6490
TDD 410-313-2323

March 25, 2016

Re: Patapsco River and Patuxent River Watershed Study

Dear Resident:

The Howard County Department of Public Works Stormwater Management Division will soon be undertaking a comprehensive watershed assessment within the Patapsco River and the Main Stem Patuxent River watersheds. The watershed assessment is being performed to create an inventory of the natural resources as well as existing problems (erosion, trash, lack of wooded stream buffers, etc.) within these watersheds. Another result of the assessment will be a list of potential projects that can be done to protect and restore these resources, address the problems, and ultimately improve water quality in our streams and water bodies.

The County welcomes participation in development of the study from watershed residents, businesses, and organizations. Public workshops will be planned after the initial field work has been completed to present the results from the assessment and to discuss proposed restoration projects suggested by the study. Exact workshop dates will be advertised when the dates are finalized.

Field crews of two or three County employees or consultants will conduct their assessments on public property to the extent possible but there may be a need for them to be on private property briefly to access certain sites. You may see a crew briefly in your neighborhood. The field crews will be there only to assess existing conditions through visual observations, taking photos, and preparing sketches. Field crews will use extreme care when on private property.

The County anticipates that the majority of the field assessment work will occur during the April to June 2016 time frame with the possibility of a quick second visit to verify field information later in summer 2016.

If you have any specific questions or concerns or would like additional information regarding the watershed assessment, please contact the County by emailing cslowe@howardcountymd.gov or calling 410-313-6444.

APPENDIX E: FIELD REPORTS FROM CONSULTANT FIELD TEAMS

Biohabitats

The Stables Building
2081 Clipper Park Road
Baltimore, MD 21211
410.554.0156
www.biohabitats.com

MEMORANDUM

Date: May 27, 2016 (Revised June 28, 2016)

To: Christine Lowe, Howard County, Stormwater Management Division

From: Biohabitats, Inc.

RE: **Howard County Watershed Assessments in 2016**

Subject: **Patapsco River South Branch and Upper Patuxent River Field Summary Report**

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1. Number of Field Assessments Completed

Table 1. Number of field assessments completed				
Consultant Firm Name	**Biohabitats**			
Study Area Name	**Patapsco River South Branch**			
Type	**# Sites (or Stream Miles) Assigned (from Table A below)**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP conversion	1	1	0	1
New BMP	0	0	0	0
Stream Restoration	12.77 miles	11.35 miles	0	11.35 miles
Tree Planting	10	9	11	20
Outfall stabilization	13	11	0	11

Table 1. Number of field assessments completed				
Consultant Firm Name	**Biohabitats**			
Study Area Name	**Upper Patuxent River**			
Type	**# Sites (or Stream Miles) Assigned (from Table A below)**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP conversion	3	3	0	3
New BMP	1	1	0	1
Stream Restoration	3.24 miles	2.87 miles	0	2.87 miles
Tree Planting	2	2	0	2
Outfall stabilization	2	2	2	4

2. Primary Reasons that Sites Could Not be Assessed

Stream Restoration

- PRU-SR-F301 (0.37 miles) was not assessed as there were horses fenced in within the stream assessment area that prevented safe access to the stream.
- SBP-SR-F407 (0.37 miles) was only partially assessed as access was denied for one of the properties adjacent to the stream.
- SBP-SR-F412 (0.56 miles) was only partially assessed as there were bison within the stream assessment area that prevented safe access to a portion of the stream.
- SBP-SR-F414 (0.49) miles was not assessed as there were several dogs loose on the property that prevented safe access to the stream.

Outfall Stabilization

- SBP-OF-F405 was not assessed as the outfall was already in good condition.
- SBP-OF-F412 was not assessed as there was a fence which prevented access.

Tree Planting

- SBP-TP-F401 was not assessed as the site had been planted with trees in recent years and was still in good condition. An adjacent site (SBP-TP-F401A) presented a better opportunity and was assessed for tree planting feasibility instead.
- PRU-TP-F302A was not assessed as the site had a surrounding fence that prevented access by the field team, however the site was still assessed for feasibility from behind the fence boundary.

3. Other Comments about Data or Assumptions Made

Stream Restoration

- In cases where the bank erosion was similar in character and flip flopped from left bank to right bank the length of erosion on left and right banks was summed for the respective banks and a total length of erosion was included in the notes. This total length of erosion may be less than the sum of erosion on left and right banks if overlap occurred.

Tree Planting

- For sites on private property, it was assumed that property owners would be receptive to tree planting.
- Watering was assessed as onsite sources available or access for a truck.
- Additional sites added in the field were identified during the stream restoration assessment. The tree planting assessment polygon for the additional sites did not always match property boundaries like for the assigned sites. Since the additional sites were identified during the stream restoration assessment, the tree planting assessment polygons for additional sites could cross several properties and/or only include portions of properties adjacent to a stream.
- Regional forest association was based on USDA Forest Service Potential Natural Vegetation Groups, version 2000, available at http://www.firelab.org/sites/default/files/images/downloads/pnv2000.pdf.
- No optional sketches of the tree planting areas were completed.
- An additional eight Tree Planting Recommendation sites were added during Stream Restoration Assessment field visits where potential tree planting opportunities were present adjacent to streams. These Tree Planting Recommendation sites were named corresponding to their adjacent streams. Because there was overlap between assigned Tree Planting Assessment site IDs and Stream Restoration Assessment site IDs (i.e. SBP-SR-F401 and SBP-TP-F401), there is consequential overlap in Tree Planting Recommendation site IDs. Sites that were recommended in the field during stream restoration assessment are clearly called out as such in the notes sections of their site assessment forms.

Outfall Stabilization

- It was assumed that ‘distance from outfall to stream channel’ was the vertical distance from the invert of the outfall pipe to the immediate receiving channel (outfall channel).
- PRU-OF-F306 was added as an outfall stabilization recommendation during a stream restoration assessment.
- SBP-OF-F413 is located at the upstream end of SBP-SR-F421 and was evaluated during field assessment of this stream reach; consequently, no additional Outfall Stabilization Recommendation form was submitted for this outfall as its recommendation was incorporated into the Stream Restoration Recommendation form for SBP-SR-F421.

4. Number of Recommendations Made at Field Sites

Table 2. Number of site recommendation forms completed for field sites assessed				
Consultant Firm Name	**Biohabitats**			
Study Area Name	**Patapsco River South Branch**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	1	0	1	0
New BMP recommendations	0	0	0	0
Stream Restoration recommendations	31	10	14	7
Tree Planting recommendations	26	15	9	2
Outfall stabilization recommendations	2	1	1	0

Table 2. Number of site recommendation forms completed for field sites assessed				
Consultant Firm Name	**Biohabitats**			
Study Area Name	**Upper Patuxent River**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	3	0	2	1
New BMP recommendations	4	0	0	4
Stream Restoration recommendations	4	1	1	2
Tree Planting recommendations	1	0	1	0
Outfall stabilization recommendations	2	0	0	2

5. General Comments about the Types of Recommendations Made

Stream Restoration

- Over 4.5 miles of stream restoration opportunities were identified by the field crews. The average project length was approximately 900 LF. These opportunities varied widely

from livestock fencing and straight forward gully or bank repairs to significant restoration projects along the higher order stream reaches. Field crews generally thought that tree impacts could be minimized and no sites were predicted to result in significant tree impacts. The overall access ratings were moderate to easy, with only two sites (approximately 0.4 miles) rating in the difficult range.

- The Upper Patuxent River watershed presents better opportunities overall for stream restoration. The heavy urbanization of this watershed has resulted in widespread erosion and trash throughout the streams. Additionally, due to the stream's proximity to roads within County right-of-way, access will be straightforward for most sites in this watershed. Conversely, the Patapsco River South Branch watershed is predominantly farmland which will require both property owner coordination and working around livestock for a large percentage of the sites.

Tree Planting

- Of the sites that were rated high restoration potential, two (SBP-TP-F401A and F408C) appeared to be the best opportunities. SBP-TP-401A is directly adjacent to a previous restoration project and the landowner expressed high interest in expanding the previous project.

Outfall Stabilization

- All of the outfall stabilization recommendations were proposed as Regenerative Stormwater Conveyance. One of the assessed outfalls (SBP-OF-F413) was accounted for with a stream restoration recommendation polygon.

New BMP Opportunities

- New BMP Recommendations were typically filtering practices or bioretention. Some site recommendations require parking spot elimination.

BMP Conversions

- BMP Conversion recommendations were typically bioretention for existing dry pond conditions. If soils appear hydric with wetland vegetation, recommended to convert to wet pond or wetland.

6. List of Sites Reported to Howard County Because of Suspected Illicit Discharges, Safety Concerns, or Other Reasons for County Follow-Up

Overall

- No sites were reported to Howard County because of suspected illicit discharges, safety concerns, or any other reason.

7. Other Comments/Explanations Related to Data Collected

Overall

- Field crews encountered several property owners who were unaware of the planned field assessments. It is the recommendation of Biohabitats that the current method of sending notification letters to private property owners as a means of informing them of the impending work be reevaluated and augmented with a less passive approach in rural areas. For future assessment work, field crews should be provided with contact information for property owners that they will be interacting with so as to ensure that property owners fully consent before field crews access the property.
- Unless a unique opportunity was presented, photos were not generally attached to Stream Restoration Opportunities, New BMP Recommendations, and Outfall Stabilization Recommendations because they are attached to the relevant assessment features.

Outfall Stabilization

- Two outfall stabilization assessment sites require local repair or stabilization, but did not warrant a full outfall stabilization recommendation as the receiving channel appears stable. These include:

Site ID	Name	Local Repair required
PRU-OF-F301	First and Decatur	portion of outfall pipe and headwall broken
SBP-OF-F407	13858 Forsythe	corroded CMP barrel

New BMP Opportunities

- PRU-NB-F301 is a heavily industrial site and may be subject to NPDES 12SW General Permit.

Howard County Watershed Assessments

Patapsco River Lower North Branch Northern Portion

Upper Patuxent River

June 2016

KCI Technologies, Inc.
936 Ridgebrook Road
Sparks, MD 21152

CONTENTS

TABLES

FIGURES

1 Introduction

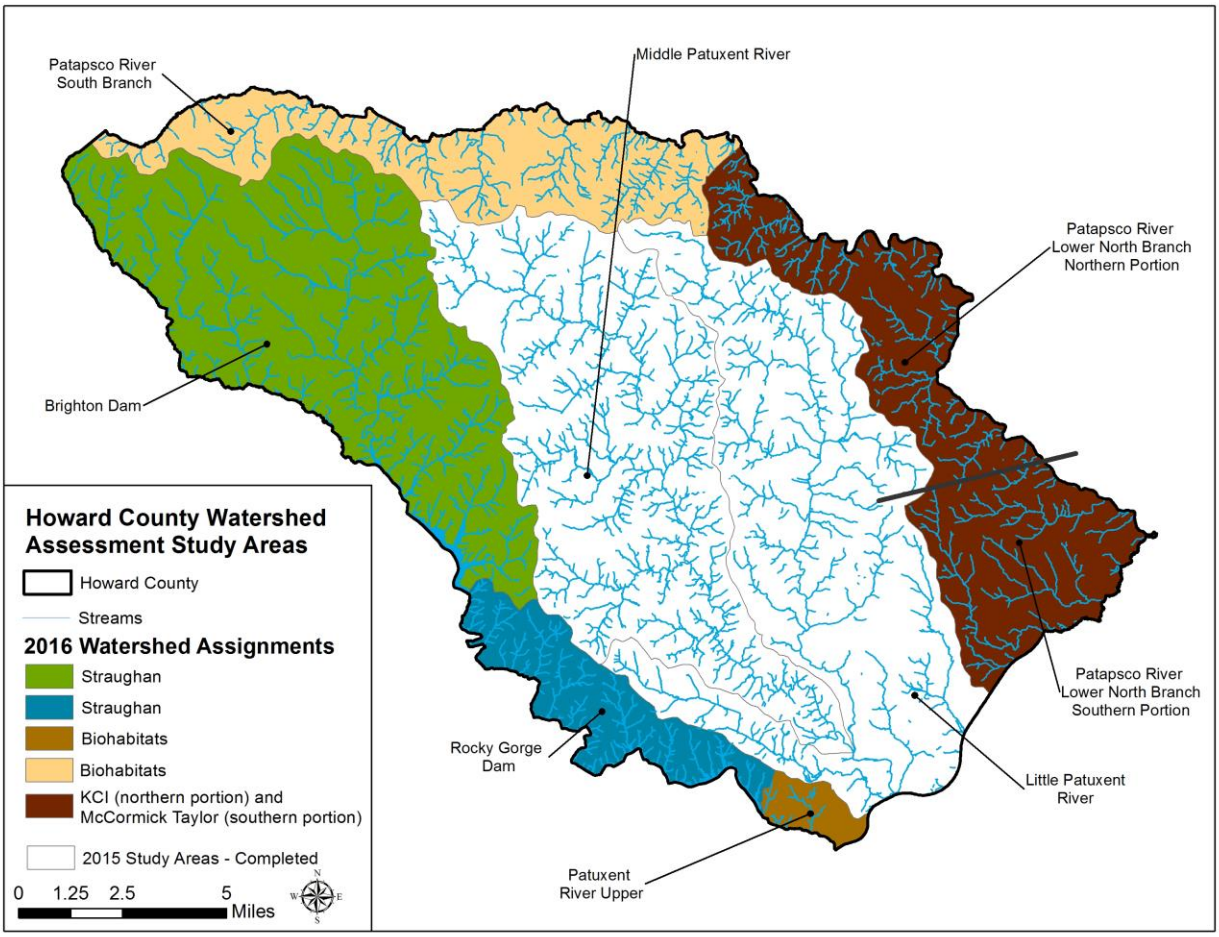
KCI Technologies, Inc. (KCI) completed detailed field and desktop watershed assessments in the northern portion of the Patapsco River Lower North Branch (LNB) watershed and a small portion of the Upper Patuxent River watershed in the Spring of 2016 in support of Howard County's efforts to complete Countywide watershed assessments (Figure 1).

The assessments are designed to meet the County's National Pollutant Discharge Elimination System (NPDES) permit conditions under section III.E.1.a which requires the County to complete detailed watershed assessments for the entire County by the end of the current permit term (December 2019).

The goal of the project is to identify feasible and meaningful restoration and retrofit projects that when implemented, provide progress towards meeting the County's local and Chesapeake Bay Total Maximum Daily Load (TMDL) goals and progress toward impervious surface treatment targets. In addition to the Bay TMDL targets there are currently final approved TMDLs and Stormwater Waste Load Allocations (SW-WLA) for the Patapsco River Lower North Branch for sediment, bacteria, phosphorus, and nitrogen.

Assessments and recommendations will be evaluated and sites will be selected and prioritized for further study, design and implementation. Results of the initial assessments are included below.

Figure 1. Watershed Assessment Study Areas



2 Field Assessment Results

The following sub-sections describe the results of the assessments in terms of the total number of sites per category completed with detail on the numbers assigned, those assigned sites completed, and any additional sites that were added and assessed through the course of the field effort. Results are summarized in Table 1.

Table 1. Number of Field Assessments Completed

Consultant Firm	**KCI Technologies, Inc.**			
Study Area	**Patapsco River Lower North Branch**			
Type	**# Sites (or Stream Miles) Assigned**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP Conversion	10	10	0	10
New BMP	6	6	3	9
Stream Restoration	14.3 miles	14.3 miles	0.7 miles	15.0 miles
Tree Planting	18	18	3	21
Outfall stabilization	44	44	15	59
Study Area	**Upper Patuxent River**			
Type	**# Sites (or Stream Miles) Assigned**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP Conversion	0	0	0	0
New BMP	0	0	0	0
Stream Restoration	0.0 miles	0.0 miles	0.3 miles	0.3 miles
Tree Planting	0	0	0	0
Outfall stabilization	0	0	5	5

2.1 BMP Conversion Field Assessments

A total of 10 BMP conversion field assessments were assigned. Site access permissions were obtained for all sites and each was evaluated in the field. The facility type documented in the County database matched the observed conditions at all of the visited ponds. A breakdown of the number of field assessment sites assigned and completed can be found in Table 1.

2.2 New BMP Field Assessments

A total of 6 new BMP field assessments were initially assigned and 3 additional sites were added. Assessments were completed at all 9 sites. A breakdown of the number of field assessment sites assigned and completed can be found in Table 1.

2.3 Stream Restoration Assessment

A total of 14.3 miles of stream were assigned for evaluation. All pre-assigned sites were able to be assessed. A total of 0.7 miles of stream were added in the field. Those areas that were added include pre-assigned reaches that were extended to capture continued erosion that existed beyond the assigned reach; as well as degraded tributaries that drain to a pre-assigned reach. In total, 15.3 miles of stream were evaluated during the field efforts. KCI conducted a stream assessment on an additional 0.3 mile reach in the Upper Patuxent River watershed, PRU-SR-F685, at the request of the County.

A total of 29 unusual condition points were captured. Of those points, 16 were taken to document an exposed pipe. Pipe conditions ranged from small roof drain pipes to exposed sewer pipes. Other documented unusual conditions included road culverts, fish blockages, and debris jams.

In general, erosion was typically found to be segmented throughout a reach, with the eroded bank alternating as the channel meanders. In these cases, the erosion was typically found to be very similar throughout and therefore, one erosion point was used to identify the total reach of observed erosion. The total length of erosion noted per bank is provided based on an estimate of actual erosion and excluding the areas that did not contain erosion.

2.4 Tree Planting Field Assessments

A total of 18 tree planting field assessments were initially assigned. Two sites, LNB-TP-F605 and LNB-TP-F606 were combined into one site due to their proximity and similarity. One assigned planting area, LNB-TP-F617, was located at Mt Hebron High School and was visited but a full assessment was not conducted. The field crew visited this site with Greg Connor (Assistant Manager- Grounds Services at Howard County Public Schools), and it was determined to be unsuitable for planting due to the school's current use of the area. Eight of the sites had been recently planted and a full assessment was not completed.

An additional three sites were added in the field. Two sites, LNP-TP-F651 and LNP-TP-F652 were identified while driving between tree planting assessment sites and the remaining site, LNP-TP-F653, was added and assessed during the stream restoration assessment effort.

A total of 20 tree planting assessments were completed. A breakdown of the number of field assessment sites assigned and completed can be found in Table 1.

2.5 Outfall Stabilization Field Assessments

A total of 40 outfall stabilization sites were assigned for evaluation. Of those, 18 sites were in good condition and a full assessment was not conducted. An additional 5 sites were not assessed because the field crew was unable to locate the outfalls in the field. In these cases, the areas at and around the mapped location of the outfall was traversed; however, no sign of the outfall was observed. One site, LNB-OF-F618, was a duplicate with site LNB-OF-F642, and only one assessment was conducted at this outfall. Full assessments were conducted at the remaining 20 sites.

A total of 14 sites were added during the assessments and are linked to Pipe Outfall points that were assessed as part of the stream restoration assessments, with the exception of one site, LNB-OF-F680 which was adjacent to another outfall stabilization point, LNB-OF-F617. In total, 59 outfall stabilization assessments were performed.

KCI conducted a stream assessment on an additional reach in the Upper Patuxent River watershed, in which five outfall stabilization assessments were conducted and are linked to Pipe Outfall points.

3 Field Recommendations Results

The following sub-sections describe the recommendations made as a result of the field assessments in terms of the total number of recommendations per category and a breakdown of the general restoration/retrofit potential within each category. Results are summarized in Table 2.

Table 2. Number of Site Recommendations Completed for Field Sites Assessed

Consultant Firm	**KCI Technologies, Inc.**			
Study Area	**Patapsco River Lower North Branch**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion	9	7	0	2
New BMP	5	1	3	1
Stream Restoration	38	13	19	6
Tree Planting	12	11	1	0
Outfall stabilization	18	12	4	2
Study Area	**Upper Patuxent River**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
BMP conversion	0	0	0	0
New BMP	0	0	0	0
Stream Restoration	1	1	0	0
Tree Planting	0	0	0	0
Outfall stabilization	4	2	2	0

3.1 BMP Conversion Recommendations

Of the 10 sites assessed, 9 sites were recommended for conversion. The one site not recommended for conversion, LNB-BC- F609, had a drainage area of approximately 100 acres and was not determined to be feasible for retrofit.

At site LNB-BC-F606, an adjacent homeowner expressed concern to the field crew about trees and invasive bamboo growing aggressively near the residential property.

Five sites with existing dry ponds can be converted to wet ponds to provide water quality volume treatment for their contributing drainage area. Created wetland conversions were recommended at two sites, and SPSC and infiltration conversion were recommended at the remaining two sites. Seven out of the nine sites were considered to have high conversion potential. A breakdown of the number of field assessment of retrofit potential can be found in Table 2. The existing site soils should be investigated to determine the best conversion options for next design phase.

3.2 New BMP Recommendations

Six sites were not recommended with any new BMP practices. The most common reason new BMPs were not recommended was a lack of open space within the study area. Many commercial sites were found to have large impervious areas draining directly into existing stormwater drainage systems with little or no open space available.

Three sites were considered feasible for new BMP practices. Two sites were recommended with one BMP footprint (LNB-NB-F511A and LNB-NB-F603) and one site had three bioretention BMP footprints recommended (LNB-NB-F605A, B, and C). The most common recommendations were biorentention and filtering practices. Further investigations regarding soils, water balance analysis, and contributing drainage areas are needed to determine the best retrofit options for the next design phase. Of these sites, one was found to have a high retrofit potential, 3 sites have medium potential, and one site has low potential (Table 2).

3.3 Stream Restoration Recommendations

Stream restoration recommendations were created for 41 sites. Of these, 16 sites were rated as having high restoration potential, 19 as medium potential, and 6 as low potential. In many cases, each stream restoration recommendation site includes multiple stream reaches. These areas were lumped together to better represent a complete and practical restoration project where similar conditions exist, the general restoration approach would be similar, and it would be cost effective to prepare design plans and mobilize construction for the entire site.

One stream restoration recommendation was made in the Upper Patuxent River watershed, PRU-SR-F685B.

Stream restoration recommendations were made for all areas that the field crews felt would result in a project which was feasible to move forward. Overall, many of the sites assessed contained only moderate erosion, but in these areas, the erosion conditions typically existed over a long distance. As a result, many of the restoration recommendations include sites that may not appear severely degraded or be considered a high priority, but due to the consistent conditions over a long distance, are expected to result in a feasible project that will yield significant restoration credit.

3.4 Tree Planting Recommendations

A total of 12 tree planting recommendation sites were created at the field assessment sites (Table 2). Of these, 11 sites were evaluated to have a high restoration potential and one site had medium potential. Sites with high restoration potential were generally open, mowed fields with minimal site preparation required. Sites with medium or low restoration potential generally had more site preparation required, included mowing, trash and debris removal, and invasive removal that would reduce the survival potential of planted trees.

The most common reason for not recommending a site for planting was that the area had already recently been planted. Aside from the one site at Mt Hebron High School, LNB-TP-F617, which was determined to not be suitable for planting due to current use of the area, all other sites not recommended for planting had recently already been planted. If it was immediately obvious that planting was not possible at the site, the complete assessment was not conducted.

3.5 Outfall Stabilization Recommendations

A total of 18 outfall stabilization recommendation sites were created during the field assessments. Of these, 12 sites were rated as having high restoration potential, 4 as medium potential, and 2 as low potential. In general, the outfall stabilization recommendations included stabilization of a degraded outfall channel located immediately downstream of the outfall. Of the 18 recommendations, one recommendation for drop structures was made, rip-rap stabilization was made at 2 sites, and RSC was recommended at 15 sites.

A total of 4 outfall stabilization recommendation sites were created during the Upper Patuxent River field assessment. Of these, two sites were rated as having high restoration potential, and two were rated as having medium potential. Of the 5 recommendations, rip-rap stabilization was recommended at two sites and RSC was recommended at two sites.

4 Desktop Assessment Results

KCI was asked to prepare assessments and generate recommendations for BMP, stream restoration, tree planting, and outfall stabilization sites that were visited previously during various studies. Data from site visits, photos, and concept plans were used to complete the assessments. The following sub-sections describe the results of the desktop assessments in terms of the total number of sites per category completed with detail on the numbers assigned, those assigned sites completed, and any additional sites that were added and assessed through the course of the desktop effort. Results are summarized in Table 3.

Table 3. Number of Desktop Assessments Completed

Consultant Firm	**KCI Technologies, Inc.**		
Study Area	**Patapsco River Lower North Branch**		
Type	**# Sites (or Stream Miles) Assigned**	**# Sites (or Stream Miles) for Which Desktop Assessment Was Completed**	**For These Sites, Number of Concept Plans Previously Prepared**
BMP conversion	1	1	1
New BMP	16	16	0
Stream Restoration	0.6 miles	0.6 miles	0.0 miles
Tree Planting	3	3	3
Outfall stabilization	5	5	0

4.1 BMP Conversion Desktop Assessments

One BMP conversion desktop assessment was assigned. This pond retrofit site was identified in the Tiber-Hudson Subwatershed Restoration Action Plan, prepared by the Center for Watershed Protection in 2013. The Retrofit Reconnaissance Investigation form from the previous study was used to complete the desktop analysis. A breakdown of the number of desktop assessment sites assigned and completed can be found in Table 3.

4.2 New BMP Desktop Assessments

A total of 16 new BMP desktop assessments were assigned. Of these, 15 sites were identified in the Tiber-Hudson Subwatershed Restoration Action Plan, prepared by the Center for Watershed Protection in 2013, and one site was identified in the Tiber Branch and Sucker Branch Interceptor Improvements MS4 Site Identification project, conducted by Century Engineering in 2016. The Retrofit Reconnaissance Investigation forms for 14 sites were used to complete the desktop analysis. A breakdown of the number of field assessment sites assigned and completed can be found in Table 3.

4.3 Stream Restoration Desktop Assessments

A total of 0.6 miles of stream restoration desktop assessments were assigned. These sites were identified in the Tiber Branch and Sucker Branch Interceptor Improvements MS4 Site Identification project, conducted by Century Engineering in 2016. A breakdown of the number of field assessment sites assigned and completed can be found in Table 3.

4.4 Tree Planting Desktop Assessments

A total of three tree planting desktop assessment sites were assigned. These three planting areas are located within Waterloo Park. These sites had been identified in the Low Impact Development Retrofits and Tree Planting Summary Report, prepared by Versar in 2013. A field assessment was conducted and the planting areas were determined to be unsuitable for planting. Two of the planting areas were too narrow and close to the walking path and baseball field, and natural reforestation was already occurring in the third planting area. A breakdown of the number of field assessment sites assigned and completed can be found in Table 3.

4.5 Outfall Stabilization Desktop Assessments

A total of five outfall stabilization desktop assessments sites were assigned. These sites were identified in the Tiber Branch and Sucker Branch Interceptor Improvements MS4 Site Identification project, conducted by Century Engineering in 2016. Information provided in the report was used to complete the assessment.

5 Desktop Recommendations Results

The following sub-sections describe the recommendations made as a result of the desktop assessments in terms of the total number of recommendations per category and a breakdown of the restoration/retrofit potential within each category. Results are summarized in Table 4.

Table 4. Number of Site Recommendations Completed for Desktop Sites Assessed

Consultant Firm	**KCI Technologies, Inc.**			
Study Area	**Patapsco River Lower North Branch**			
		Desktop Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion	1	0	0	1
New BMP	17	1	7	9
Stream Restoration	3	3	0	0
Tree Planting	0	0	0	0
Outfall stabilization	5	5	0	0

5.1 BMP Conversion Recommendations

The one assigned desktop assessment site was recommended for retrofit. The site is an existing dry ponds and is proposed to be converted to a wet pond to provide water quality volume treatment for the contributing drainage area. The site was found to have a low conversion potential due to its location on private property, and the presence of water/wastewater utilities. A breakdown of the number of desktop assessment sites and retrofit potential can be found in Table 4. The existing site soils and water balance analysis should be investigated to decide the best conversion options for the next design phase.

5.2 New BMP Recommendations

A total of 17 new BMPs were recommended from the 16 desktop assessments. One site had two BMPs recommended at the site. Only one of these site was found to have a high restoration potential, 7 had medium potential, and 9 had low potential. Bioretention was the most commonly recommended BMP. Further investigations of soils and contributing drainage areas are recommended to decide the best retrofit option for the next design phase. A breakdown of the number of desktop assessment sites and retrofit potential can be found in Table 4.

5.3 Stream Restoration Recommendations

All five assigned stream reaches, totaling 0.6 miles, were recommended for restoration. Reaches were grouped by proximity into three distinct sites, all of which were determined to have a high restoration potential (Table 4).

5.4 Outfall Stabilization Recommendations

All five outfall desktop assessment sites were recommended for stabilization and were determined to have a high outfall stabilization potential. RSC was recommended for one site, drop structure was recommended for three sites, and rip rap stabilization was recommended for one site. A breakdown of the number of desktop assessment sites and retrofit potential can be found in Table 4.

Howard County Watershed Assessments
Field Summary Report

Patapsco River Lower North Branch Watershed
Southern Portion

July 1, 2016

Prepared for:

Howard County Government

Stormwater Management Division

Bureau of Environmental Services

6751 Columbia Gateway Drive, Suite 514

Columbia, Maryland 21046-3143

Prepared by:

McCORMICK TAYLOR

509 South Exeter Street, 4th Floor
Baltimore, Maryland 21202

1.

Table 1. Number of field assessments completed				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name*	**Patapsco River Lower North Branch (LNB) – southern portion**			
Type	**# Sites (or Stream Miles) Assigned (from Table A below)**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP conversion	24	24	0	24
New BMP	11	11	0	11
Stream Restoration	16.6 miles	16.6 miles	1.4 miles	18.0 miles
Tree Planting	8	8	4	12
Outfall stabilization	27	27	14	41

2. If there were sites that could not be assessed in the field, please summarize primary reasons.

BMP Sites:
All sites were evaluated.

Stream Restoration Sites:
Portions of 14 stream assessment sites (1.39 miles total) did not include completion of the detailed assessment form because these reaches were observed with existing good/stable condition.

Tree Planting Sites:
4 tree planting sites did not include completion of the detailed assessment form primarily due to future residential development or the sites were in existing good/forested condition with little or no opportunity for planting.

Outfall Stabilization Sites:
7 outfall sites did not include completion of the detailed assessment form primarily due to no outfall within vicinity of the point or the sites were in existing good/stable condition.

3. Other comments about data or assumptions made.

BMP Sites:

- Facility type does not match County database:
  - LNB-BC-F501 is a wet pond in current conditions.
  - LNB-BC-F502 is a wet pond in current conditions.

    - LNB-BC-F510 has been retrofitted (SDP-02-157). Notes say it is a dry pond, but with PVC underdrain/observation wells in the facility, it appears to be a sand filter or bioretention.
    - LNB-BC-F511 is a wet pond in current conditions.
    - LNB-BC-F514 is a wet pond in current conditions.
    - LNB-BC-F520 is a wet pond in current conditions.
- Sites with new facilities/already treated:
    - LNB-NB-F503 has two new infiltration facilities that are not identified in the County database. These facilities were added as new BMP recommendation footprints and drainage areas for ease of input into the database, and are labeled with the suffixes "EX 1" and "EX 2".
    - LNB-NB-F607 has a new bioretention facility near the baseball fields. It is listed in the County database under the future projects layer with an associated existing BMP drainage area.

Outfall Stabilization Sites:
Outfall stabilization points at 15 sites were moved due to the point being in an incorrect location. In 1 case, the outfall could not be found within the vicinity of the point provided; instead the stormwater pond structure was assessed.

Desktop Sites:
Data for the desktop BMP conversion, new BMP footprints, and outfall stabilization assessments were taken from the Howard County Low Impact Development (LID) Retrofits and Tree Planting Summary Report completed for Howard County by Versar and McCormick Taylor in May, 2013.

4.

Table 2. Number of site recommendation forms completed for field sites assessed				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name*	**Patapsco River Lower North Branch (LNB) – southern portion**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	24	11	9	4
New BMP recommendations	30	6	11	13
Stream Restoration recommendations	53	16	13	24
Tree Planting recommendations	12	7	4	1
Outfall stabilization recommendations	20	6	3	11

5. General comments about the types of recommendations made.

<u>BMP Sites:</u>

- Recommended BMP conversion sites include wet ponds, wetlands, bioretention facilities, sand filters, and rain gardens. These facilities were recommended based on the land use in the area, existing conditions (soil, standing water, vegetation, etc.), and depth of outfall, riser, or inlet structure.
- Recommended new BMP sites primarily include bioretention facilities, sand filters, and swales. Additional facilities include underground sand filters/detention facilities, infiltration facilities, rain gardens, pervious pavement, and roof drain disconnection. New BMP sites were recommended based on available space with a reasonable drainage area, existing utilities (avoiding significant visible conflicts), storm drain location, and existing land use.
- Overall, 17 BMP conversions and new BMP sites have high potential based on the need for repair, the feasibility of construction and access, minimal conflicts, size of impervious drainage area, and land use in the vicinity. Of these high priority facilities, those with the most potential are listed below:
    - LNB-BC-F501 has several feet of sediment accumulation (outfall/low flow is large 42 inch pipe nearly buried).
    - LNB-BC-F506 has a severe headcut and erosion at the outfall channel.

- LNB-BC-F513 - the manhole cover was off of the pond riser and has since been placed back on the riser top. There is one foot of standing water in the forebay.
- LNB-BC-F514 corrosion was found at the pond barrel and CMP that goes under the road just downstream of the pond barrel.
- LNB-NB-F505 has several recommended BMP opportunities, homeowners association property ownership, and existing storm drain with facilities.
- LNB-NB-F607 has several recommended BMP opportunities, county property and available open space, and existing storm drain infrastructure to tie into.
- LNB-NB-F609 has several recommended BMP opportunities, county property and available open space, and existing storm drain infrastructure to tie into.

Stream Restoration Sites:

- Stream restoration is generally recommended in reaches with moderate to severe active erosion, threatened infrastructure, impaired habitat, and limited to moderate constraints.
- Overall, 14 stream reaches in the Lower North Branch watershed have high stream restoration potential. Of these high priority reaches, those with the most potential are listed below:
  - LNB-SR-F501 has moderate to severe bank erosion predominantly located on the right bank side. A 580 linear foot upstream section of concrete channel has been recommended for impervious surface removal. A downstream section is lacking riparian buffer.
  - LNB-SR-F505 includes two actively eroding channels with extensive moderate bank erosion at the upstream extents. Constraints appear to be fairly limited, with the exception of a young forest. One of the recommendation polygons (505C) has limited erosion and high constraints, but is included due to a significant debris blockage that is likely to release a large amount of sediment and cause additional erosion problems in the future. This segment is also causing frequent flooding on the adjacent auto property and may be associated with an owner complaint.
  - LNB-SR-F510 is an actively eroding channel that is experiencing moderate to severe bank erosion, an abundance of sediment depositional areas, and numerous tree falls. Bank erosion is most severe along sharp meander bends with minimal vegetative protection.
  - LNB-SR-F513 includes two actively eroding channels that are experiencing moderate to severe bank erosion and headcutting. Private property and a utility crossing are threatened at the upstream extent of the northern channel. Potential educational opportunity for middle school students. Ownership constraints are low as the majority of the recommended project occurs on County property.
  - LNB-SR-F517 includes two channels experiencing moderate to severe erosion. An outfall at the downstream extent needs stabilization and may undermine the roadway if left untreated. An exposed pipe crosses the western channel. Portions of the recommended project occur on County property.
  - LNB-SR-F554 and LNB-SR-F635 are actively eroding channels with severe erosion. Each channel has a severe headcut located at the upstream extent, within close proximity of an outfall or road crossing. Also associated with LNB-BC-F506 BMP conversion recommendation.

Tree Planting Sites:

- Tree planting recommendations were ranked high when located in cleared areas that are owned by Howard County and some sites that are located in areas adjacent to eroded stream segments. None of the cleared areas assessed contained recent tree plantings.

Outfall Stabilization Sites:

- Outfall stabilization recommendation types include riprap, outfall and apron replacement, drop structures, and regenerative stormwater conveyance.
- Overall, 6 outfalls located in the Lower North Branch watershed have high outfall stabilization potential. Four of these outfalls were recommended for regenerative stormwater conveyance since they are associated with steep slopes and moderate to severe erosion within the outfall channel. One of the outfalls is in need of a drop structure due to a steep slope and severe erosion. One outfall is recommended for stream stabilization and outfall repair due to an undercut outfall apron and moderately eroded outfall channel.

6. List of sites reported to Howard County because of suspected illicit discharges, safety concerns, or other reasons for County followup.

- LNB-BC-F506 is a BMP with a severe headcut and erosion at the outfall channel.
- LNB-BC-F513 - the manhole cover was off of the riser at this pond and has since been placed back on the riser top.
- LNB-SR-F522 had a suspected illicit discharge from an outfall on the floodplain. During the field assessment, the pipe was flowing with no recent rainfall and a man was found digging a trench by hand to convey flow through the outfall directly into a tributary.

7. Other comments/explanations related to data collected.

- Site selection of streams was much improved for this round of assessments. Could still consider performing stream assessments on larger drainage network within local drainage areas or subwatershed areas.
- Consider simplifying database entries and/or incorporating automated data population where possible. For example, fields that occur multiple times for a given site could be autopopulated (e.g. weather for stream reach breaks) and fields that require multiple inputs for limited information could be simplified (e.g. utilities and conflicts for new BMP sites).
- Consider adding contours to reference data as well as all stream network data (hydrology) associated with the watershed.
- Consider adding a layer for existing BMPs not found in County database.

8.

Table 3. Number of desktop assessments completed			
Consultant Firm Name	**McCormick Taylor**		
Study Area Name	**Patapsco River Lower North Branch (LNB) – southern portion**		
Type	**# Sites (or Stream Miles) Assigned – see Table B below**	**Total # Sites (or Stream Miles) For Which Desktop Assessment was Completed**	**For These Sites, Number of Concept Plans Previously Prepared**
BMP conversion	1	1	1
New BMP	4	4	8
Stream Restoration	N/A	N/A	N/A
Tree Planting	N/A	N/A	N/A
Outfall stabilization	1	1	1

Table 4. Number of desktop assessments completed			
Consultant Firm Name	**McCormick Taylor**		
Study Area Name	**Brighton Dam**		
Type	**# Sites (or Stream Miles) Assigned – see Table B below**	**Total # Sites (or Stream Miles) For Which Desktop Assessment was Completed**	**For These Sites, Number of Concept Plans Previously Prepared**
BMP conversion	N/A	N/A	N/A
New BMP	1	1	3
Stream Restoration	N/A	N/A	N/A
Tree Planting	N/A	N/A	N/A
Outfall stabilization	N/A	N/A	N/A

9.

Table 5. Number of site recommendation forms completed for desktop assessment sites				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name	**Patapsco River Lower North Branch (LNB) – southern portion**			
		Desktop Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	1	0	1	0
New BMP recommendations	8	0	6	2
Stream Restoration recommendations	N/A	N/A	N/A	N/A
Tree Planting recommendations	N/A	N/A	N/A	N/A
Outfall stabilization recommendations	1	0	0	1

Table 6. Number of site recommendation forms completed for desktop assessment sites				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name	**Brighton Dam**			
		Desktop Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	N/A	N/A	N/A	N/A
New BMP recommendations	3	0	3	0
Stream Restoration recommendations	N/A	N/A	N/A	N/A
Tree Planting recommendations	N/A	N/A	N/A	N/A
Outfall stabilization recommendations	N/A	N/A	N/A	N/A

STRAUGHAN ENVIRONMENTAL

Revised June 28, 2016

RE: Howard County NPDES Support Services
Rocky Gorge Dam and Brighton Dam Watershed Assessments
KCI Project Number: 16158563.12 KCI Task Number: 12
KCI Project Manager: Mike Pieper
Straughan Project No. 4970-001

Rocky Gorge Dam and Brighton Dam Watersheds
Preliminary Site Assessment Summary Report

1. Number of assessments completed

Table 1.1 Number of Field Assessments Completed				
Consultant Name	Straughan Environmental			
Study Area Name	Brighton Dam			
Type	**No. Sites (or Stream Miles) Assigned**	**No. Assigned Sites (or Stream Mi.) Completed**	**No. Add'l Sites (or Stream Mi.) Added in Field**	**Total No. Sites (or Stream Mi.) Completed**
BMP Conversion	8	8	0	8
New BMP	8	8	0	8
Stream Restoration	13.5 mi	2.5 mi	0.4 mi	2.9 mi
Tree Planting	3	3	19	22
Outfall Stabilization	3	3	1	4

Table 1.2 Number of Field Assessments Completed				
Consultant Name	Straughan Environmental			
Study Area Name	Rocky Gorge Dam			
Type	**No. Sites (or Stream Miles) Assigned**	**No. Assigned Sites (or Stream Mi.) Completed**	**No. Add'l Sites (or Stream Mi.) Added in Field**	**Total No. Sites (or Stream Mi.) Completed**
BMP Conversion	1	1	1	2
New BMP	1	1	0	1
Stream Restoration	3.2 mi	1.2 mi	0.2 mi	1.4 mi
Tree Planting	3	3	5	8
Outfall Stabilization	0	0	0	0

Table 1.3 Number of Desktop Assessments Completed				
Consultant Name	Straughan Environmental			
Study Area Name	Howard County			
Type	**No. Sites Assigned**	**No. Assigned Sites Completed**	**No. Add'l Sites Added**	**Total No. Sites Completed**
BMP Conversion	15	15	0	15

2. Primary reasons that sites could not be assessed

All BMP, Outfall, and Tree planting sites were assessed, but there were a number of stream restoration sites or portions of sites for which assessments could not be completed. The primary reason was lack of site access.. Most sites that were not assessed had fences or "No Trespassing" signs posted. For many sites, notification had been sent to a landowner who did not live at the property, and the individuals managing and/or residing at the property had not been notified, which created a few confusing or tense situations with farmers who were suspicious of our intent. Field crews left the property when requested to do so. A number of sites appeared to be good candidates for stream assessments from a distance, but active permission should be obtained before completing them.

Seven sites were not assessed, or had portions that were not assessed, due to being in good condition.

The centerline for RGD-SR-F204 appeared to follow a historic access road or trail. A shorter potential channel was identified that led from the southeast edge of the existing field and then joined with the identified path. Neither the identified path nor the potential channel had flow at the time of inspection, and areas of erosion did not appear recent based on the extent of vegetation growth. The site was documented with photos.

3. Other comments about data or assumptions made

BMP Sites

- RGD-BC-F251 was added in the field.
- Two existing BMP assessments noted that repairs were needed to the facilities:
    - BRD-BC-F103: rocks missing in gabion channel from forebay to pond; channel from street to forebay starting to erode adjacent to neighboring property
    - BRD-BC-F105: low-flow PVC pipe is cracked and broken at weir; several rodent holes observed along pond berm

- Readily observed structures or markers (manhole, electric lines, etc.) were used to determine conflicts at BMP sites. Stream impacts were assigned if the site contained an observed stream or GIS demarcated stream. For data fields about evidence of water table, bedrock, and poor infiltration, a "Yes" value was only assigned if standing water or bedrock was observed in the field; otherwise "Unknown" or "No" was selected. No outfall could be located at BRD-NB-F101; this was noted in the assessment. Three other site outfalls (BRD-NB-F103, BRD-NB-F104 and BRD-NB-F108) could not be inspected due to fences or obstacles.

Stream Sites

- Four stream sites (0.6 miles total) were added in the field: BRD-SR-F151, BRD-SR-F152, BRD-SR-F153, and RGD-SR-F251.
    - Due to dense overhead vegetation at BRD-SR-F153, both in the field and in aerial imagery, the stream centerline location had to be approximated and may not be accurate along the full length.
- Adjustments were made to assessment centerlines of six stream sites:
    - BRD-SR-F121: minor upstream extension to roadway culvert
    - RGD-SR-F201: correction of path to show where stream flowed through large CMP rather than the existing agricultural pond as originally believed
    - RGD-SR-F204 and RGD-SR-F206: extension of downstream ends to mouth of assessed stream
    - RGD-SR-F205: correction to location of downstream end of stream
    - RGD-SR-F207: correction of stream paths along both branches
- Two stream reaches had data collected from a distance due to fences: BRD-SR-F104A, BRD-SR-F109A; because of this, not all assessment fields could be completed for some data points.
- Three sites could be assessed, but not all assessment fields were able to be completed due to murky high water after rains (i.e., bankfull depth, epifaunal substrate): BRD-SR-F111, BRD-SR-F113, and BRD-SR-F152.
- In addition to documenting unusual or problem conditions, the "Unusual Conditions" point type was also used to document several positive field conditions that would be useful when developing initial designs (i.e., wetlands or groundwater entering from high on stream bank).
- Due to heavy rains preceding the assessments, there was a degree of uncertainty in determining the stream type for three sites: BRD-SR-F117 (marked unknown), BRD-SR-F112, and BRD-SR-F153 (best judgement for both indicates perennial).
- The larger streams downstream of BRD-SR-F121 and RGD-SR-F204 would likely be good candidates for further stream restoration opportunities if they have not already been assessed during previous portions of the Howard County NPDES Watershed Assessments.

Tree Planting Sites

- 24 tree planting sites were added in the field: BRD-TP-F151 through BRD-TP-F169 and RGD-TP-F251 through RGD-TP-F255.
- 11 tree planting sites were evaluated from a distance due to barriers.

Outfall Sites

- BRD-OF-F151 was added in the field.

4. Number of recommendation forms completed for sites assessed

Table 4.1 Number of Recommendation Forms Completed for Field Sites Assessed				
Consultant Name	Straughan Environmental			
Study Area Name	Brighton Dam			
Type	**No. Recommendations**	**High**	**Medium**	**Low**
BMP Conversion	8	4	4	0
New BMP	24	7	11	6
Stream Restoration	17	3	9	5
Tree Planting	26	15	11	0
Outfall Stabilization	3	0	2	1

Table 4.2 Number of Recommendation Forms Completed for Field Sites Assessed				
Consultant Name	Straughan Environmental			
Study Area Name	Rocky Gorge Dam			
		Retrofit Potential (No. Sites)		
Type	**No. Recommendations**	**High**	**Medium**	**Low**
BMP Conversion	2	0	2	0
New BMP	2	0	1	1
Stream Restoration	8	1	4	3
Tree Planting	8	6	2	0
Outfall Stabilization	0	0	0	0

Table 4.3 Number of Recommendation Forms Completed for Desktop Sites Assessed				
Consultant Name	Straughan Environmental			
Study Area Name	Howard County			
Type	**No. Recommendations**	**High**	**Medium**	**Low**
BMP Conversion	15	10	4	1

5. General comments about types of recommendations made

BMP Sites

- Drainage areas (DA) for BMP conversion sites ranged from 8 to 41 acres. Table 4.4 of the "2000 Maryland Stormwater Design Manual" recommends minimum or maximum feasible drainage area limits by BMP type; this table was referenced when developing BMP conversion recommendations (bioretention, wet pond, wetland, micro-pool extended detention, etc.).
- New BMP feasibility determinations were based on the observed existing land use and potential drainage issues. Two sites, BRD-NB-F108 and RGD-NB-F201, were not viable for new BMPs.
    - BRD-NB-F108: Existing land use is a nursery and landscaping business with a large number of constraints.
    - RGD-NB-F201: Proposed location is between two existing BMPs and should be considered for a conversion site (added as assessment site RGD-BC-F251).
- At sites where new BMPs were deemed viable, drainage area recommendations in Table 4.4 of the "2000 Maryland Stormwater Design Manual" were again referenced when recommending BMP types (swale, micro-bioretention, rain garden, etc.).
- Replacement of impervious pavement with a pervious paving alternative or complete pavement removal was also recommended for sites with excessive pavement.
- Green roofs were recommended in two instances (BRD-NB-F103D and BRD-NB-F105E). This was based only on the large roof area available, and structural analysis is required for further determination of feasibility.

Stream Sites

- Most sites, even those that could not be accessed for an assessment, were very small first order streams through crop fields or pastures, and would primarily benefit from animal exclusion and vegetative buffer establishment. Buffers could include trees, brush, and/or wetland planting.
- All of the sites with completed assessments had areas of notable erosion (2' or more high over a length of 10' or more). There are three sites where buffer creation is expected to be the best

on-site method to enhance bank stability, while the rest of the sites would benefit from more substantial bank stabilization efforts.

- Site RGD-SR-F201 is located on Howard County Park Property and has the unique restoration opportunity to daylight approximately 250' of stream that is currently flowing through a large (42 or 48 inch) CMP pipe. This, however, would likely involve changes to a historic agricultural pond (also on park property), which may spark concerns about accumulated nutrients or sediments.
- Restoration recommendations included stabilizing banks, controlling stream grade, raising bed elevations, and reconnecting floodplains through bank grading, bioengineering bank stabilization measures, riffle grade controls, step pool systems, and rock and log vane structures.
- Recommendations at various sites also included additional habitat improvements through the use of root-wads and felled trees, the creation and enhancement of wetlands along banks, and the creation of vernal pools and oxbow wetlands.
- Further assessment upstream or downstream of two sites would increase the restoration potential and create more viable restoration opportunities at the sites: BRD-SR-F102 and BRD-SR-F105. Further assessments could not be completed at this time due to access issues.
- Restoration at site RGD-SR-F207 is only recommended if nutrient problem from upstream in-line BMP is also addressed.
- Two sites are on property owned by nursery or landscaping companies, which may offer unique opportunities for partnering: BRD-SR-F120 and BRD-SR-F104.

Tree Planting Sites

- 19 sites require invasive plant removal within the planting area or along existing adjacent tree lines.
- 7 sites likely require livestock exclusion fencing.
- Roughly one quarter of the sites may have the opportunity for wetland tree and brush planting based on the hydrology.
- While assessing site BRD-TP-F102, a neighbor noted that "droves" of birdwatchers come to see a unique bird in the adjacent woods in early spring. A planting opportunity here could be used to enhance the habitat for that species, which may be of particular benefit if it is considered a rare species by the State.
- Additional tree planting areas may be viable within BRD-TP-F103, but the full site could not be assessed due to access limitations.

Outfall Sites

- Restoration potential at outfall sites was not classified as "High" due to limited access, ownership problems, and significant tree impact potential.

STRAUGHAN ENVIRONMENTAL

6. List of sites reported to Howard County because of suspected illicit discharges, safety concerns, or other reasons for county follow-up

Two observations were reported to Howard County for follow-up:

- A potential illicit discharge at point RGD-SR-F207C-PO001, which is a 4" PVC pipe that extends 5 feet out from the right bank to discharge along the stream centerline. The only nearby structure was a horse barn on top of the hill, and it is expected this pipe connects to that building. The pipe was discharging water at the time of inspection despite no recent rains.
- According to one of the property owners at site BRD-SR-F121, some of his new neighbors have been cutting trees from a forest conservation easement and burning them. The field team reported this information along with point BRD-SR-F121A-UC004, which is an area of recently burnt vegetation along the streambank. Later investigation revealed that the conservation easement in question is located away from the stream. No further information was gained about the burnt area.

7. Other comments/explanations related to data collected

- BMP site visits were done during the first week of May 2016, which involved consistent rainfall. Thus, the dry pond definition given in the Howard County database may not have been observed upon visiting existing BMP sites. This also applies to the Outfall sites visited in that timeframe with respect to "baseflow."
- Straughan has several recommendations for future NPDES assessments that take place on private property:
    - Send notifications to *both* the landowner's address and the physical address when these two are different
    - Revise the notification letter to accurately reflect the extent to which private property will be accessed
    - Consider enclosing pre-stamped return postcards to obtain active permission for assessments on farm properties

Appendix F: Tables Listing Individual Retrofit and Restoration Opportunities with Scores and Rankings

Rankings and Scores for Patxuent River Watershed Project Recommendations
Appendix F

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift-Programmatic Benefit-Feasbility Proportional Score	Total Score Combined Metrics	Watershed	2016 Concept
BRD-NB-F103A	New BMP	Straughan	5.5	8	6	8	8	30	Brighton Dam	Yes
BRD-BC-F102	BMP Conversion	Straughan	3.4	5	10	5	8	28	Brighton Dam	Yes
BRD-NB-F102B	New BMP	Straughan	0.0	2	10	10	6	28	Brighton Dam	Yes
BRD-NB-F102C	New BMP	Straughan	0.0	2	10	10	6	28	Brighton Dam	Yes
BRD-BC-D001	BMP Conversion	Straughan	2.6	4	10	5	8	27	Brighton Dam	Yes
PRU-BC-F302	BMP Conversion	Biohabitats	5.2	8	3	8	4	23	Patuxent River Upper	Yes
PRU-NB-F301A	New BMP	Biohabitats	0.4	2	10	8	6	26	Patuxent River Upper	Yes
RGD-SR-F206	Stream Restoration	Straughan	10.7	10	3	8	6	27	Rocky Gorge Dam	Yes
RGD-SR-F207	Stream Restoration	Straughan	16.4	10	3	8	6	27	Rocky Gorge Dam	Yes
PRU-NB-F301B	New BMP	Biohabitats	0.2	2	10	8	6	26	Patuxent River Upper	Yes
PRU-NB-F301C	New BMP	Biohabitats	0.4	2	10	8	6	26	Patuxent River Upper	Yes
PRU-NB-F301D	New BMP	Biohabitats	0.5	2	10	8	6	26	Patuxent River Upper	Yes
PRU-OF-F306A	SPSC	Biohabitats	1.2	4	6	10	4	24	Patuxent River Upper	Yes
BRD-NB-F102A	New BMP	Straughan	0.1	2	10	8	6	26	Brighton Dam	Yes
BRD-NB-F102F	New BMP	Straughan	0.4	2	10	8	6	26	Brighton Dam	Yes
BRD-NB-F105A	New BMP	Straughan	0.0	2	10	8	6	26	Brighton Dam	Yes
PRU-OF-F306B	SPSC	Biohabitats	1.5	4	6	10	4	24	Patuxent River Upper	Yes
PRU-SR-F305A	Stream Restoration	Biohabitats	15.4	10	3	8	6	27	Patuxent River Upper	Yes
PRU-SR-F307A	Stream Restoration	Biohabitats	14.7	10	3	8	6	27	Patuxent River Upper	Yes
PRU-SR-F685B-PO002	SPSC	KCI	2.3	4	6	10	6	26	Patuxent River Upper	Yes
PRU-SR-F685B-PO003	SPSC	KCI	2.7	4	6	10	6	26	Patuxent River Upper	Yes
BRD-NB-F104A	New BMP	Straughan	0.4	2	10	5	8	25	Brighton Dam	Yes
BRD-SR-F102A	Stream Restoration	Straughan	7.9	8	3	8	6	25	Brighton Dam	Yes
BRD-SR-F109A	Stream Restoration	Straughan	16.1	10	3	8	4	25	Brighton Dam	Yes
BRD-SR-F120	Stream Restoration	Straughan	6.6	8	3	8	6	25	Brighton Dam	Yes
BRD-SR-F121A	Stream Restoration	Straughan	9.0	8	3	8	6	25	Brighton Dam	Yes
BRD-SR-F122	Stream Restoration	Straughan	6.0	8	3	8	6	25	Brighton Dam	Yes
PRU-SR-F685B	Stream Restoration	KCI	6.5	8	3	8	6	25	Patuxent River Upper	Yes
RGD-TP-F201	Tree Planting	Straughan	5.2	8	6	5	6	25	Rocky Gorge Dam	Yes
PRU-SR-F305F	Stream Restoration	Biohabitats	5.5	8	3	8	6	25	Patuxent River Upper	Yes
BRD-OF-F151	SPSC	Straughan	1.2	4	6	10	4	24	Brighton Dam	Yes
BRD-SR-F151A	Stream Restoration	Straughan	3.1	5	3	8	8	24	Brighton Dam	Yes
RGD-SR-F201A	Stream Restoration	Straughan	3.7	5	3	8	8	24	Rocky Gorge Dam	Yes
BRD-BC-F101	BMP Conversion	Straughan	1.9	4	3	10	6	23	Brighton Dam	Yes
BRD-BC-F104	BMP Conversion	Straughan	0.6	2	10	5	6	23	Brighton Dam	Yes
BRD-NB-F103B	New BMP	Straughan	1.8	4	3	8	8	23	Brighton Dam	Yes
BRD-TP-F103A	Tree Planting	Straughan	1.4	4	6	5	8	23	Brighton Dam	Yes
RGD-SR-F251A	Stream Restoration	Straughan	8.4	8	3	8	4	23	Rocky Gorge Dam	Yes
RGD-TP-F255	Tree Planting	Straughan	1.3	4	6	5	8	23	Rocky Gorge Dam	Yes
BRD-OF-F103A	SPSC	Straughan	1.5	4	6	10	2	22	Brighton Dam	No
BRD-SR-F104	Stream Restoration	Straughan	4.8	5	3	8	6	22	Brighton Dam	No
BRD-SR-F111	Stream Restoration	Straughan	3.2	5	3	8	6	22	Brighton Dam	No

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift-Programmatic Benefit-Feasbility Proportional Score	Total Score Combined Metrics	Watershed	2016 Concept
BRD-TP-F101	Tree Planting	Straughan	4.4	5	6	5	6	22	Brighton Dam	No
BRD-TP-F154	Tree Planting	Straughan	3.8	5	6	5	6	22	Brighton Dam	No
PRU-BC-F303	BMP Conversion	Biohabitats	3.9	5	3	8	6	22	Patuxent River Upper	No
PRU-SR-F304B	Stream Restoration	Biohabitats	4.6	5	3	8	6	22	Patuxent River Upper	No
RGD-TP-F251	Tree Planting	Straughan	3.8	5	6	5	6	22	Rocky Gorge Dam	No
BRD-BC-F103	BMP Conversion	Straughan	2.5	4	3	8	6	21	Brighton Dam	No
BRD-BC-F105	BMP Conversion	Straughan	1.4	4	3	8	6	21	Brighton Dam	No
BRD-BC-F107	BMP Conversion	Straughan	2.5	4	3	8	6	21	Brighton Dam	No
BRD-NB-F103D	New BMP	Straughan	3.9	5	6	2	8	21	Brighton Dam	No
BRD-SR-F105A	Stream Restoration	Straughan	2.4	4	3	8	6	21	Brighton Dam	No
BRD-TP-F102	Tree Planting	Straughan	1.9	4	6	5	6	21	Brighton Dam	No
BRD-TP-F152	Tree Planting	Straughan	2.3	4	6	5	6	21	Brighton Dam	No
BRD-TP-F153C	Tree Planting	Straughan	1.8	4	6	5	6	21	Brighton Dam	No
BRD-TP-F155	Tree Planting	Straughan	3.0	4	6	5	6	21	Brighton Dam	No
BRD-TP-F157	Tree Planting	Straughan	0.8	2	6	5	8	21	Brighton Dam	No
BRD-TP-F158	Tree Planting	Straughan	2.6	4	6	5	6	21	Brighton Dam	No
BRD-TP-F159	Tree Planting	Straughan	0.3	2	6	5	8	21	Brighton Dam	No
BRD-TP-F165	Tree Planting	Straughan	0.3	2	6	5	8	21	Brighton Dam	No
BRD-TP-F169	Tree Planting	Straughan	1.6	4	6	5	6	21	Brighton Dam	No
PRU-BC-F301	BMP Conversion	Biohabitats	2.2	4	3	10	4	21	Patuxent River Upper	No
PRU-TP-F302	Tree Planting	Biohabitats	1.4	4	6	5	6	21	Patuxent River Upper	No
RGD-BC-F201	BMP Conversion	Straughan	2.9	4	3	8	6	21	Rocky Gorge Dam	No
RGD-SR-F205A	Stream Restoration	Straughan	1.7	4	3	8	6	21	Rocky Gorge Dam	No
RGD-TP-F203	Tree Planting	Straughan	2.7	4	6	5	6	21	Rocky Gorge Dam	No
RGD-TP-F253	Tree Planting	Straughan	0.5	2	6	5	8	21	Rocky Gorge Dam	No
BRD-BC-F106	BMP Conversion	Straughan	3.9	5	3	8	4	20	Brighton Dam	No
BRD-SR-F113A	Stream Restoration	Straughan	3.6	5	3	8	4	20	Brighton Dam	No
BRD-TP-F163	Tree Planting	Straughan	3.9	5	6	5	4	20	Brighton Dam	No
BRD-SR-F117A	Stream Restoration	Straughan	1.2	4	3	8	4	19	Brighton Dam	No
BRD-SR-F153A	Stream Restoration	Straughan	1.8	4	3	8	4	19	Brighton Dam	No
BRD-TP-F103B	Tree Planting	Straughan	0.6	2	6	5	6	19	Brighton Dam	No
BRD-TP-F103C	Tree Planting	Straughan	0.4	2	6	5	6	19	Brighton Dam	No
BRD-TP-F153A	Tree Planting	Straughan	0.4	2	6	5	6	19	Brighton Dam	No
BRD-TP-F153B	Tree Planting	Straughan	0.8	2	6	5	6	19	Brighton Dam	No
BRD-TP-F162	Tree Planting	Straughan	0.7	2	6	5	6	19	Brighton Dam	No
BRD-TP-F166	Tree Planting	Straughan	0.1	2	6	5	6	19	Brighton Dam	No
BRD-TP-F167	Tree Planting	Straughan	0.2	2	6	5	6	19	Brighton Dam	No
RGD-TP-F202	Tree Planting	Straughan	0.3	2	6	5	6	19	Rocky Gorge Dam	No
RGD-TP-F252	Tree Planting	Straughan	1.3	4	6	5	4	19	Rocky Gorge Dam	No
RGD-TP-F254	Tree Planting	Straughan	0.2	2	6	5	6	19	Rocky Gorge Dam	No
BRD-NB-F103C	New BMP	Straughan	1.3	4	3	5	6	18	Brighton Dam	No
BRD-NB-F104B	New BMP	Straughan	0.4	2	6	2	8	18	Brighton Dam	No

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift-Programmatic Benefit-Feasbility Proportional Score	Total Score Combined Metrics	Watershed	2016 Concept
BRD-NB-F104C	New BMP	Straughan	0.4	2	3	5	8	18	Brighton Dam	No
BRD-NB-F105E	New BMP	Straughan	1.2	4	6	2	6	18	Brighton Dam	No
BRD-OF-F103B	Outfall Stabilization	Straughan	7.7	8	3	5	2	18	Brighton Dam	No
BRD-BC-F108	BMP Conversion	Straughan	4.8	5	3	5	4	17	Brighton Dam	No
BRD-TP-F151	Tree Planting	Straughan	0.3	2	6	5	4	17	Brighton Dam	No
BRD-TP-F156	Tree Planting	Straughan	0.3	2	6	5	4	17	Brighton Dam	No
BRD-TP-F160	Tree Planting	Straughan	0.3	2	6	5	4	17	Brighton Dam	No
BRD-TP-F161	Tree Planting	Straughan	0.2	2	6	5	4	17	Brighton Dam	No
BRD-TP-F164	Tree Planting	Straughan	0.1	2	6	5	4	17	Brighton Dam	No
BRD-TP-F168	Tree Planting	Straughan	0.3	2	6	5	4	17	Brighton Dam	No
BRD-NB-D021	New BMP	McCormick Taylor	0.3	2	3	5	6	16	Brighton Dam	No
BRD-NB-D022	New BMP	McCormick Taylor	0.4	2	3	5	6	16	Brighton Dam	No
BRD-NB-D023	New BMP	McCormick Taylor	0.6	2	3	5	6	16	Brighton Dam	No
BRD-NB-F101B	New BMP	Straughan	1.2	4	3	5	4	16	Brighton Dam	No
BRD-NB-F102D	New BMP	Straughan	0.0	2	6	2	6	16	Brighton Dam	No
BRD-NB-F102E	New BMP	Straughan	0.2	2	3	5	6	16	Brighton Dam	No
BRD-NB-F105B	New BMP	Straughan	0.1	2	6	2	6	16	Brighton Dam	No
BRD-NB-F105C	New BMP	Straughan	0.1	2	6	2	6	16	Brighton Dam	No
BRD-NB-F105D	New BMP	Straughan	0.2	2	3	5	6	16	Brighton Dam	No
BRD-NB-F106A	New BMP	Straughan	0.1	2	6	2	6	16	Brighton Dam	No
BRD-NB-F106B	New BMP	Straughan	0.0	2	3	5	6	16	Brighton Dam	No
BRD-NB-F107A	New BMP	Straughan	0.5	2	3	5	6	16	Brighton Dam	No
BRD-NB-F107B	New BMP	Straughan	0.8	2	3	5	6	16	Brighton Dam	No
PRU-SR-F685B-PO001	Outfall Stabilization	KCI	2.2	4	3	5	4	16	Patuxent River Upper	No
BRD-NB-F101A	New BMP	Straughan	0.1	2	6	2	4	14	Brighton Dam	No
PRU-SR-F685A-PO001	Outfall Stabilization	KCI	0.8	2	3	5	4	14	Patuxent River Upper	No

Appendix G: Individual Concept Plans for Top-Ranked Opportunities

List of Concept Plans in Patuxent River Watershed

Site ID	Site Name	Project Type	Watershed
BRD-BC-D001	Burntwoods Roads	BMP Conversion	Brighton Dam
BRD-BC-F101	Cattail Creek Country Club	BMP Conversion	Brighton Dam
BRD-BC-F102	Glenwood Middle School BMP	BMP Conversion	Brighton Dam
BRD-BC-F104	Ridge Hunt Dr	BMP Conversion	Brighton Dam
BRD-NB-F102A	WH Boyer BMP	New BMP	Brighton Dam
BRD-NB-F102B	WH Boyer BMP	New BMP	Brighton Dam
BRD-NB-F102C	WH Boyer BMP	New BMP	Brighton Dam
BRD-NB-F102F	WH Boyer BMP	New BMP	Brighton Dam
BRD-NB-F103C	Glenelg High School East	New BMP	Brighton Dam
BRD-NB-F104A	Glenelg High School West	New BMP	Brighton Dam
BRD-NB-F105A	Lisbon Elementary	New BMP	Brighton Dam
BRD-OF-F151	Farm View Ct	Outfall Stabilization	Brighton Dam
BRD-SR-F102A	Woodbine Rd - Stream	Stream Restoration	Brighton Dam
BRD-SR-F109A	AE Mullinix Rd	Stream Restoration	Brighton Dam
BRD-SR-F120	Boyer Landscaping	Stream Restoration	Brighton Dam
BRD-SR-F121A	Shady Lane - Stream	Stream Restoration	Brighton Dam
BRD-SR-F122	Broccolino Way - Stream	Stream Restoration	Brighton Dam
BRD-SR-F151A	Glenelg High School	Stream Restoration	Brighton Dam
BRD-TP-F103A	Shady Lane - Trees	Tree Planting	Brighton Dam
PRU-BC-F302	North Laurel Road	BMP Conversion	Patuxent River Upper
PRU-BC-F304	Industrial Park - Davis Avenue	BMP Conversion	Patuxent River Upper
PRU-NB-F301	Industrial Park - Davis Avenue	New BMP	Patuxent River Upper
PRU-OF-F306	Whiskey Bottom West	Outfall Stabilization	Patuxent River Upper
PRU-SR-F305A	Lyon Avenue - A	Stream Restoration	Patuxent River Upper
PRU-SR-F305F	Lyon Avenue - F	Stream Restoration	Patuxent River Upper
PRU-SR-F307A	Patuxent Lane	Stream Restoration	Patuxent River Upper
PRU-SR-F685B	North Laurel Park	Stream Restoration	Patuxent River Upper
PRU-SR-F685B-PO002	Livery Lane A	Outfall Stabilization	Patuxent River Upper
PRU-SR-F685B-PO003	Livery Lane B	Outfall Stabilization	Patuxent River Upper
RGD-SR-F201A	Scagg's Farm - Stream	Stream Restoration	Rocky Gorge
RGD-SR-F206	Willow Pond Farm - Stream	Stream Restoration	Rocky Gorge
RGD-SR-F207	Paternal Farm - east branch	Stream Restoration	Rocky Gorge
RGD-SR-F251A	Mink Hollow - Stream	Stream Restoration	Rocky Gorge
RGD-TP-F201	Mink Hollow - Trees	Tree Planting	Rocky Gorge
RGD-TP-F255	Scagg's Farm	Tree Planting	Rocky Gorge

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-D001
Site Name: Burntwoods Roads

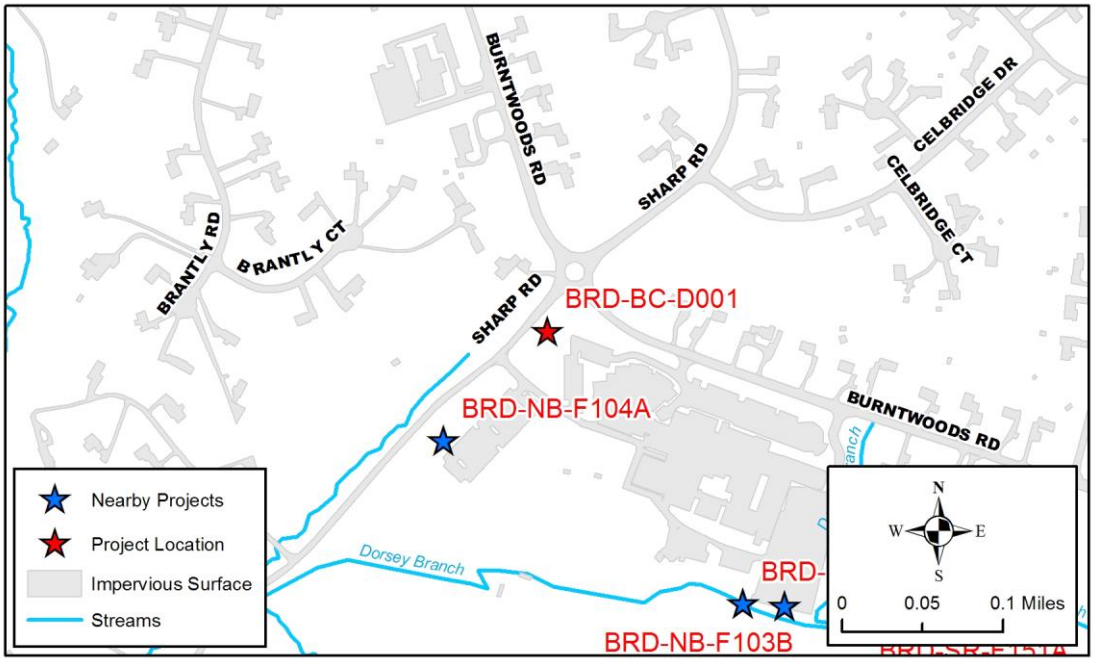
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Infiltration Basin
Ownership: County School
Single Owner

BMP Structure ID: HO101602
Existing BMP Type: DP

Existing Conditions:

This facility, built in 1984, is designed as a dry pond to provide storm water management associated with an addition to Glenelg High School. Most of the development runoff is from parking areas, collected into a major storm drain system and discharges into a concrete channel within the pond, via a 21 in. RCCP pipe and to the riser at northwest of the pond. A 24 in. RCP spillway then discharges to a riprap channel which runs along Sharp Road before entering a stream on the west side of Sharp Road. No water quality improvement is being provided by the pond. No accumulated sediment or vegetation, other than mowed turf, observed.



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-D001
Site Name: Burntwoods Roads
Contractor: Straughan
Watershed: Brighton Dam

Overall pond view.

Receiving riprap ditch.

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-D001
Site Name: Burntwoods Roads
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities appear to be present.

Concept Description:

The proposed retrofit concept is to remove the concrete channel in the basin, convert the existing dry pond into an infiltration basin and provide a new stilling basin and a level spreader immediately downstream of the 21 in. RCCP. The riser structure will remain in place; however, the low-flow path of the infiltration basin will be modified to maximize the low-flow length. The facility must also comply with MD Pond Code 378. Infiltration was chosen since it provides the highest BMP pollutant removal efficiency. Depending on the available filter bed surface area and side slope constraints, greater than 1 in. rainfall is treated. A geotechnical investigation is required to confirm infiltration rates. If the geotechnical analysis shows inadequate infiltration rates, then a secondary option, such as micropool extended detention pond or retention pond, should be considered.

Nearby Opportunities:

BRD-NB-F104A

Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	3.65	WQVolume Target (cft.):	8,999
Impervious Area within Drainage (ac.):	2.55	Max Treated (cft.):	15,616
Impervious Area Treated (ac.):	2.55	Percent Treated:	174%
Impervious Area Treated Credit (ac.):	3.06	Rainfall Depth Treated (in.):	1.74

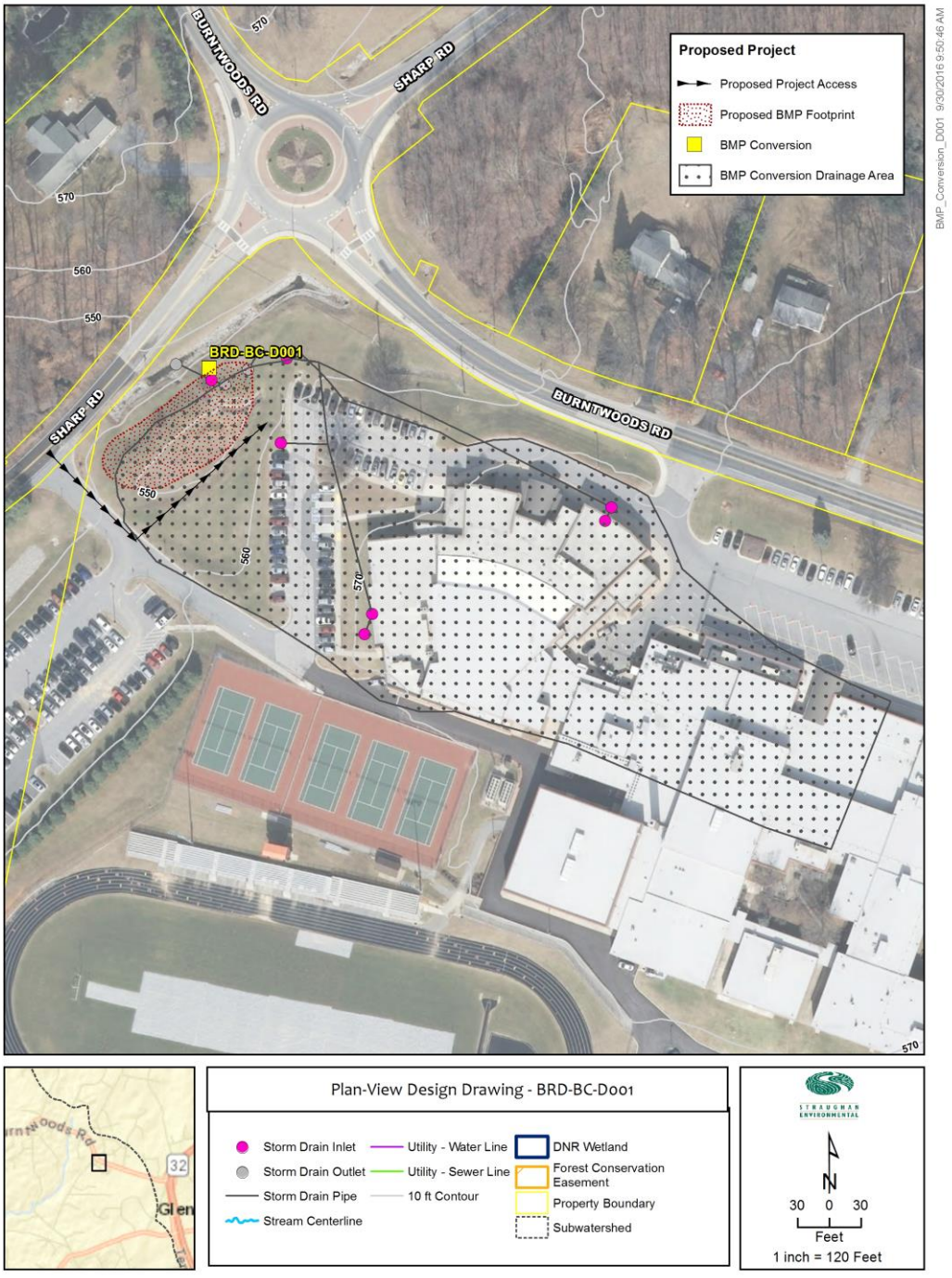
Costs

Estimated Design Cost:	$220,000
Estimated Construction Cost:	$103,440
30% Contingency:	$97,032
Estimated Total Cost	$420,472
Cost per Impervious Credit Acre:	$137,409

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-D001
Site Name: Burntwoods Roads

Contractor: Straughan
Watershed: Brighton Dam



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F101
Site Name: Cattail Creek Country Club

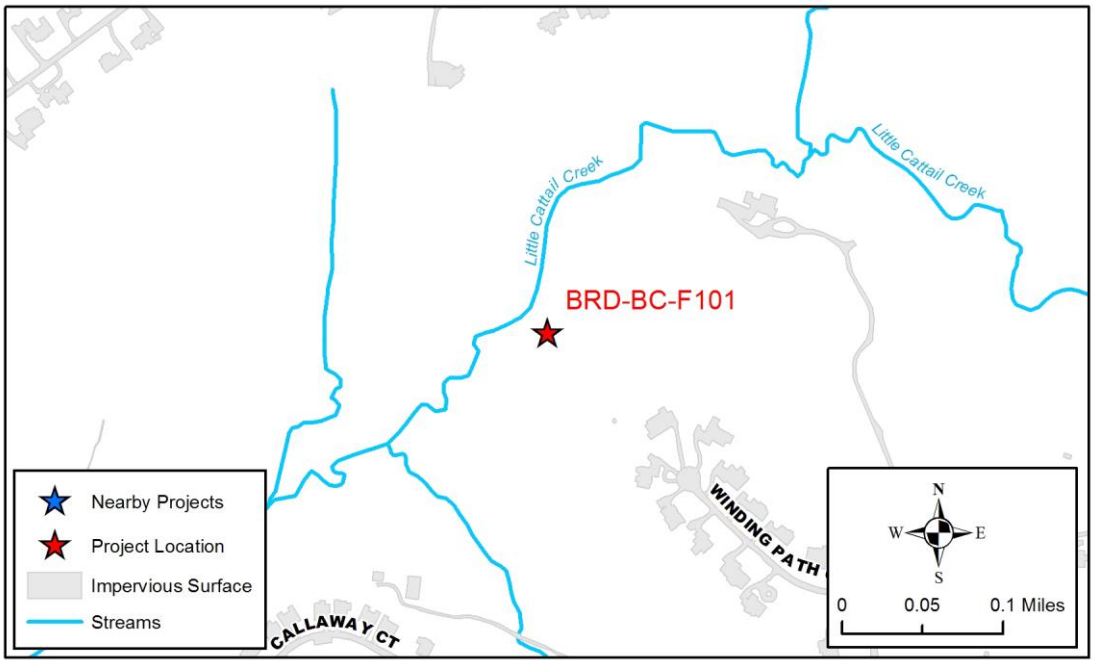
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Wet Pond - Wetland
Ownership: Private- Residential
Single Owner

BMP Structure ID: HO101752
Existing BMP Type: EDSD

Existing Conditions:

Currently, the facility is an extended detention dry pond (EDSD) built in 2000. A 54 in. HDPE pipe brings runoff to a 7600 cf. forebay with gabion outfall. A low flow channel takes forebay outflow to a 6.75 in. low-flow pipe at elevation 434.3 ft., 5 ft. weir at elevation 437.5 ft., 350 ft. weir at elevation 440.5 ft., and wall top at elevation 441.0 ft. The weir and orifice are part of a concrete retaining wall that serves to pond the 2 (437.93 ft.), 10 (440.31 ft.), and 100 (440.96 ft.) yr. runoff volumes. Wetland vegetation was observed along the low flow channel. The receiving channel is approximately 75 ft. from the wall. The current surface area of 50,000 sf. allows multiple conversion possibilities. Woody vegetation was observed along the retaining wall. The facility is owned by Cattail Country Club Inc.



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F101
Site Name: Cattail Creek Country Club
Contractor: Straughan
Watershed: Brighton Dam

Pond view from inflow riprap apron.

Pond view from forebay bank.

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F101
Site Name: Cattail Creek Country Club
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities were observed in the field. As-builts show a 54 in. HDPE stormwater pipe discharging to the forebay.

Concept Description:

The proposed retrofit is a created wetland. The presence of wetland vegetation promotes this conversion for ecological uplift and habitat creation. The 89.97 ac. drainage area consists of 15% impervious area collecting upslope pervious and residential lot runoff. A wetland requires a permanent pool and meandering flow paths. A modification to the existing outfall structure (raising the low-flow orifice) is required. Given available surface area, greater than 1.0-in. rainfall depth is treated. The created wetland discharges via the existing outfall structure to the stream. MD Pond Code 378 compliance will be required.

Nearby Opportunities:

None recommended

Proposed Project Credit	
Drainage Area (ac.):	89.97
Impervious Area within Drainage (ac.):	13.51
Impervious Area Treated (ac.):	13.5
Impervious Area Treated Credit (ac.):	13.5

Water Quality Volume	
WQVolume Target (cft.):	60,471
Max Treated (cft.):	73,019
Percent Treated:	121%
Rainfall Depth Treated (in.):	1.21

Costs	
Estimated Design Cost:	$220,000
Estimated Construction Cost:	$477,764
30% Contingency:	$209,329
Estimated Total Cost	$907,093
Cost per Impervious Credit Acre:	$67,142

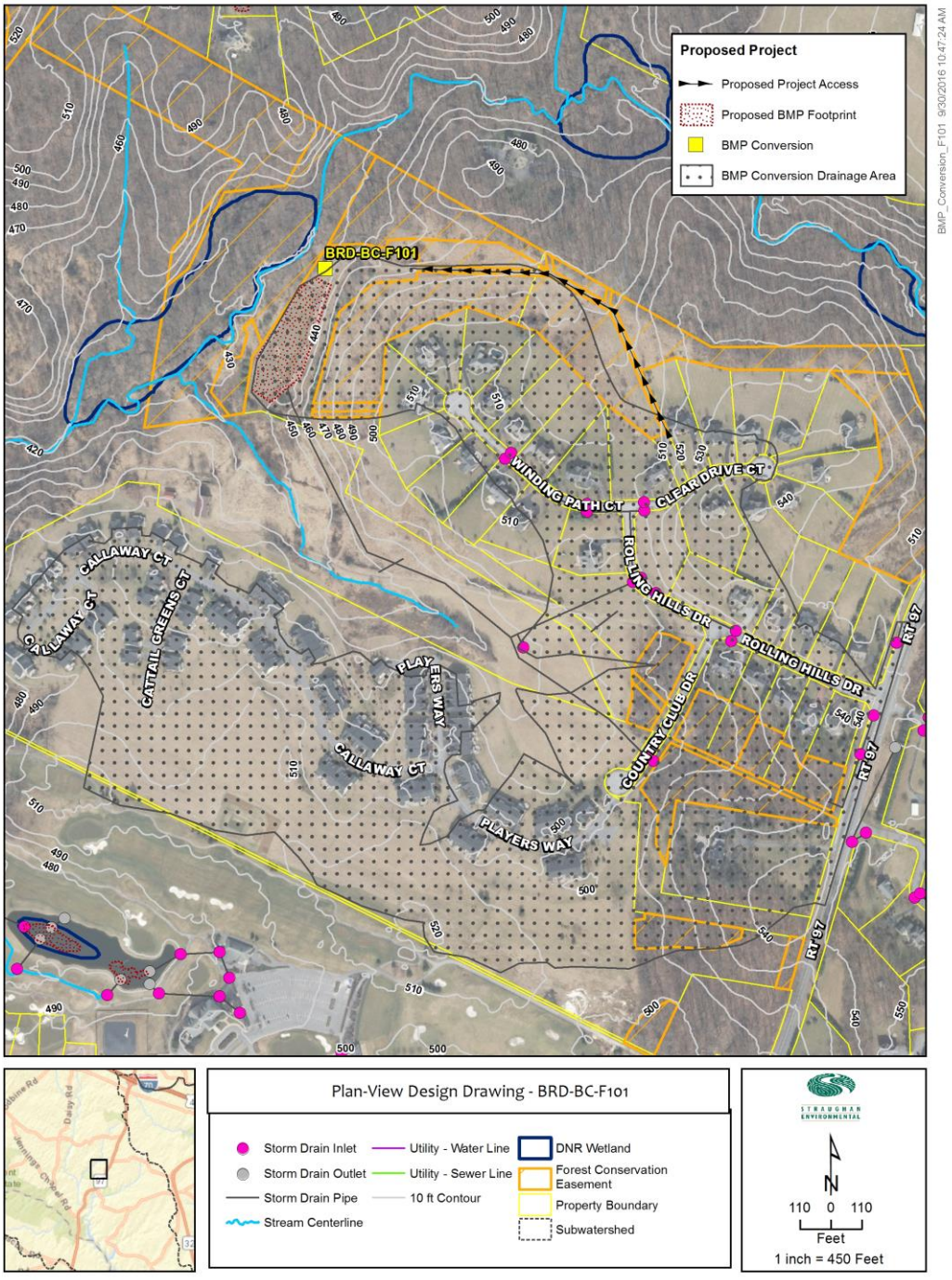
Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F101

Site Name: Cattail Creek Country Club

Contractor: Straughan

Watershed: Brighton Dam



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F102
Site Name: Glenwood Middle School BMP

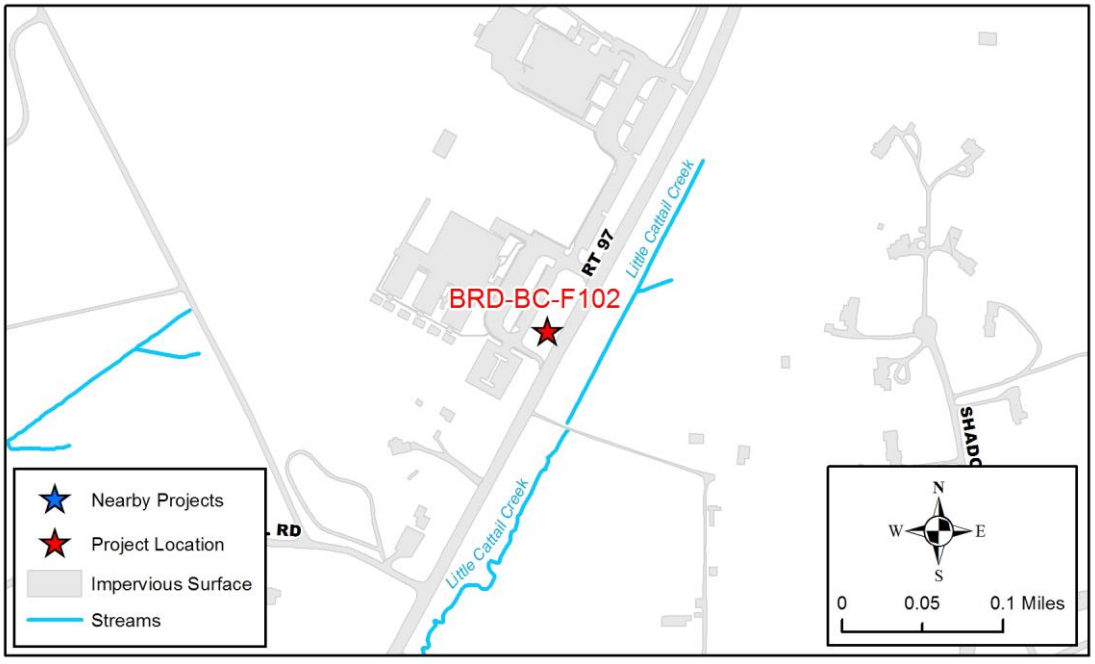
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Bioretention
Ownership: County School
Single Owner

BMP Structure ID: HO101627
Existing BMP Type: DP

Existing Conditions:

Currently, the facility is an extended detention dry pond built in 1998. The facility drainage area is 8.36 ac. with 33% impervious area covering the nearby school. A 24 in. pipe brings runoff from an adjacent ditch to the pond. The riser structure consists of a 6 in. perforated draw-down PVC pipe at 576.00 ft., weir crest at 578.50 ft. and riser top at 581.33 ft. The dam elevation is 581.80 ft. The discharge enters a 24 in. pipe with eventual discharge to a stream. Ponded water was observed around the draw-down orifice. Mowed turf and sediment deposition was observed in the pond.



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F102
Site Name: Glenwood Middle School BMP

Contractor: Straughan
Watershed: Brighton Dam

Overall pond view from south berm.

Upstream ditch discharging to pond.

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F102
Site Name: Glenwood Middle School BMP
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities were observed in the field. As-builts show a 24 in. stormwater pipe discharging to the pond. Utility pole and signage are located nearby.

Concept Description:

The proposed retrofit is an infiltration practice such as bioretention. The presence of only HSG B soils promotes this conversion. The 8.36 ac. drainage area consists of 33% impervious area collecting upslope pervious and school building runoff. Infiltration requires a minimum infiltration rate so soil borings are required. A modification to the existing outfall structure may be required. Given existing land use, 10,560 cf. of storage is required for water quality treatment to 1.0 in. The filter bed surface area and filter bed depths can be altered to maximize the available surface area while still promoting positive drainage to the existing storm drain. This may require a combining excavation for half the media depth and then raising the filter bed above the existing facility surface. The infiltration facility discharges via the existing outfall structure to the drainage network and eventual stream. A geotechnical investigation is required to confirm infiltration rates. If the geotechnical analysis shows inadequate infiltration rates, then a secondary option, such as micropool extended detention pond or retention pond, should be considered. Ensure compliance with MD Pond Code 378.

Nearby Opportunities:

None recommended

Proposed Project Credit	
Drainage Area (ac.):	8.36
Impervious Area within Drainage (ac.):	2.77
Impervious Area Treated (ac.):	2.77
Impervious Area Treated Credit (ac.):	2.77

Water Quality Volume	
WQVolume Target (cft.):	10,560
Max Treated (cft.):	11,000
Percent Treated:	104%
Rainfall Depth Treated (in.):	1.04

Costs

Estimated Design Cost:	$220,000
Estimated Construction Cost:	$257,600
30% Contingency:	$143,280
Estimated Total Cost	$620,880
Cost per Impervious Credit Acre:	$224,144

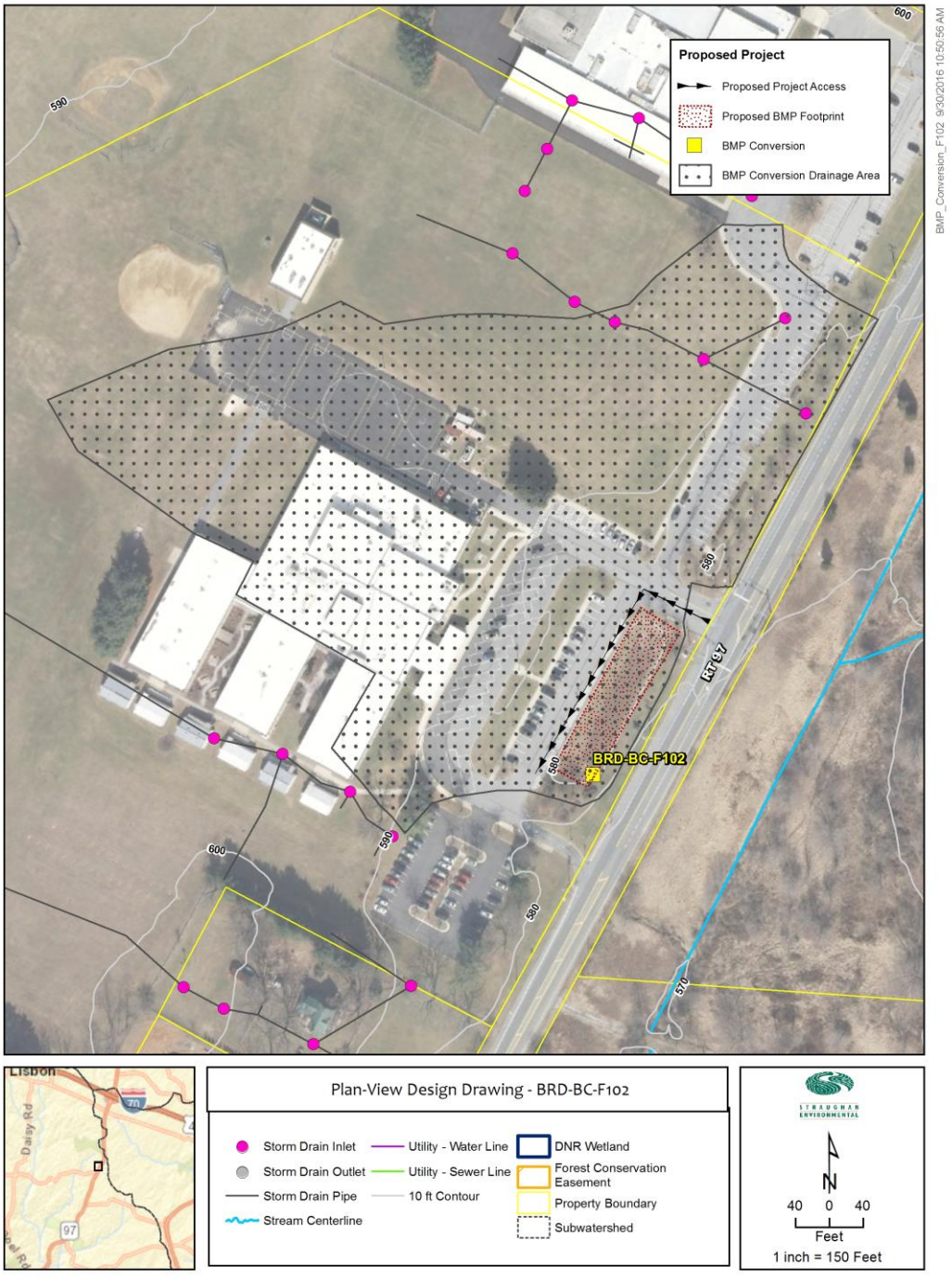
Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F102

Site Name: Glenwood Middle School BMP

Contractor: Straughan

Watershed: Brighton Dam



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F104
Site Name: Ridge Hunt Dr

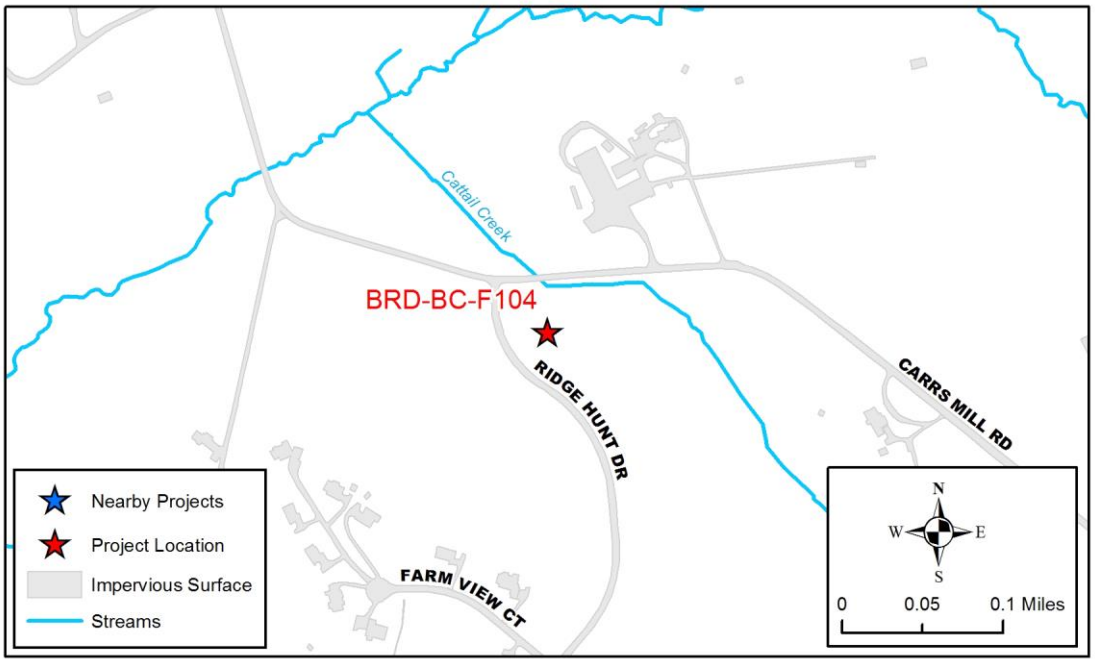
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Bioretention
Ownership: Private- HOA
Single Owner

BMP Structure ID: HO101771
Existing BMP Type: EDSD

Existing Conditions:

Currently, the facility is an extended detention dry pond built in 1997. The facility drainage area is 7.95 ac. with 8% impervious area covering the residential neighborhood. An 18 in. pipe brings runoff to the pond forebay and main basin. The forebay weir is at 506.24 ft. with riprap apron to main basin. The pond bottom is 501.00 ft. The riser structure consists of a 6 in. perforated draw-down PVC pipe at 576.00 ft., a 6 in. weir crest at 503.38 ft., a 3 ft. weir crest at 504.40 ft., and riser top at 507.17 ft. The dam elevation is 508.60 ft. An impervious core is located in the embankment. The emergency spillway crest is at 506.55 ft. The discharge enters a 24 in. pipe, invert 500.90 ft. to discharge to a 20 ft. riprap apron at invert 500.08 ft. and eventual discharge to a stream 75 ft. downslope. Small shrubs and grasses were observed in the facility. No sediment accumulation observed. Anti-seep collar, concrete cradle, core trench and RCP were located on as-builts.



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F104
Site Name: Ridge Hunt Dr

Contractor: Straughan
Watershed: Brighton Dam

Pond view from emergency spillway.

Overall pond view from south.

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F104
Site Name: Ridge Hunt Dr
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities were observed in the field. As-builts show an 18 in. stormwater pipe discharging to the pond.

Concept Description:

The proposed retrofit is bioretention. The presence of HSG B soils promotes this conversion. The 7.95 ac. drainage area consists of 8% impervious area collecting upslope pervious and residential runoff. Bioretention drainage area is limited to 5 ac. per MDE manual but exceptions can be granted. A modification to the existing outfall structure may be required. A combination of filling in the existing basin with bioretention soil media and excavation to place the remained of the necessary bioretention soil media may be required. 100-yr. water surface elevations must not be increased. Given existing land use, 3,439 cf. of storage is required for water quality treatment to 1.0 in. The bioretention facility discharges via the existing outfall structure to the existing riprap apron and eventually the stream. Ensure compliance with current MD Pond Code 378 standards.

Nearby Opportunities:

None recommended

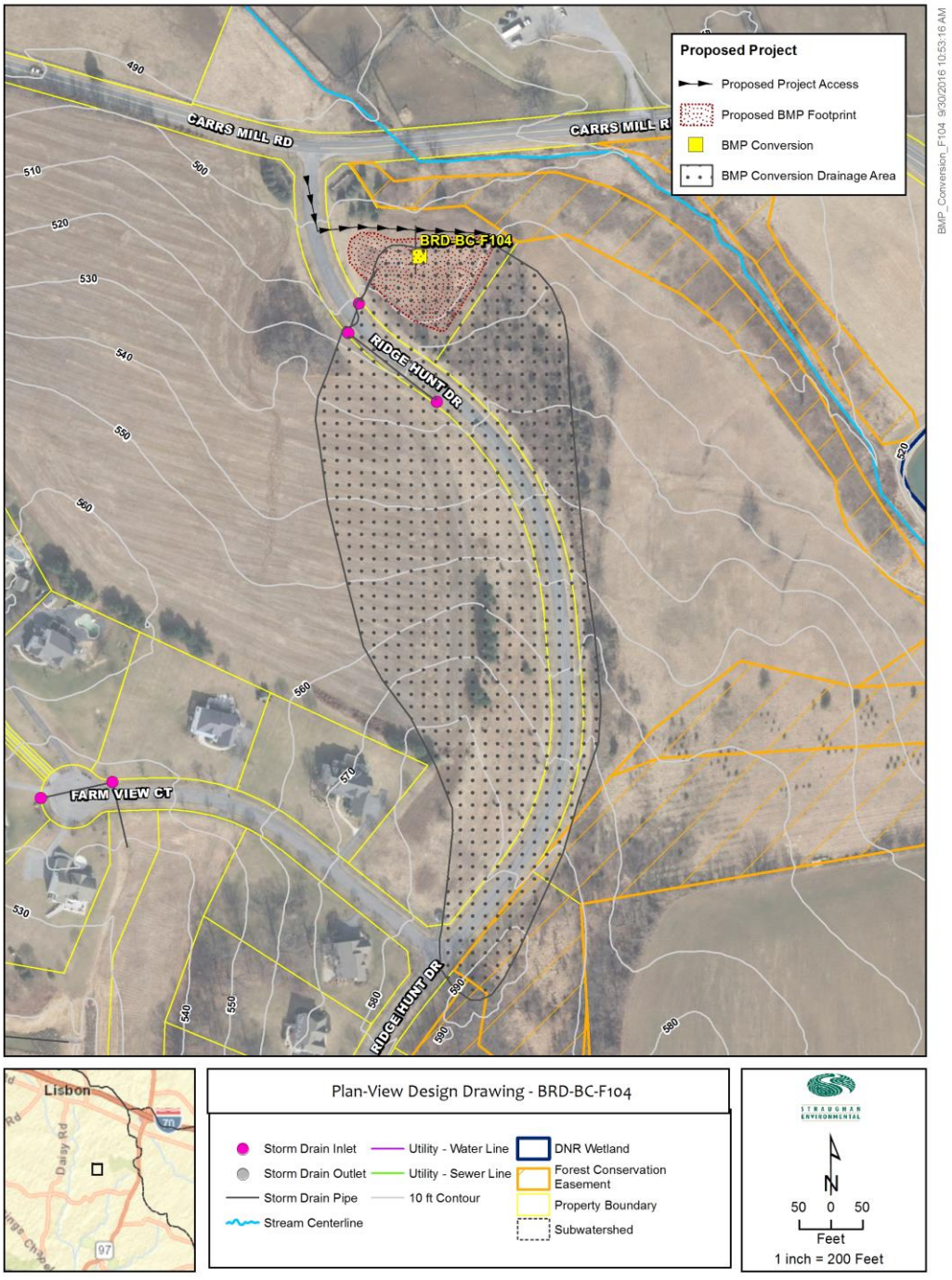
Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	7.95	WQVolume Target (cft.):	3,439
Impervious Area within Drainage (ac.):	0.61	Max Treated (cft.):	3,800
Impervious Area Treated (ac.):	0.61	Percent Treated:	110%
Impervious Area Treated Credit (ac.):	0.61	Rainfall Depth Treated (in.):	1.1

Costs	
Estimated Design Cost:	$220,000
Estimated Construction Cost:	$161,705
30% Contingency:	$114,512
Estimated Total Cost	$496,217
Cost per Impervious Credit Acre:	$813,470

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: BRD-BC-F104
Site Name: Ridge Hunt Dr

Contractor: Straughan
Watershed: Brighton Dam



Howard County Watershed Assessment Concept Plan: New BMP

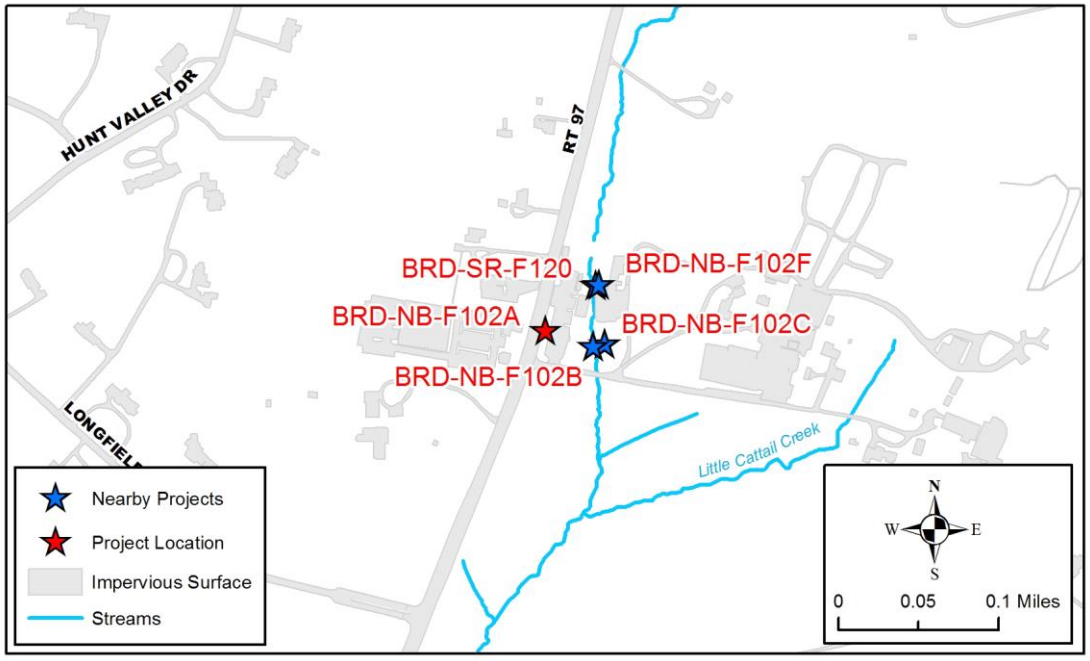
Site ID: **BRD-NB-F102A**
Site Name: **WH Boyer BMP**

Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Bio-Swale
Ownership: Private- Commerical/Industrial
Single Owner

Existing Conditions:

Currently, the location is a strip of pervious area with property owner business signage and shrubs and flowering plants. Two telephone poles with overhead lines run along on side of the grassed area. Maryland Route 97 runoff sheet flows into the grassed area and parking lot with final outflow to the nearby stream.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102A
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam

Existing site conditions looking south with Route 97 on the right.

Existing site conditions looking north with Route 97 on the left.

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102A
Site Name: WH Boyer BMP
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Telephone poles and overhead wires exist on location. As-builts are needed to determine conflicts with existing underground utilities and possible connection to existing drainage networks.

Concept Description:

The proposed bioswale location parallels Route 97 on private property. The 0.10 ac. drainage area consists of 58% impervious area collecting runoff from Route 97. The longitudinal slope and available surface area allow greater than 1.0-in. rainfall depth treatment. Connection to existing drainage systems or installation of new drainage to the nearby receiving stream is required. There may be an opportunity to partner with the landscaping company to complete the construction of this project on the property. If completed together then overall F102 site mobilization and design work cost is decreased.

Nearby Opportunities:

BRD-NB-F102B, BRD-NB-F102C, BRD-NB-F102F, and BRD-SR-F120.

Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	0.09	WQVolume Target (cft.):	194
Impervious Area within Drainage (ac.):	0.06	Max Treated (cft.):	388
Impervious Area Treated (ac.):	0.06	Percent Treated:	200%
Impervious Area Treated Credit (ac.):	0.07	Rainfall Depth Treated (in.):	2

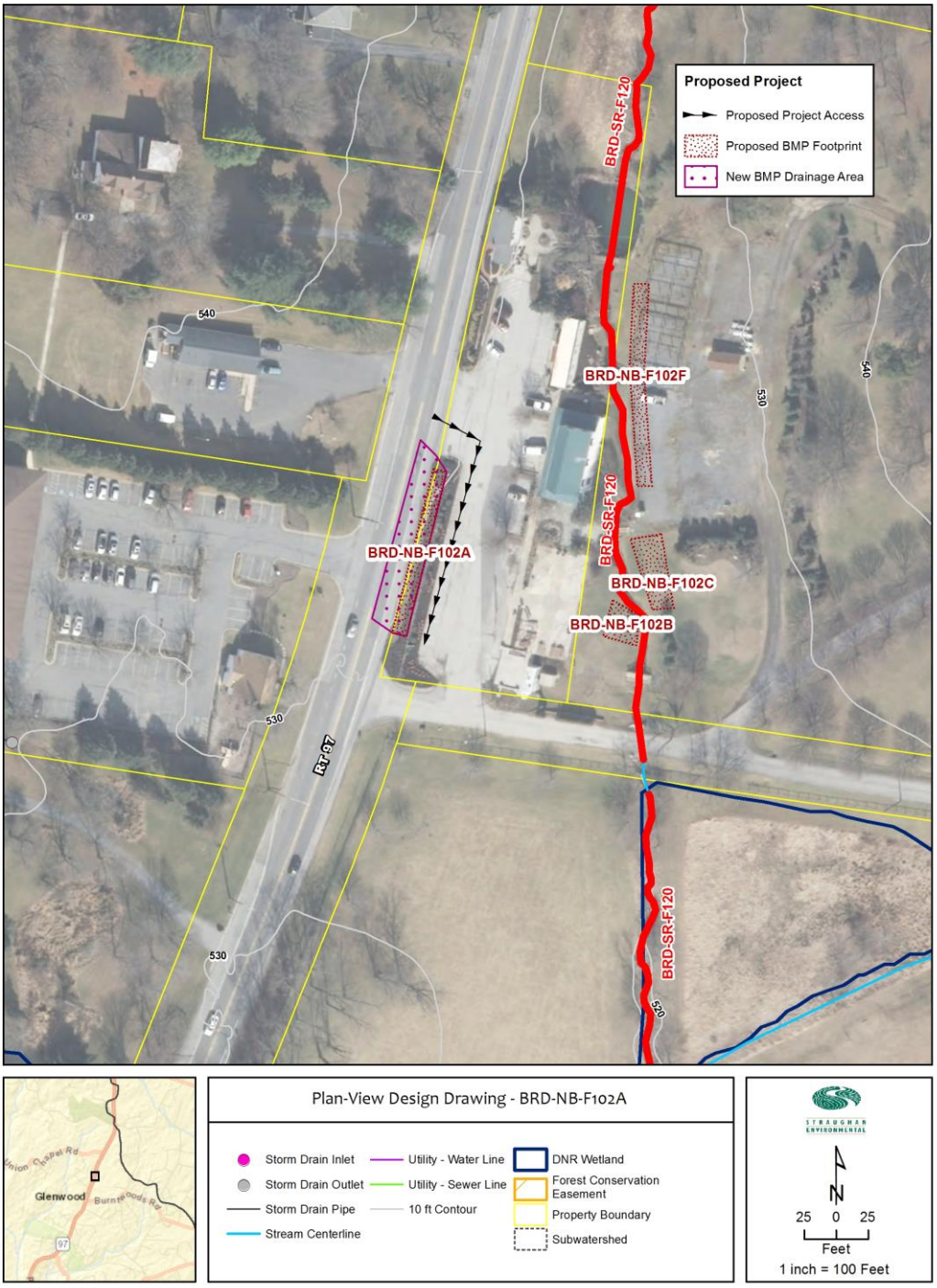
Costs

Estimated Design Cost:	$120,000
Estimated Construction Cost:	$49,200
30% Contingency:	$50,760
Estimated Total Cost	$219,960
Cost per Impervious Credit Acre:	$3,142,286

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102A
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam



Plan-View Design Drawing - BRD-NB-F102A

- Storm Drain Inlet
- Storm Drain Outlet
- Storm Drain Pipe
- Stream Centerline
- Utility - Water Line
- Utility - Sewer Line
- 10 ft Contour
- DNR Wetland
- Forest Conservation Easement
- Property Boundary
- Subwatershed

25 0 25
Feet
1 inch = 100 Feet

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: **BRD-NB-F102B**

Site Name: **WH Boyer BMP**

Contractor: Straughan

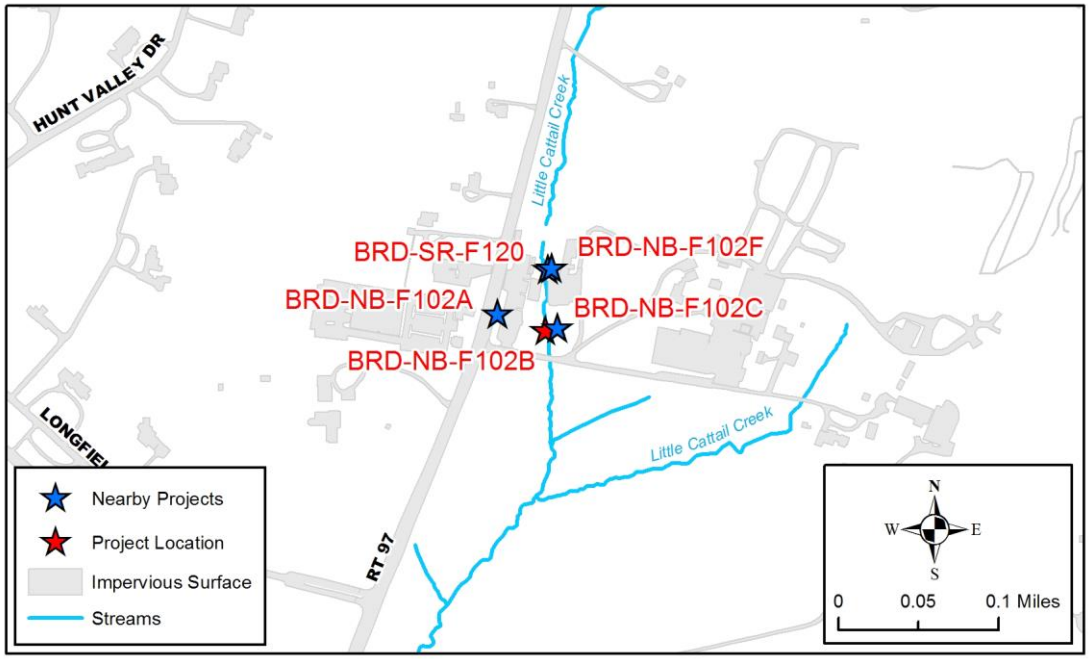
Watershed: Brighton Dam

Proposed BMP Type: Rain Garden

Ownership: Private- Commerical/Industrial
Single Owner

Existing Conditions:

Currently, the location is a grassed area, adjacent to the receiving stream. Upslope parking lot runoff flows across this grassed area. Minor structures (e.g. sheds, food truck) are located on the upslope concrete pad.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102B
Site Name: WH Boyer BMP
Contractor: Straughan
Watershed: Brighton Dam

Grassed area between parking lot and stream.

Contributing impervious area to rain garden footprint.

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102B
Site Name: WH Boyer BMP
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Telephone poles and overhead wires exist on location. Additionally, subdrains are located discharging to the stream. As-builts are needed to determine conflicts with existing underground utilities.

Concept Description:

The proposed rain garden location will be placed on the grassed area between the concrete pad and stream. The 0.12 ac. drainage area consists of 62% impervious area collecting runoff from the upslope parking lot. The available surface area allows greater than 1.0-in. rainfall depth treatment. Direct discharge to the stream and soil infiltration designates no storm drain piping required. There may be an opportunity to partner with the landscaping company to complete the construction of this project on the property. If completed together then overall F102 site mobilization and design work cost is decreased.

Nearby Opportunities:

BRD-NB-F102A, BRD-NB-F102C, BRD-NB-F102F, and BRD-SR-F120.

Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	0.12	WQVolume Target (cft.):	263
Impervious Area within Drainage (ac.):	0.07	Max Treated (cft.):	324
Impervious Area Treated (ac.):	0.07	Percent Treated:	123%
Impervious Area Treated Credit (ac.):	0.07	Rainfall Depth Treated (in.):	1.23

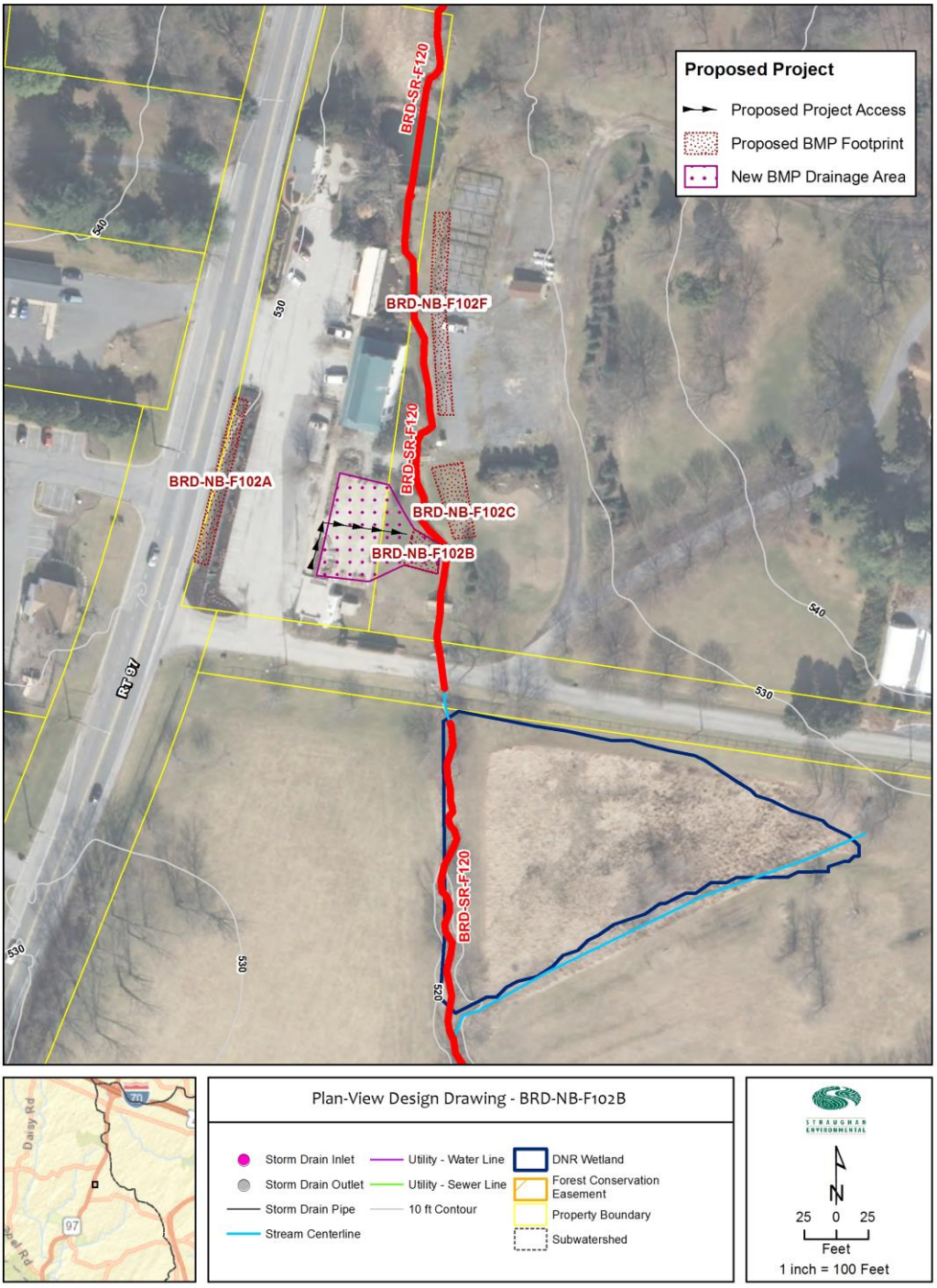
Costs

Estimated Design Cost:	$100,000
Estimated Construction Cost:	$26,810
30% Contingency:	$38,043
Estimated Total Cost	$164,853
Cost per Impervious Credit Acre:	$2,355,043

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102B
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam



Howard County Watershed Assessment Concept Plan: New BMP

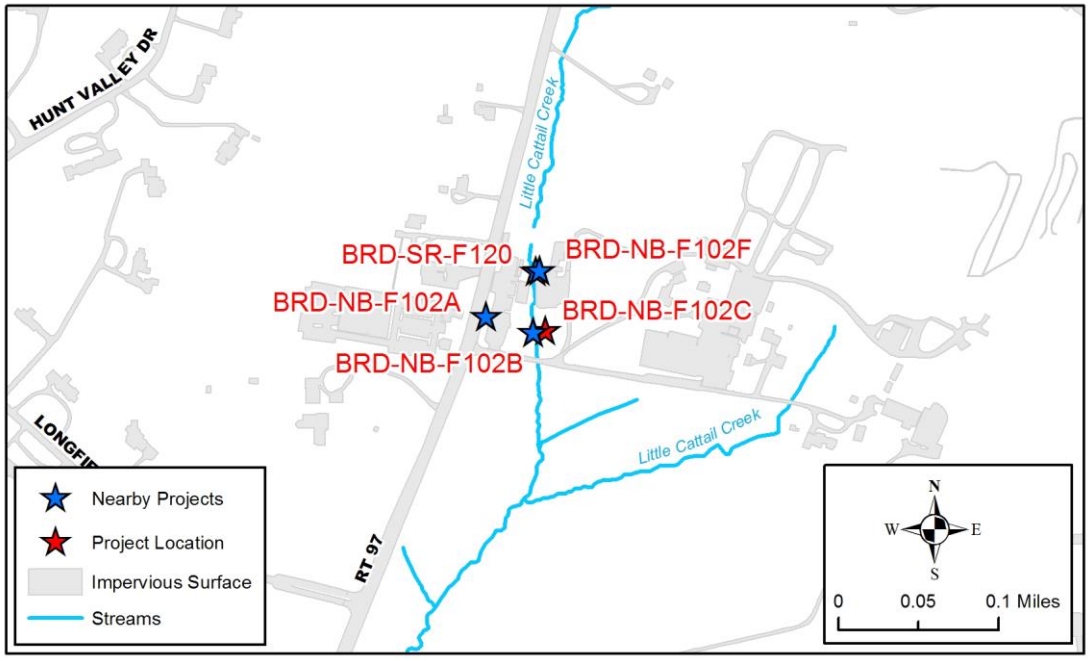
Site ID: BRD-NB-F102C
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Rain Garden
Ownership: Private- Commerical/Industrial
Single Owner

Existing Conditions:

Currently, the location is pervious area adjacent to the stream. Runoff sheet flows across a gravel road, through the grassed area and finally discharges to the nearby stream.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102C
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam

Grassed area for footprint area.

Downstream view of receiving stream.

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102C
Site Name: WH Boyer BMP
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities were observed in the field. As-Builts are needed to check underground utility conflicts.

Concept Description:

The proposed rain garden location is on the opposite bank from the business parking lot and building. The 0.13 ac. drainage area consists of 5% impervious area collecting runoff from upslope grassed area and gravel road. The available surface area allows greater than 1.0-in. rainfall depth treatment. Direct discharge to the stream and soil infiltration designates no storm drain piping required. Additionally, to maintain the 10,000 sf. maximum contributing drainage area for rain gardens, a diversion dike or swale will be required to bypass part of the upslope area to direct discharge to the stream. There may be an opportunity to partner with the landscaping company to complete the construction of this project on the property. If completed together then overall F102 site mobilization and design work cost is decreased.

Nearby Opportunities:

BRD-NB-F102A, BRD-NB-F102B, BRD-NB-F102F, and BRD-SR-F120.

Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	0.13	WQVolume Target (cft.):	45
Impervious Area within Drainage (ac.):	0.01	Max Treated (cft.):	99
Impervious Area Treated (ac.):	0.01	Percent Treated:	221%
Impervious Area Treated Credit (ac.):	0.01	Rainfall Depth Treated (in.):	2.21

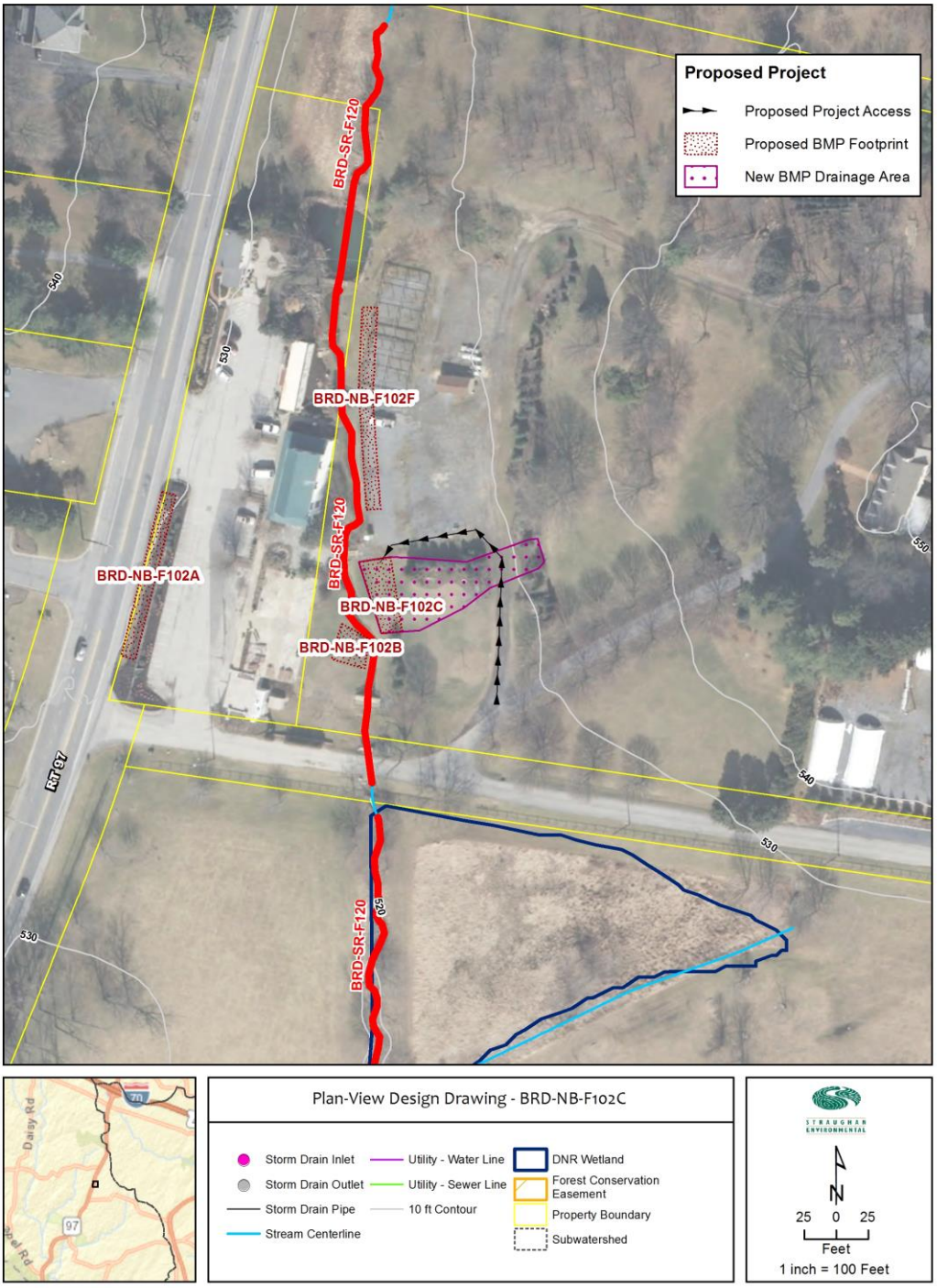
Costs

Estimated Design Cost:	$100.000
Estimated Construction Cost:	$32,245
30% Contingency:	$39,674
Estimated Total Cost	$171,919
Cost per Impervious Credit Acre:	$17,191,850

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102C
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam



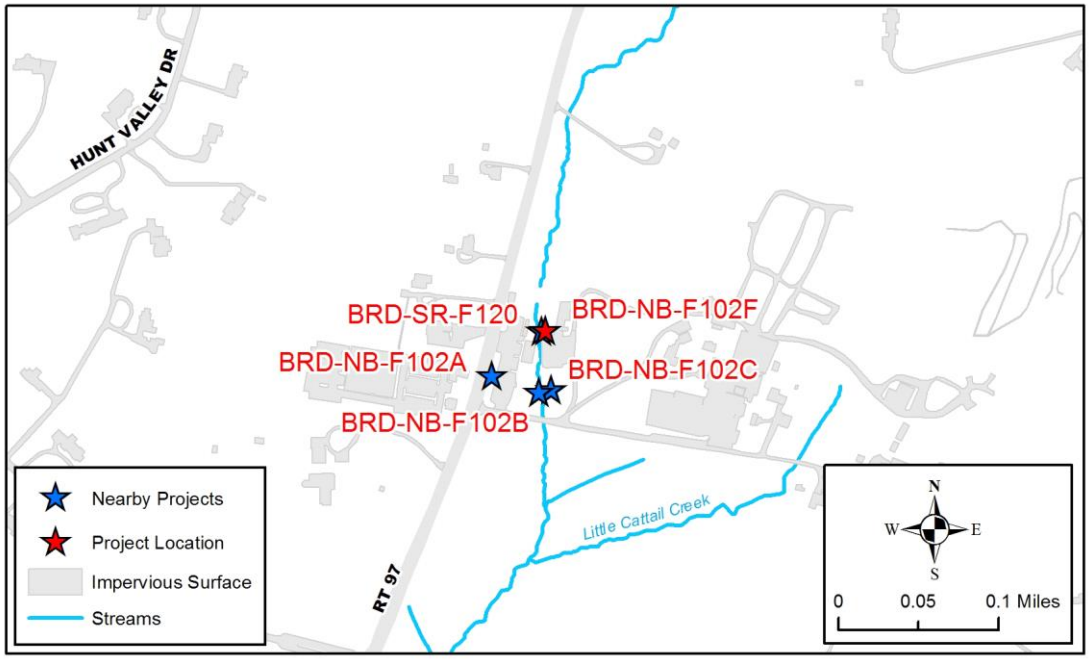
Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102F
Site Name: WH Boyer BMP
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Bio-Swale
Ownership: Private- Commerical/Industrial
Single Owner

Existing Conditions:

Currently, the location is a strip of pervious area between the stream and back gravel parking lot. The parking lot was not filled with equipment or cars when visited. Existing drainage is upslope sheet flow across the gravel parking lot to discharge into the stream.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102F
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam

Upstream view of receiving stream with footprint beyond bridge on right bank of stream.

Footprint area, looking north, between gravel lot and stream beyond wooden bridge.

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102F
Site Name: WH Boyer BMP
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities were observed in the field. As-builts are needed to check underground utility conflicts.

Concept Description:

The proposed bioswale location is between the gravel lot and stream. The 1.00 ac. drainage area consists of 29% impervious area collecting upslope pervious and gravel lot runoff. Based on design criteria, some of the gravel lot may need to be converted to bioswale footprint area. The longitudinal slope and available surface area allow greater than 1.0-inch rainfall depth treatment. The bioswale discharges directly to the stream. There may be an opportunity to partner with the landscaping company to complete the construction of this project on the property. If completed together then overall F102 site mobilization and design work cost is decreased.

Nearby Opportunities:

BRD-NB-F102A, BRD-NB-F102B, BRD-NB-F102C, and BRD-SR-F120.

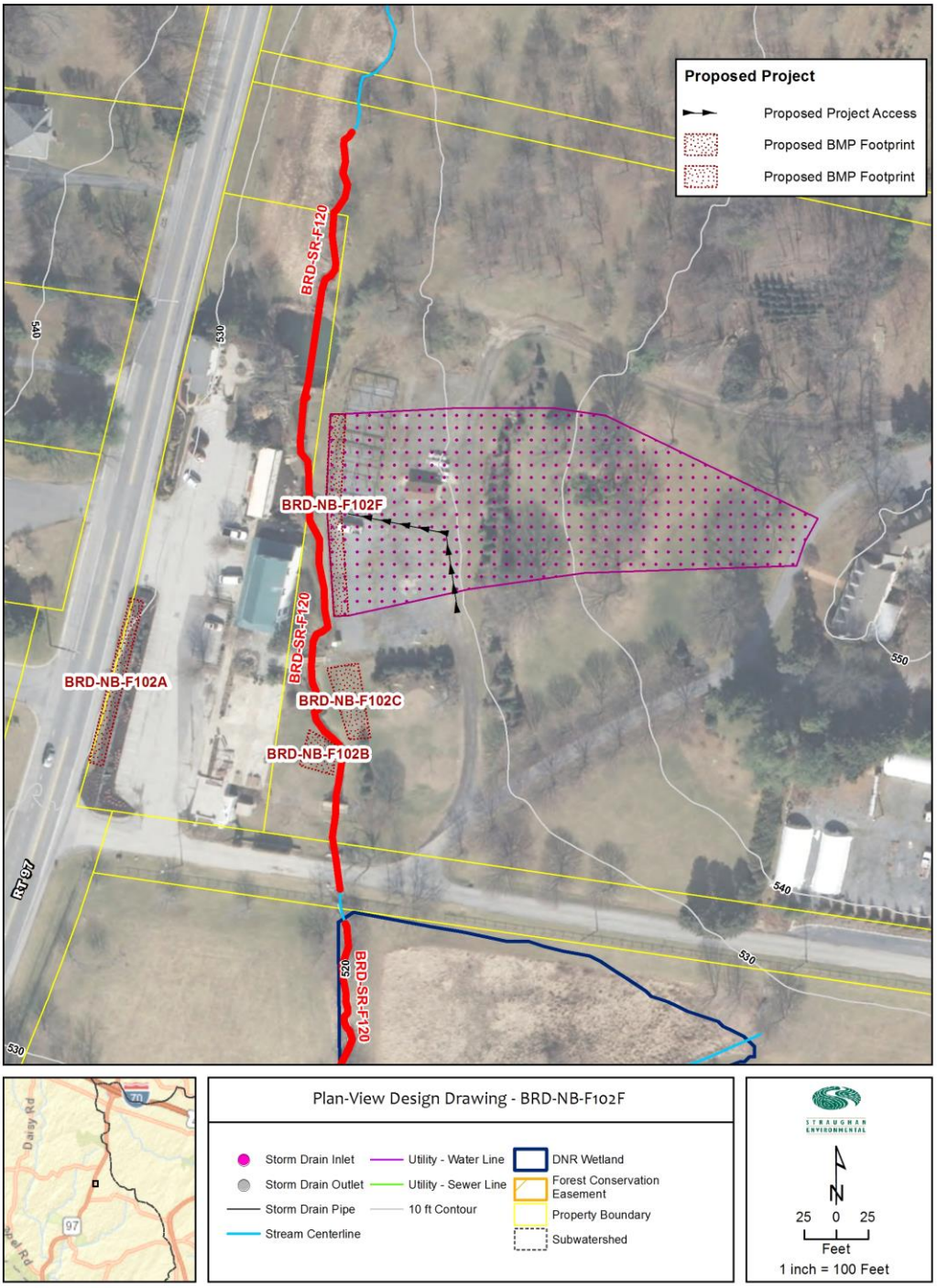
Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	1	WQVolume Target (cft.):	1,118
Impervious Area within Drainage (ac.):	0.29	Max Treated (cft.):	2,236
Impervious Area Treated (ac.):	0.29	Percent Treated:	200%
Impervious Area Treated Credit (ac.):	0.35	Rainfall Depth Treated (in.):	2

Costs	
Estimated Design Cost:	$120,000
Estimated Construction Cost:	$70,440
30% Contingency:	$57,132
Estimated Total Cost	$247,572
Cost per Impervious Credit Acre:	$707,349

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F102F
Site Name: WH Boyer BMP

Contractor: Straughan
Watershed: Brighton Dam



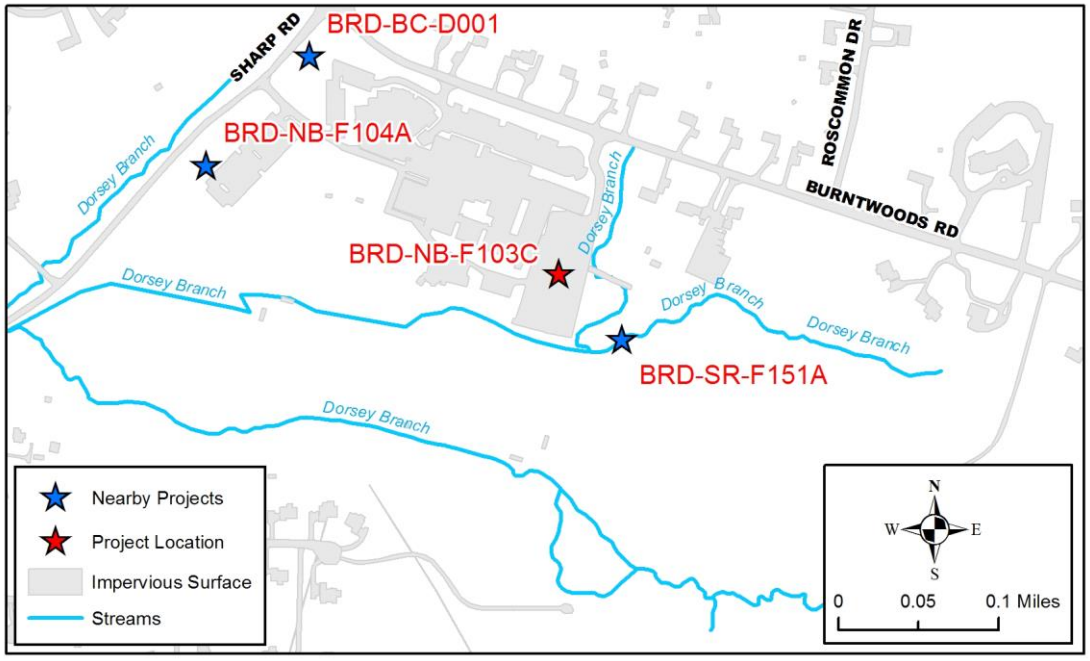
Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F103C
Site Name: Glenelg High School East
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Bioretention
Ownership: County School
Single Owner

Existing Conditions:

Currently, the location is paved parking lot with one-way traffic pattern marked. Existing section width is wide enough to allow two-way traffic (60 ft.). The parking lot was filled with cars when visited. Existing drainage is upslope sheet flow across the parking lot to a concrete pad and discharge into the stream.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F103C
Site Name: Glenelg High School East

Contractor: Straughan
Watershed: Brighton Dam

Existing parking lot two-way section width with one-way traffic flow arrows.

Existing parking lot two-way section width with one-way traffic flow arrows.

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F103C
Site Name: Glenelg High School East
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities were observed in the field. As-builts show no underground utilities in the parking lot.

Concept Description:

The proposed bioretention locations involve replacing pavement with the bioretention footprints. The 2.06 ac. drainage area consists of 70% impervious area collecting upslope pervious and paved road runoff. Based on the concept footprint, the parking section will be wide enough to allow one-way traffic flow with 30 degree parking stall design. No parking space removal is required. Given available surface area, the 1.0-in. rainfall depth is treated. The bioretention outflows are stably discharged to the stream.

Nearby Opportunities:

BRD-BC-D001, BRD-NB-F104A, and BRD-SR-F151A

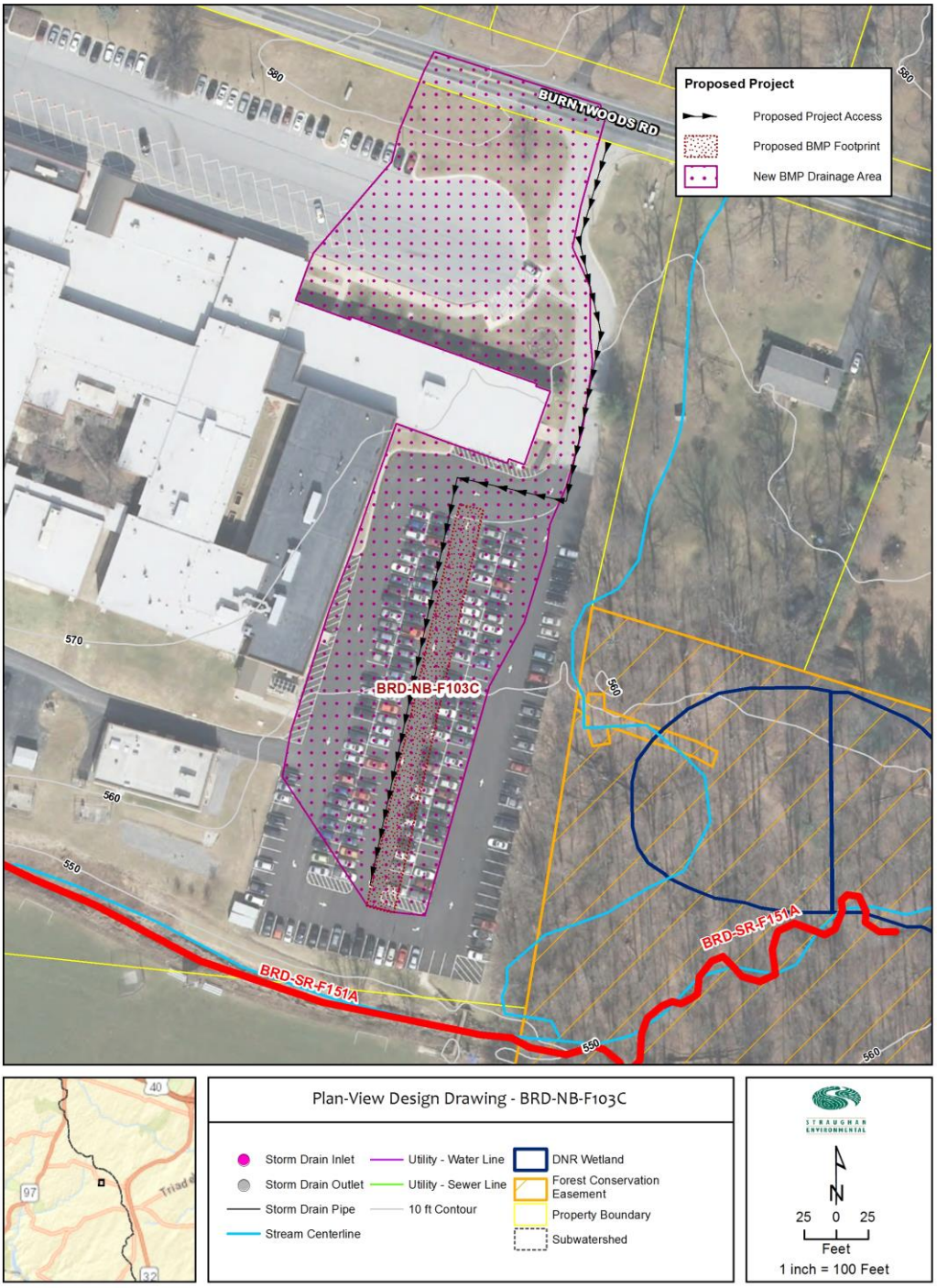
Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	2.06	WQVolume Target (cft.):	5,107
Impervious Area within Drainage (ac.):	1.45	Max Treated (cft.):	5,217
Impervious Area Treated (ac.):	1.45	Percent Treated:	102%
Impervious Area Treated Credit (ac.):	1.45	Rainfall Depth Treated (in.):	1.02

Costs	
Estimated Design Cost:	$200,000
Estimated Construction Cost:	$262,765
30% Contingency:	$138,830
Estimated Total Cost	$601,595
Cost per Impervious Credit Acre:	$414,893

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F103C
Site Name: Glenelg High School East

Contractor: Straughan
Watershed: Brighton Dam



Plan-View Design Drawing - BRD-NB-F103C

- Storm Drain Inlet
- Storm Drain Outlet
- Storm Drain Pipe
- Stream Centerline
- Utility - Water Line
- Utility - Sewer Line
- 10 ft Contour
- DNR Wetland
- Forest Conservation Easement
- Property Boundary
- Subwatershed

STRAUGHAN ENVIRONMENTAL

N

25 0 25

Feet

1 inch = 100 Feet

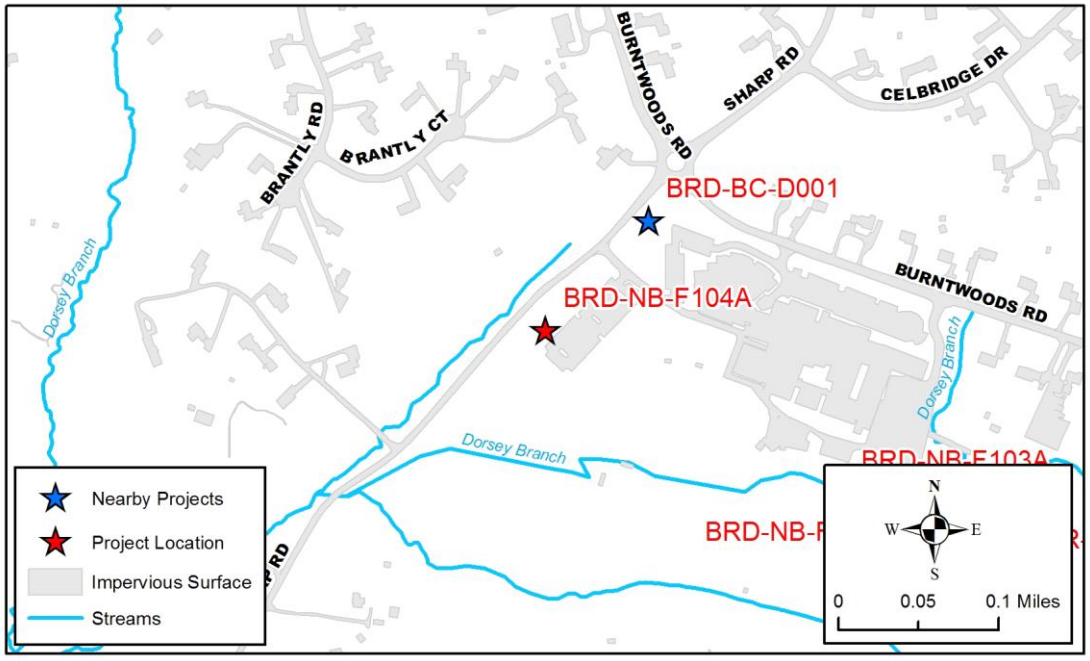
Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F104A
Site Name: Glenelg High School West
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Infiltration Trench
Ownership: County School
Single Owner

Existing Conditions:

Currently, the location is a grassed area adjacent to an existing BMP. The upslope parking lot was filled with cars when visited. Existing drainage is upslope sheet flow across the parking lot to a riprap apron and inlet. The inlet discharges through a pipe to the existing BMP.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F104A
Site Name: Glenelg High School West

Contractor: Straughan
Watershed: Brighton Dam

Possible site location in existing grassed field.

Parking lot draining to existing BMP concept footprint located in back corner of lot.

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F104A
Site Name: Glenelg High School West
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

A well was observed in the field. An inlet was noted at the parking lot corner. As-builts show that inlet directs flow via 15-18 in. RCCP to the existing SWM pond forebay.

Concept Description:

The proposed infiltration trench location collects parking lot runoff. Curb cuts and existing storm drainage removal or relocation are required to direct flow to the proposed facility. The 0.76 ac. drainage area consists of 57% impervious area collecting upslope pervious and paved lot runoff. Given available surface area, greater than 1.0-in. rainfall depth is treated. The bioretention discharges are piped under the down gradient road and to the adjacent stream. A soil boring and testing will be needed to ensure minimum infiltration requirements. Additionally, the existing BMP should be analyzed for water quality volume treatment and overall need for new BMP addition.

Nearby Opportunities:

BRD-BC-D001, BRD-NB-F103C, and BRD-SR-F151A

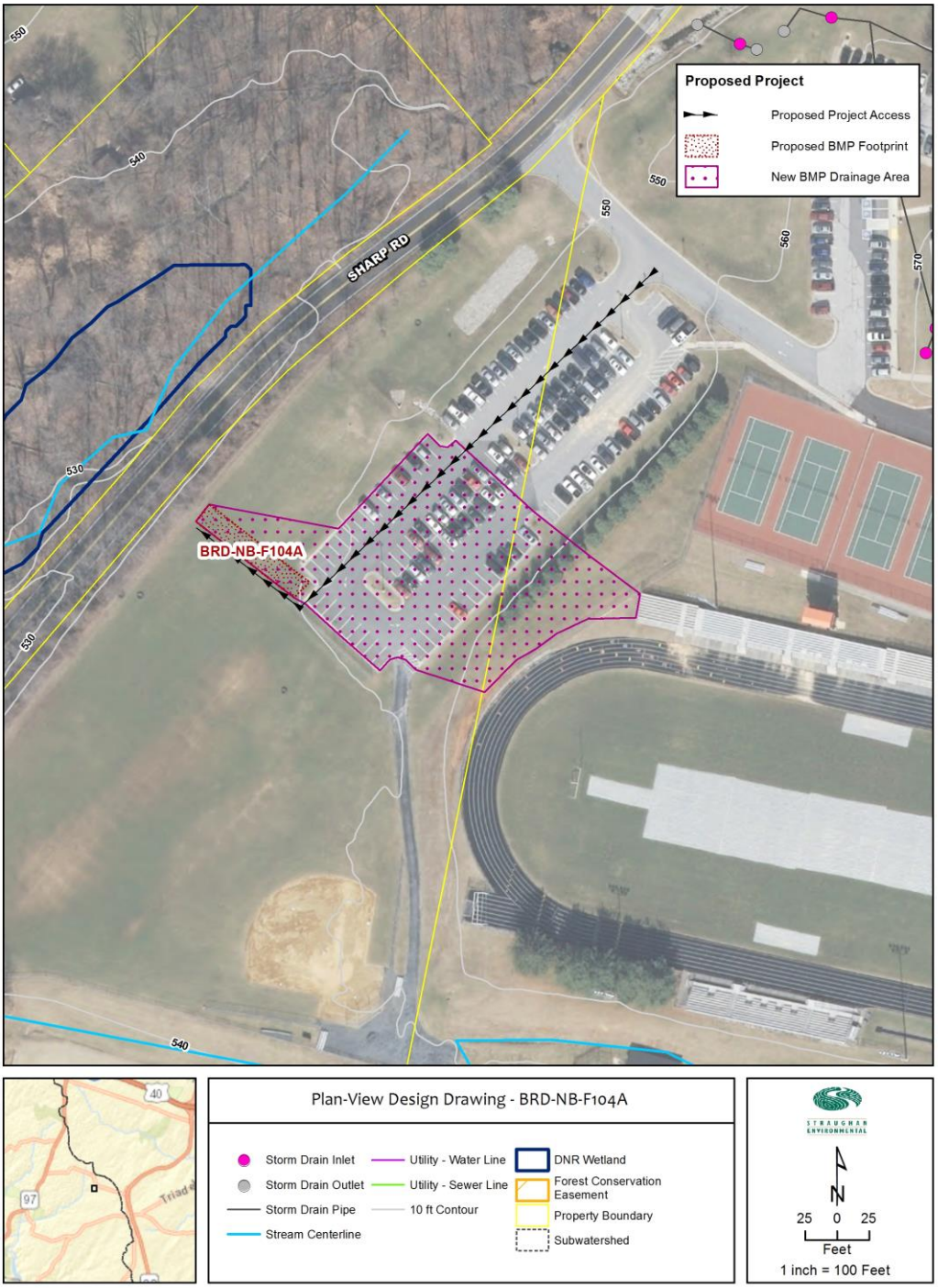
Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	0.76	WQVolume Target (cft.):	1,563
Impervious Area within Drainage (ac.):	0.44	Max Treated (cft.):	2,071
Impervious Area Treated (ac.):	0.44	Percent Treated:	132%
Impervious Area Treated Credit (ac.):	1.1	Rainfall Depth Treated (in.):	1.32

Costs	
Estimated Design Cost:	$120.000
Estimated Construction Cost:	$61,430
30% Contingency:	$54,429
Estimated Total Cost	$235,859
Cost per Impervious Credit Acre:	$214,417

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F104A
Site Name: Glenelg High School West

Contractor: Straughan
Watershed: Brighton Dam



Plan-View Design Drawing - BRD-NB-F104A

- Storm Drain Inlet
- Storm Drain Outlet
- Storm Drain Pipe
- Stream Centerline
- Utility - Water Line
- Utility - Sewer Line
- 10 ft Contour
- DNR Wetland
- Forest Conservation Easement
- Property Boundary
- Subwatershed

25 0 25
Feet
1 inch = 100 Feet

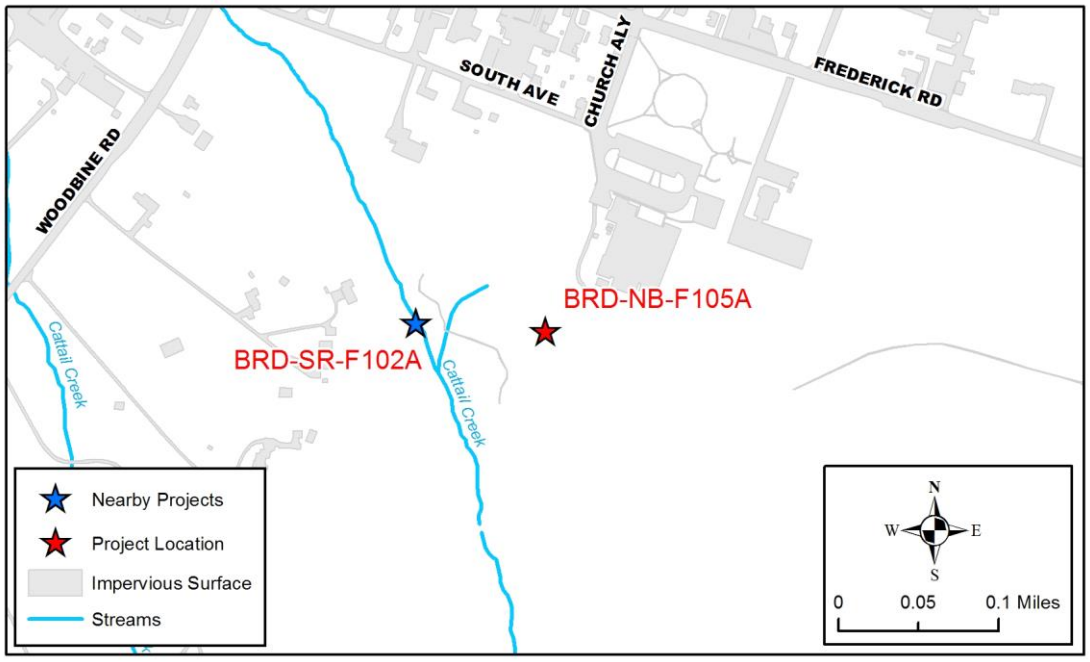
Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F105A
Site Name: Lisbon Elementary
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Bio-Swale
Ownership: County School
Single Owner

Existing Conditions:

Currently, the location is a grassed area adjacent to playing fields and a basketball court. The upslope area is paved paths and courts. Existing drainage is upslope sheet flow across the paved area, through the grassed area, and eventually discharges to the nearby stream. Drainage from the school building is piped via a 24 in. RCP to a concrete channel which discharges to the stream.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F105A
Site Name: Lisbon Elementary

Contractor: Straughan
Watershed: Brighton Dam

Southeast view of footprint site area from basketball court.

Upslope view of footprint site from existing concrete channel.

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F105A
Site Name: Lisbon Elementary
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

No utilities were observed in the field. As-builts show a 15 in. RCP storm sewer pipe from the basketball court directed toward the stream and 20 ft. riprap outfall.

Concept Description:

The proposed bioswale location will be placed from the basketball court corner to the forest edge. Grading from the court down the grassed slope will need to be gradual to prevent accidents by court users. The 0.74 ac. drainage area consists of 39% impervious area collecting upslope pervious and paved lot runoff. Given available surface area, greater than 1.0-in. rainfall depth is treated. The bioswale discharges to the forested region, and eventually the stream.

Nearby Opportunities:

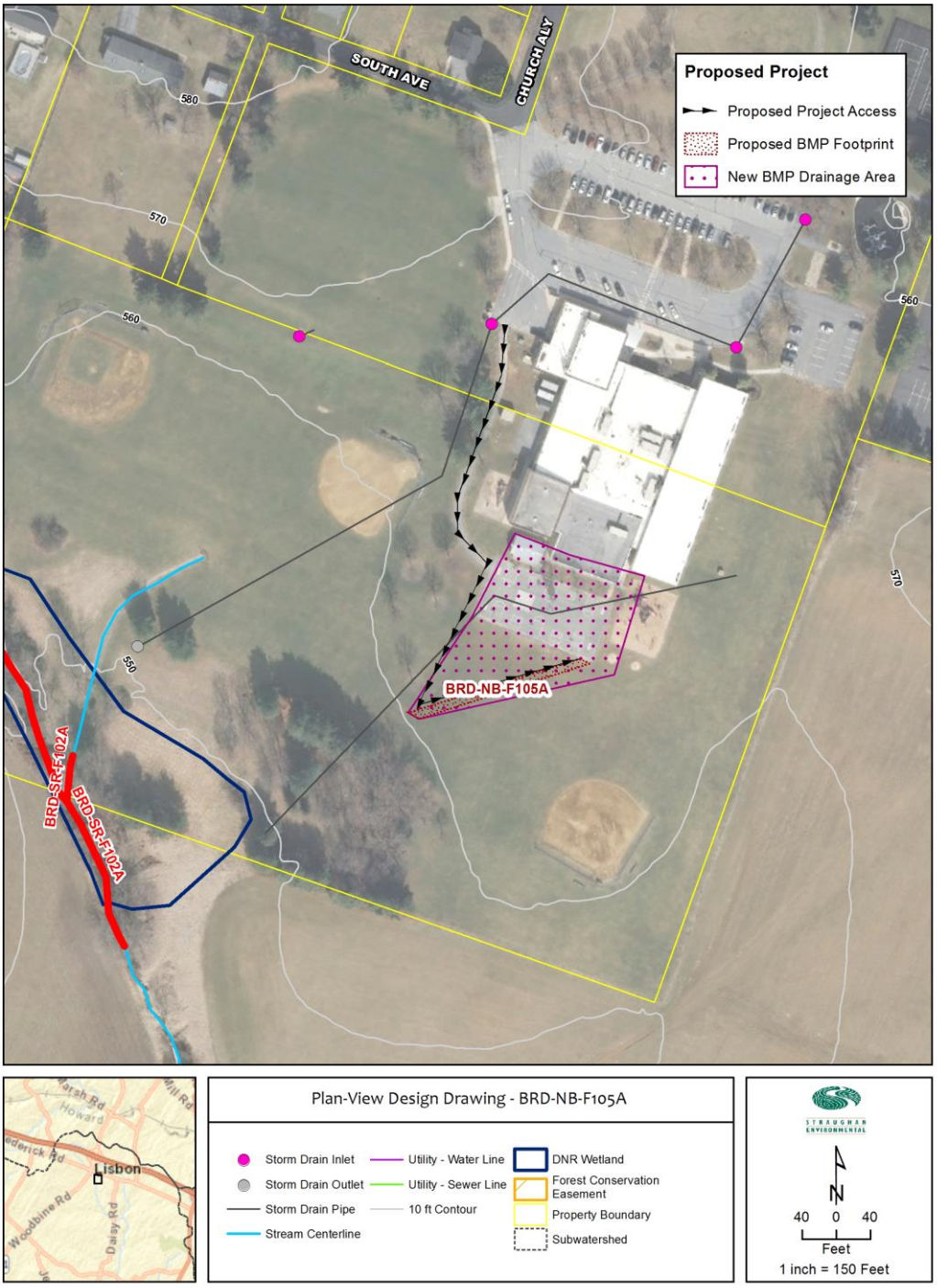
BRD-SR-F102A

Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	0.74	WQVolume Target (cft.):	1,073
Impervious Area within Drainage (ac.):	0.29	Max Treated (cft.):	1,931
Impervious Area Treated (ac.):	0.29	Percent Treated:	180%
Impervious Area Treated Credit (ac.):	0.35	Rainfall Depth Treated (in.):	1.8

Costs	
Estimated Design Cost:	$120,000
Estimated Construction Cost:	$55,635
30% Contingency:	$52,691
Estimated Total Cost	$228,326
Cost per Impervious Credit Acre:	$652,359

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: BRD-NB-F105A
Site Name: Lisbon Elementary
Contractor: Straughan
Watershed: Brighton Dam



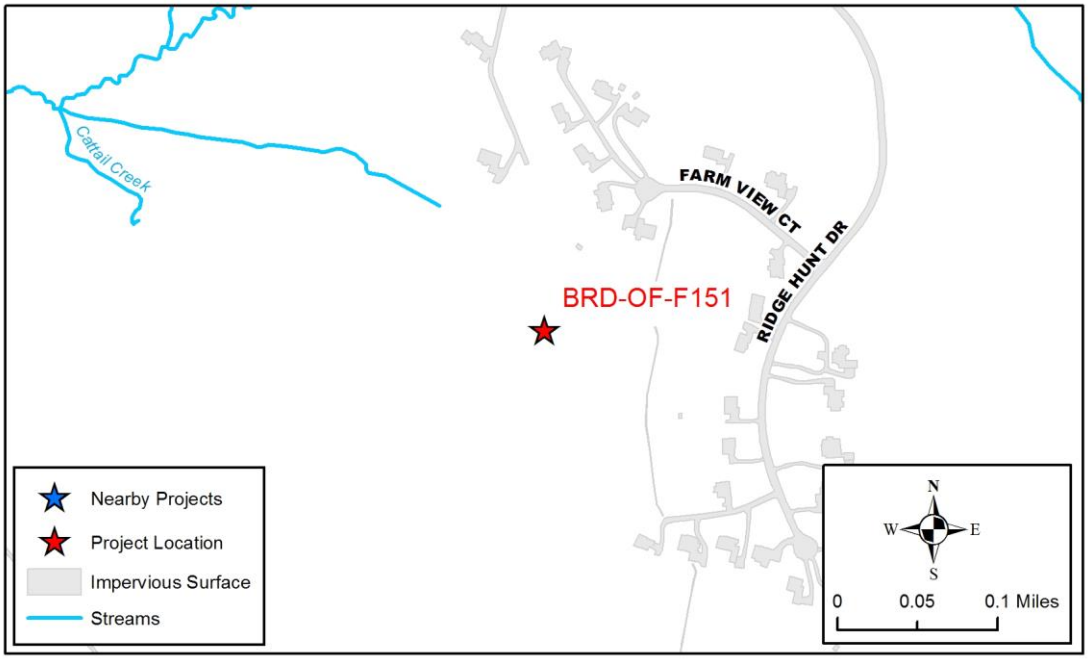
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: BRD-OF-F151
Site Name: Farm View Ct
Contractor: Straughan
Watershed: Brighton Dam

Proposed BMP Type: Outfall Stabilization
Stabilization Type: Step Pool Stormwater Conveyance
Ownership: Private- HOA
Single Owner

Existing Conditions:

Currently, the outfall channel is eroded with 1-2 ft. exposed banks below the riprap apron. Additionally, a head cut was observed along the flow path. At the confluence with the receiving stream, signs of streambank erosion were noted. An extended detention pond discharges via a 30 in. RCP to a 20 ft. class II riprap apron. The riprap apron energy dissipation has not prevented channelization and erosion between the apron and stream convergence.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: BRD-OF-F151
Site Name: Farm View Ct
Contractor: Straughan
Watershed: Brighton Dam

Downstream view of outfall channel from BMP berm.

Outfall channel below riprap apron.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: BRD-OF-F151
Site Name: Farm View Ct
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:
No utilities were observed in the field.

Concept Description:
The proposed stabilization is step pool stormwater conveyance (SPSC). The existing slope (4%) and available surface area allows establishment of the pool-riffle system. The 22.63 ac. drainage area, with 14% impervious area, is routed through the upslope extended detention pond before discharge to the eroded outfall channel. This area is within the range of feasibility for SPSC treatment. Specimen trees along the channel will need to be avoided to the maximum extent possible.

Nearby Opportunities:
None recommended

Proposed Project Credit	
Drainage Area (ac.):	22.63
Impervious Area within Drainage (ac.):	3.14
Impervious Area Treated (ac.):	3.14
Impervious Area Treated Credit (ac.):	3.14

Water Quality Volume	
WQVolume Target (cf.):	14,362
Max Treated (cf.):	14,379
Percent Treated:	100%
Rainfall Depth Treated (in.):	1

Costs

Estimated Design Cost:	$200,000
Estimated Construction Cost:	$118,000
30 % Contingency:	$95,400
Estimated Total Cost:	$413,400
Cost per Impervious Credit Acre:	$131,656

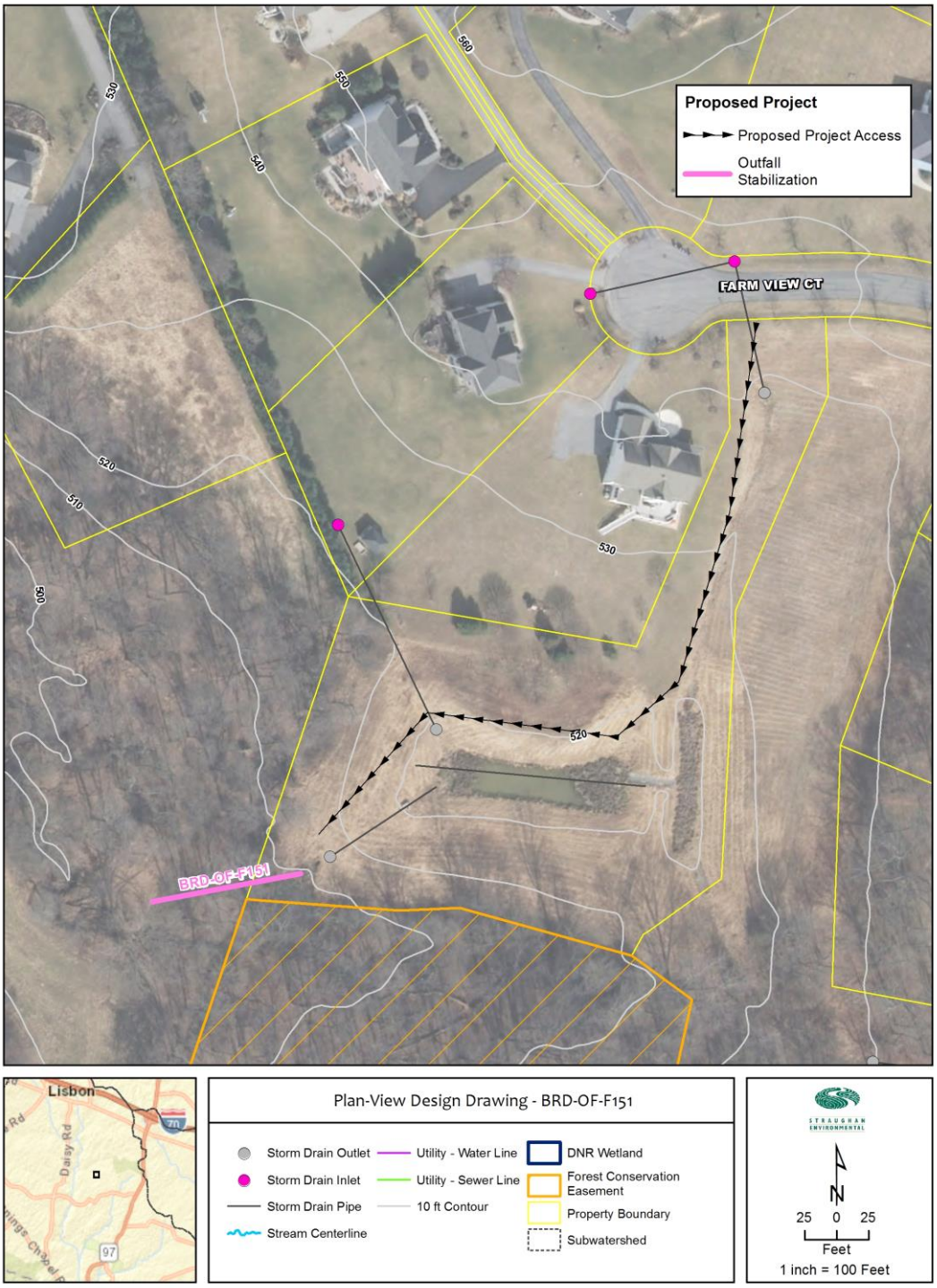
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: BRD-OF-F151

Site Name: Farm View Ct

Contractor: Straughan

Watershed: Brighton Dam



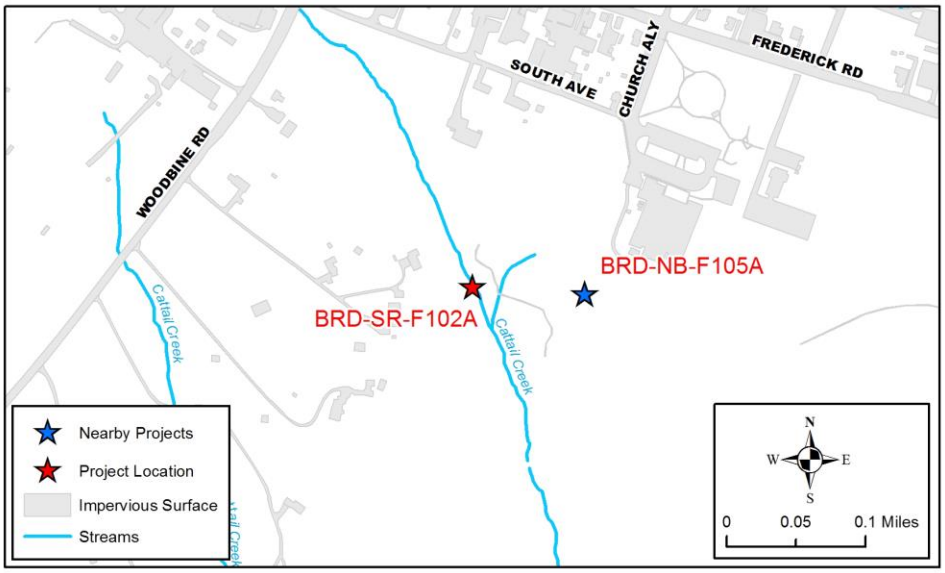
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F102A
Site Name: Woodbine Rd - Stream
Contractor: Straughan
Watershed: Brighton Dam

Ownership: County School
Multiple Owners

Existing Conditions:

The project reach is located behind Lisbon Elementary School. Just over half of the project is located on school property; the rest is located on 2 private agricultural properties, one of which appears to be actively planted with crops while the other only appeared to be a mowed open field. An in-stream habitat assessment resulted in poor ratings for epifaunal substrate (<20% stable habitat), sediment deposition (heavy deposits of fine material, more than 50% of bottom changing frequently, pools almost absent), and frequency of riffles (generally all shallow riffles providing poor habitat). Within this reach, the stream has eroded the full height (approximately 4.5 ft.) of both banks and widened along most of the project reach, causing numerous trees to fall into the channel. More trees are threatened if the banks are not stabilized. In some areas of the project reach, lower banks are reforming within the entrenched cross section. The streambed is primarily gravel with flow only 1 in. deep along most of the project reach. At the downstream end of the school property, stormwater flow discharges from a concrete channel into the stream via a section (approximately 30 ft.) of failing riprap. This riprap section is experiencing erosive back-eddies and has deteriorated, undermined, and collapsed the downstream panels of the concrete channel. Tree planting has occurred along the left bank recently, but success was indeterminable due to assessment season.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F102A
Site Name: Woodbine Rd - Stream
Contractor: Straughan
Watershed: Brighton Dam

Bank erosion and accumulation of trees and brush looking downstream along school property.

Active headcut requiring stabilization from end of concrete drainage channel (just out of photo to the left) to confluence with stream (bottom right).

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F102A
Site Name: Woodbine Rd - Stream
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Constraints include: ownership (2 private properties) and some wetland areas. Trees in the previously-planted area and along the stream would be impacted by the project, possibly including some specimen trees, but many established trees are currently in danger due to active bank erosion. The younger trees could likely be transplanted, and with high invasive presence, the net tree impact would be lower than initially assumed.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms. This is accomplished by grading banks to a stable angle and/or bioengineering techniques implemented. Banks and bed grade will be stabilized, and any trees that are removed or previously lost due to the active erosion should be used during construction for structures or habitat features. Impacts to trees, especially specimen trees, should be minimized, and invasives should be removed. The addition of woody debris, cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. The restoration effort should also include reestablishing an appropriate riparian buffer.The existing tree planting area is already a demonstration site for the school with a walking path, benches, and some signage; a stream restoration project along this reach further increases the educational value of this area for students and would also act as a demonstration site for those attending games on the adjacent sports fields.To increase the habitat benefits and overall effectiveness of bank stabilization, it is recommended that the project reach be extended upstream to Woodbine Rd. and downstream if the private landowners are amenable. An additional ~890 ft. of restoration may be possible further upstream of the current site through a third private agricultural property noted as a mowed grass field at the time of the stream assessment. The project is located near BRD-NB-F105A, but there is likely no advantage to completing the projects concurrently.Access is easy to moderate along a county right-of-way across from Whitefoot Alley. The route should avoid the sports fields during high-use seasons.

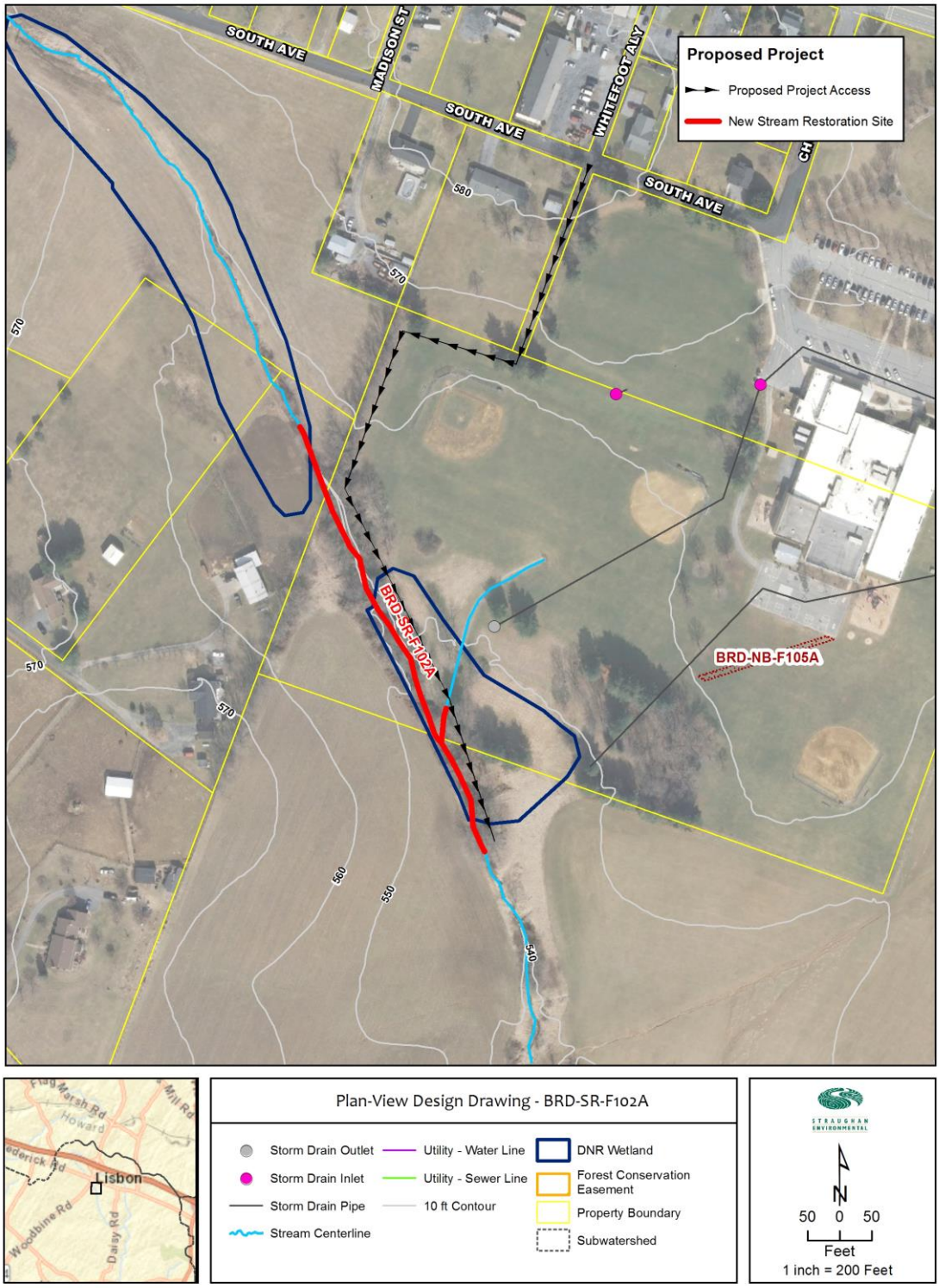
Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	787	Estimated Design Cost:	$200,000
Impervious Area Treated Credit (ac.):	7.87	Estimated Construction Cost:	$382,950
Cost per Impervious Credit Acre:	$96,294	30% Contingency:	$174,885
		Estimated Total Cost:	$757,835

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F102A
Site Name: Woodbine Rd - Stream
Contractor: Straughan
Watershed: Brighton Dam



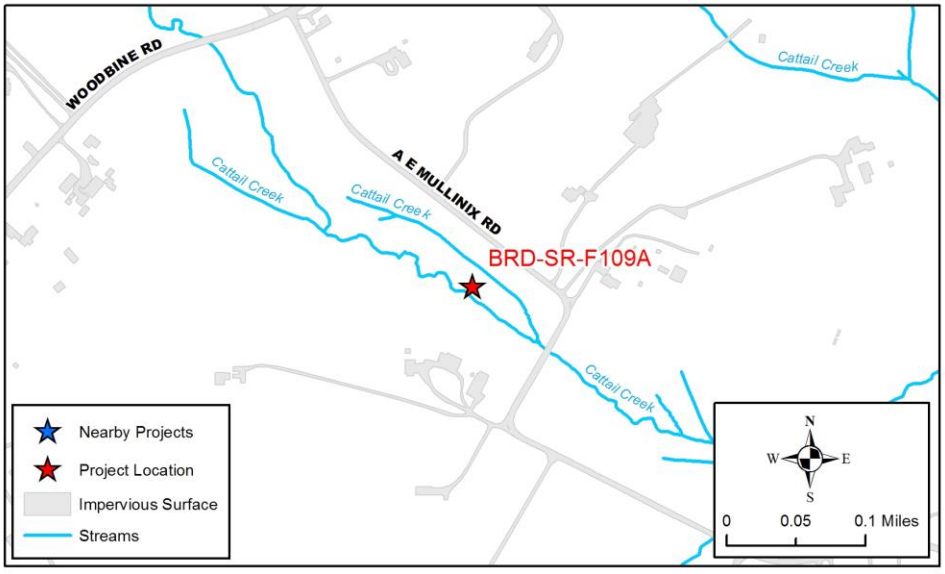
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F109A
Site Name: AE Mullinix Rd
Contractor: Straughan
Watershed: Brighton Dam

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

The project reach is located through two agricultural (grazing) properties along AE Mullinix Rd; approximately 75% of the reach is located on a single property. A dual CMP arch culvert, each 57 in. w x 32 in. h, runs under AE Mullinix Rd, bisecting the primary property. The stream is highly sinuous with active moderate to severe bank erosion along much of its length. Banks are eroded to their full height, which is typically between 4 and 5 ft., and bank material is sloughing in as the sinuosity increases. Horses are not excluded from the stream and at least one crossing was evident in each field. Access to the site was limited by fencing, so in-stream habitat assessment results are not representative of the entire project reach. Near the dual culvert, the streambed consisted primarily of gravel, and the velocity-depth regime was marginal (only 2 of 4 habitat regimes present). Bank erosion was readily observed and bank vegetation was limited to short grass.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F109A
Site Name: AE Mullinix Rd
Contractor: Straughan
Watershed: Brighton Dam

Typical stream conditions across eastern fields from culvert under AE Mullnix Rd. Bank erosion estimated to be 4 ft. or more in height at some locations.

Tight meanders and high bank erosion at downstream extent of site.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F109A
Site Name: AE Mullinix Rd
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

The only apparent constraint is property ownership and the need to adjust fences for construction access.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms and reconnect the stream to its floodplain. This would be accomplished by excluding horses from the stream and reestablishing a sufficient vegetative buffer (recommend tree planting BRD-TP-F160 and -F169). A more natural sinuosity pattern based on the overall channel slope would be established through the fields. The grade of the upstream portion of the project reach is controlled by the dual culvert at the downstream end and another culvert of unknown size and construction upstream under Woodbine Rd. Ideally, the dual culvert under AE Mullinix Rd would be redesigned to convey flow with a greater depth during baseflow conditions. Banks should be graded back to a stable angle and planted with native vegetation. The addition of woody debris, cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat.Access is easy from the stream crossing at AE Mullinix Rd. There are no utility, vegetation, or wetland constraints along this project site, but project access should go along the stream within the future forested buffer to minimize impact to the properties.

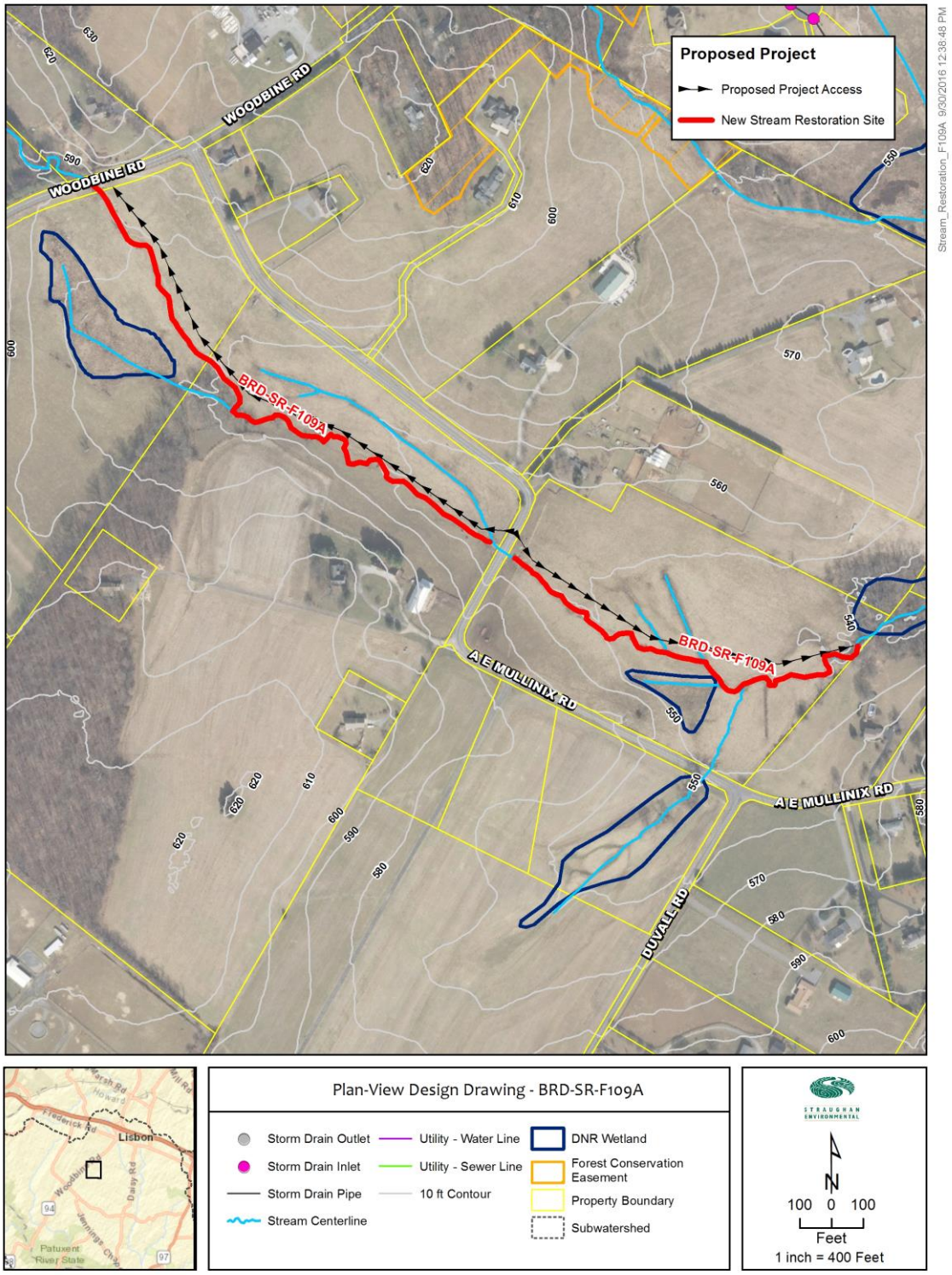
Nearby Opportunities:

BRD-TP-F160 and BRD-TP-F169

Proposed Project Credit		Costs	
Length Restored (ft):	1,696	Estimated Design Cost:	$300,000
Impervious Area Treated Credit (ac.):	17	Estimated Construction Cost:	$763,200
Cost per Impervious Credit Acre:	$81,495	30% Contingency:	$318,960
		Estimated Total Cost:	$1,382,160

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F109A
Site Name: AE Mullinix Rd
Contractor: Straughan
Watershed: Brighton Dam



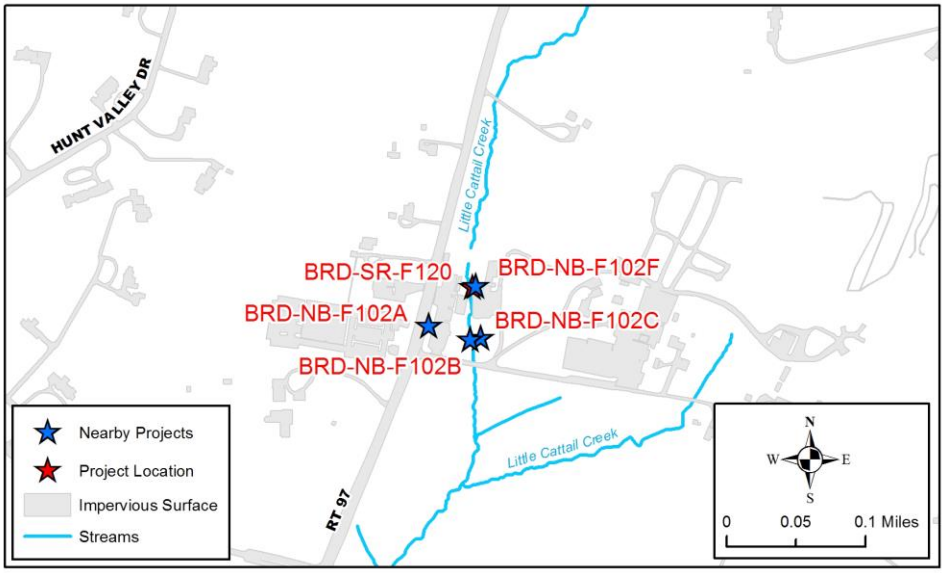
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F120
Site Name: Boyer Landscaping
Contractor: Straughan
Watershed: Brighton Dam

Ownership: Private- Mixed Use
Multiple Owners

Existing Conditions:

The project reach is located through two private properties—the northern property is an active landscaping company, and the southern property is a large grass field owned by a nursery. Between the two properties, the stream flows through a wide, short block stone culvert under a private drive that provides access to both of these properties and one other property. The headwalls constructed of the same material are highly deteriorated and collapsing, which may indicate that the rest of the culvert needs replacement. This road crossing could allow the project to be split along property lines, if necessary. Approximately one third of the project is located on the landscaping company's property, where it flows behind their offices through their outdoor show area. There is no buffer in this area and grass is mowed very short all the way to the water. Office downspouts are piped for discharge directly into the stream, which also receives overland flow from an asphalt parking from the west and a gravel parking lot just off the right bank. In this area, the stream is highly sinuous and the banks are actively eroding and sloughing. A small pond is located in-line with the stream just north of the offices. There are numerous small (approximately 2 in.) PVC pipes of unknown function leading across and into the pond, and a debris jam on the upstream side pools water. Upstream of the pond, the stream transitions to a cross section that is no longer entrenched and has little to no bank erosion. The riparian area along this upstream reach (which is outside the project) shows indications of wetland hydrology. Streambed material is almost entirely silt with some sand. The southern property was unable to be directly accessed for a thorough habitat assessment, but from vantage points along the fence line, bank erosion of several feet was observed in several areas and may be present along the entire length. A number of large trees line the banks along roughly half the reach, but are likely threatened by the noted bank erosion. Otherwise, the property along the stream is entirely grassed fields, and there were no indications of livestock at the time of assessment. From the left bank of the eastern branch, the terrain slopes steeply upward.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F120
Site Name: Boyer Landscaping
Contractor: Straughan
Watershed: Brighton Dam

Along the northern property, tight meander bends with eroding and sloughing banks. Several pipes discharge roof runoff along the stream banks.

Along the southern property stream would benefit from spot stabilization and establishing a vegetative buffer.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F120
Site Name: Boyer Landscaping
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Constraints include: Ownership, buildings on upstream property, in-line agricultural pond on upstream property, wetlands and potential for specimen tree impacts on downstream property.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms. At the upstream landscaping company, this would be accomplished by grading banks back to a stable angle, installing in-stream structures, and creating a more natural sinuosity pattern. The riparian area should be landscaped with native vegetation selected to provide stability but also continue to allow the landscaping company to use the area as an outdoor showcase area. The condition of the pond should be assessed more thoroughly and steps taken to ensure water does not become stagnant and anoxic in any portion. There may be an opportunity to fill a portion of the pond to create a wetland habitat. A number of new BMPs are also recommended on this site (BRD-NB-F102). There may be an opportunity to partner with the landscaping company to complete the construction of these projects on their property. It is highly recommended to limit mowing and allow natural wetland vegetation to establish on both banks along portion of stream upstream of the project site. Building downspouts should also be changed so that they do not discharge directly into the stream—they could be directed to the recommended rain garden, or the landowner could use rain barrels or another rooftop disconnection strategy. Given the condition of the culvert headwalls, it may be advisable to have it replaced prior to completing a restoration project to avoid future impacts to the project. In the downstream portion, banks should be graded back to a stable angle wherever possible in areas of significant erosion to reconnect the stream to the floodplain; however, impacts to specimen trees should be minimized. Where necessary, spot structural measures could be implemented to provide bank stabilization. Given the steep slopes and grass-only cover above the left bank, reduction of erosion could be realized by planting a significant riparian buffer of native vegetation to slow the overland flow. The addition of woody debris, cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. Access is easy. Preferred access would be from the private drive between the properties, but this may require approval of the other property owner.

Nearby Opportunities:

BRD-NB-F102A, BRD-NB-F102B, BRD-NB-F102C, BRD-NB-F102F

Proposed Project Credit		Costs	
Length Restored (ft):	663	Estimated Design Cost:	$300,000
Impervious Area Treated Credit (ac.):	6.63	Estimated Construction Cost:	$519,150
Cost per Impervious Credit Acre:	$160,618	30% Contingency:	$245,745
		Estimated Total Cost:	$1,064,895

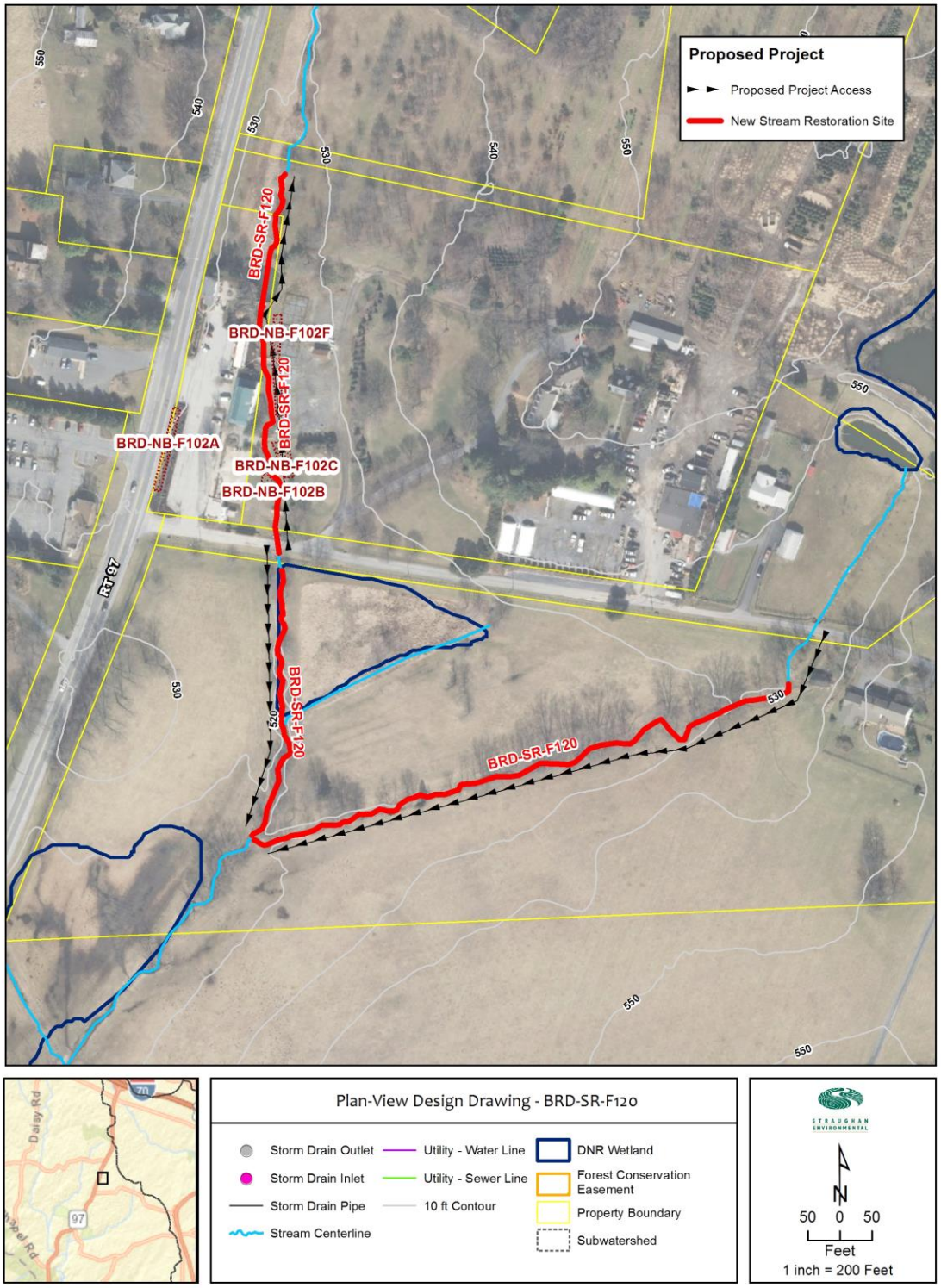
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F120

Site Name: Boyer Landscaping

Contractor: Straughan

Watershed: Brighton Dam



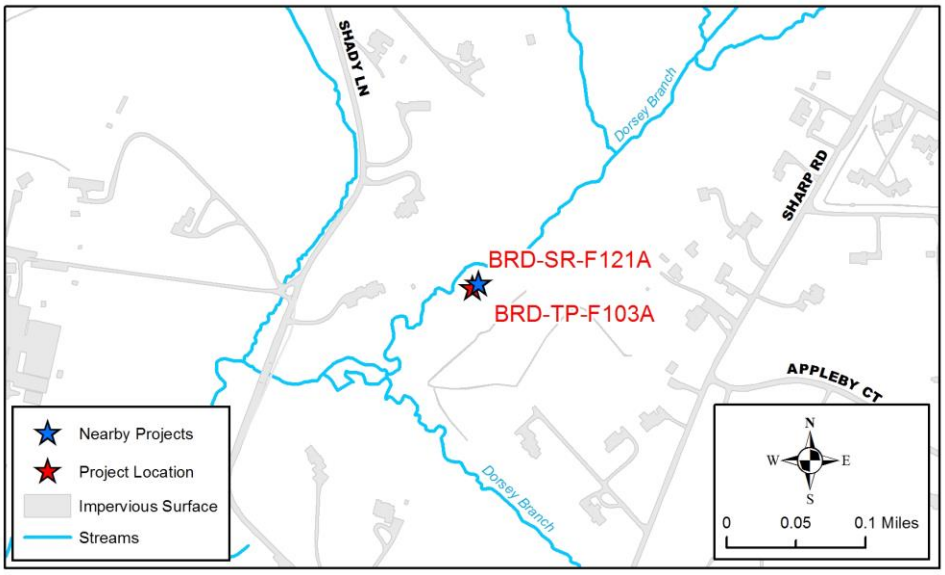
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F121A
Site Name: Shady Lane - Stream
Contractor: Straughan
Watershed: Brighton Dam

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

The proposed stream restoration project spans 3 large-lot residential properties. Additional reaches may be possible on adjacent properties further upstream on some agricultural (grazing) properties (fences prevented access during assessments) and downstream (also not assessed) with permission of landowners. Interaction with the landowner who owns the property upon which over half of the restoration length is located was positive. The stream along most of this reach is entrenched with 3.5 ft. high bank erosion. The downstream portion is highly sinuous. A large woody debris jam and a couple vehicle crossings were noted in-stream within this highly sinuous portion. Further upstream, the stream is wide, generally straight, and very shallow with little habitat variation. The banks in this reach are generally stable and more substantial vegetation is present. Much of the surrounding grassed area showed signs of wetland hydrology with a few wetland species despite regular mowing. Most of the in-stream habitat parameters were rated as 'suboptimal,' the exceptions being velocity/depth regime (only 2 of 4 habitat regimes present) and frequency of riffles (occasional riffle or bend, bottom contours provide some habitat) in the downstream portion and sediment deposition (moderate deposition of fine material, 30-50% of bottom affected) along the whole length



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F121A
Site Name: Shady Lane - Stream
Contractor: Straughan
Watershed: Brighton Dam

Looking downstream across the tight meander near the upstream property boundary of 3725 Shady Lane. Steeply eroded banks over 3 ft. in height are prevalent from the downstream extent to this point.

Looking upstream at the upstream end of the project reach. The stream is wider, slower, and straighter in this portion, with less erosion but little habitat variety.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F121A
Site Name: Shady Lane - Stream
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Constraints include: ownership, potential wetlands, and potential impacts to trees.

Concept Description:

The objective for this project site is to stabilize the banks, improve in-stream habitat for aquatic organisms, and reconnect the stream to the floodplain. Banks will be graded back to a stable angle and planted with native vegetation. Grade control structures will be used to stabilize the bed and provide an appropriate slope throughout the project to support a more natural sinuosity pattern. The addition of woody debris, cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. Vernal pools could be created along the banks and wetland areas could be enhanced as a forested wetland. Forested wetland and any forested riparian buffer should be completed as part of tree planting site BRD-TP-F103. Impacts to trees, especially specimen trees, should be minimized, and invasives should be removed. Any trees that are removed should be used during construction for structures or habitat features.Access to the site is easy and runs along the southern property line 3725 Shady Lane. More than half of the planting opportunity is located on this property, and there is space for temporary storage on the property. Heavy equipment could access the site but would require a stream crossing. Permission for work and access will need to be gained from three residential property owners.

Nearby Opportunities:

BRD-TP-F103A

Proposed Project Credit		Costs	
Length Restored (ft):	986	Estimated Design Cost:	$200,000
Impervious Area Treated Credit (ac.):	9.86	Estimated Construction Cost:	$443,700
Cost per Impervious Credit Acre:	$84,869	30% Contingency:	$193,110
		Estimated Total Cost:	$836,810

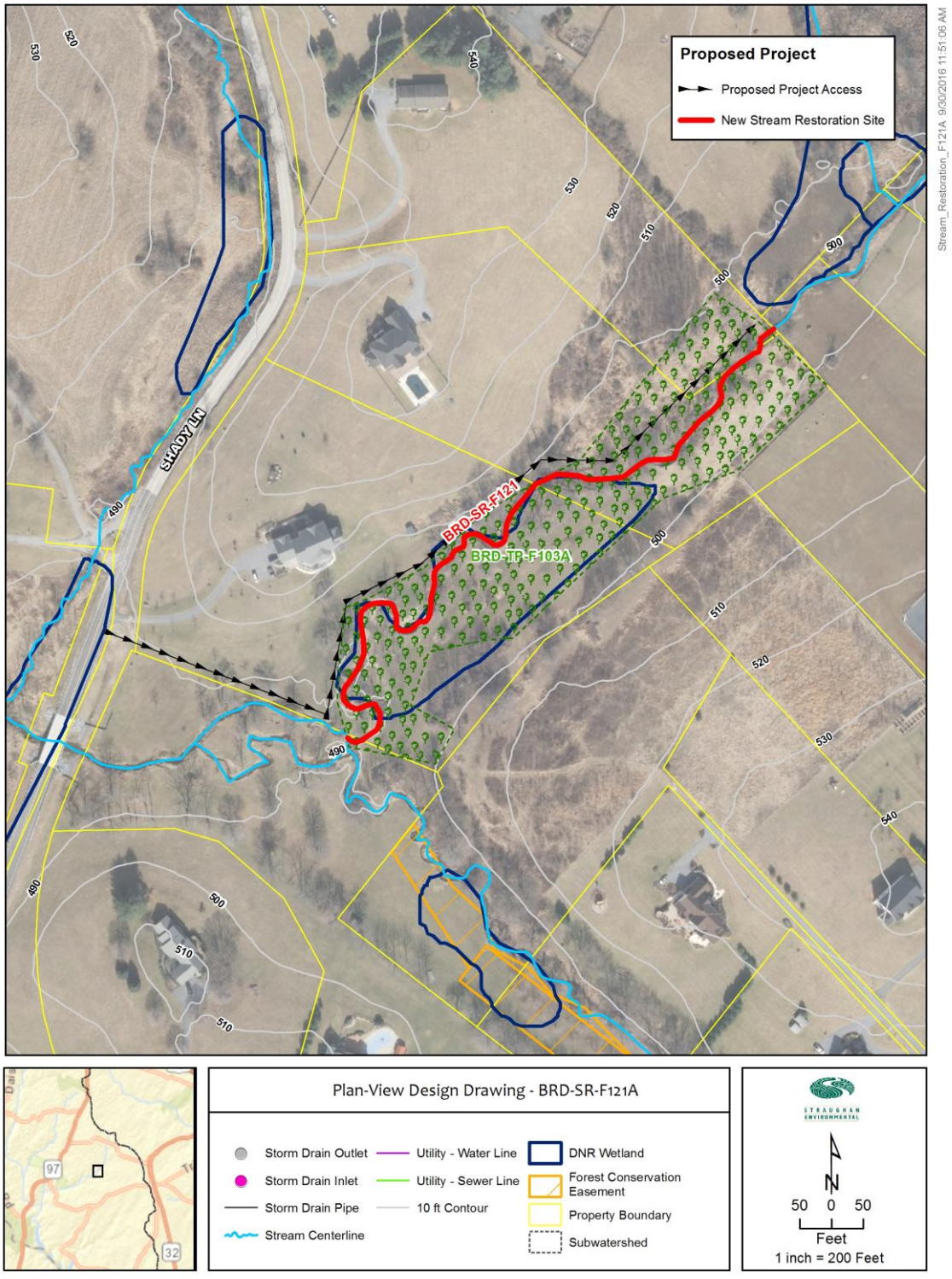
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F121A

Site Name: Shady Lane - Stream

Contractor: Straughan

Watershed: Brighton Dam



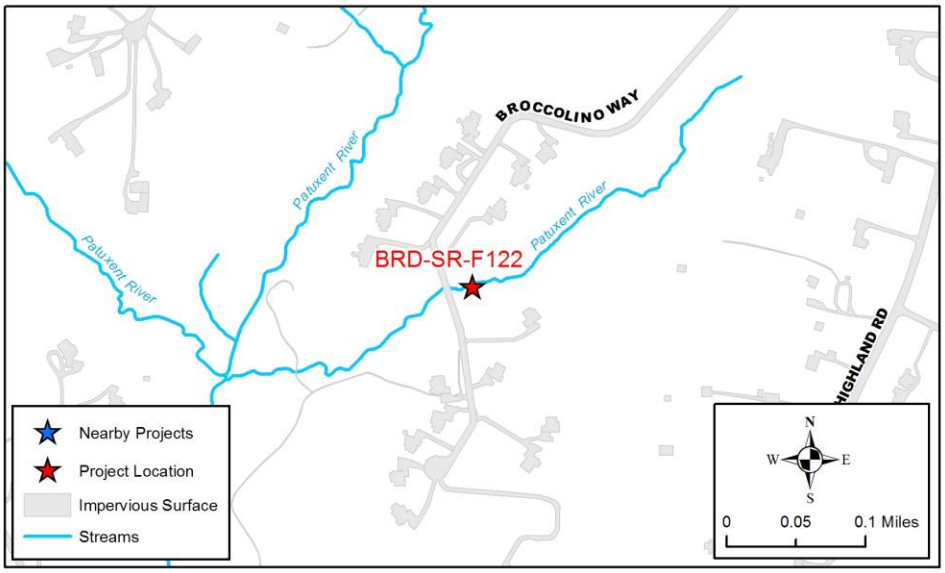
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F122
Site Name: Broccolino Way - Stream
Contractor: Straughan
Watershed: Brighton Dam

Ownership: Private- Residential
Single Owner

Existing Conditions:

The proposed stream restoration project is located at two locations within a recently-planted forest conservation easement on property owned by a residential development company. Home construction on surrounding land owned by this developer has been completed. The downstream portion (approximately 400 ft.) of this project site consists of a deep headcut (erosion is 3.5 to 4 ft. in height, both banks) running from the stream's confluence to a failed culvert under a grassed vehicle crossing. The culvert may be preventing the headcut from extending further upstream, but there is significant scour below it. The field crew noted that water was leaving the pipe before the outfall and flowing through the soil. The stream is generally in good condition for roughly 150 ft. upstream of this area before reaching an area of bank erosion just under 2 ft. in height; in this same area is an exposed 6 in. PVC pipe. The next portion of the project reach begins at the Broccolino Way bridge where there is 2 to 4 ft. bank erosion under the bridge. No vegetation has established under the bridge and planting netting is shredding and pulling away from the banks. Further upstream is a notable grade change where a previous attempt at random riprap stabilization is beginning to fail. A portion of this has trees along it with heavy invasive cover. In-stream habitat parameters were rated in the suboptimal and optimal range.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F122
Site Name: Broccolino Way - Stream
Contractor: Straughan
Watershed: Brighton Dam

Exposed 6 in. PVC pipe crossing stream in the downstream restoration reach. Bank erosion height along this reach is typically 3 to 4 ft. Forest conservation tree planting in background.

The upstream reach of this restoration site includes a channel that was previously riprapped; step pool conveyance is recommended in this area.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F122
Site Name: Broccolino Way - Stream
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Constraint: ownership, utilities, some mature tree impacts, and the need to transplant recently planted trees in access routes.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms. To stabilize banks along the headcut length, banks will be graded back to a stable angle and/or bioengineering techniques will be employed. The floodplain can also be stabilized by stone or log steps if a structural technique is necessary. Grade control structures should be used to stabilize the bed and provide an appropriate slope throughout the project; final grade should be designed to provide adequate cover over the currently exposed PVC pipe. The possible project design slope is controlled by the elevations of the downstream confluence and the upstream PVC pipe. The failing CMP culvert should be removed or properly re-designed for the current streamflow. The addition of cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. While some of the recently planted trees could be impacted, they are young enough to be transplanted. In the upstream portion, similar grade control and floodplain stabilization measures should be implemented under the bridge and appropriate soil stabilization measures provided to prevent future erosion in this shady area. Above this, regenerative stormwater conveyance or step pools will be designed to replace the failing riprap channel.

Other than minimizing the necessity to tranant trees, access for the project is easy. For the downstream portion, the access route comes off the route for the development's SWM pond. For the upstream portion, access can use the same route for the bridge portion but will need to come off of Broccolino Way just north of the bridge.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	762	Estimated Design Cost:	$200,000
Impervious Area Treated Credit (ac.):	7.62	Estimated Construction Cost:	$342,900
Cost per Impervious Credit Acre:	$92,621	30% Contingency:	$162,870
		Estimated Total Cost:	$705,770

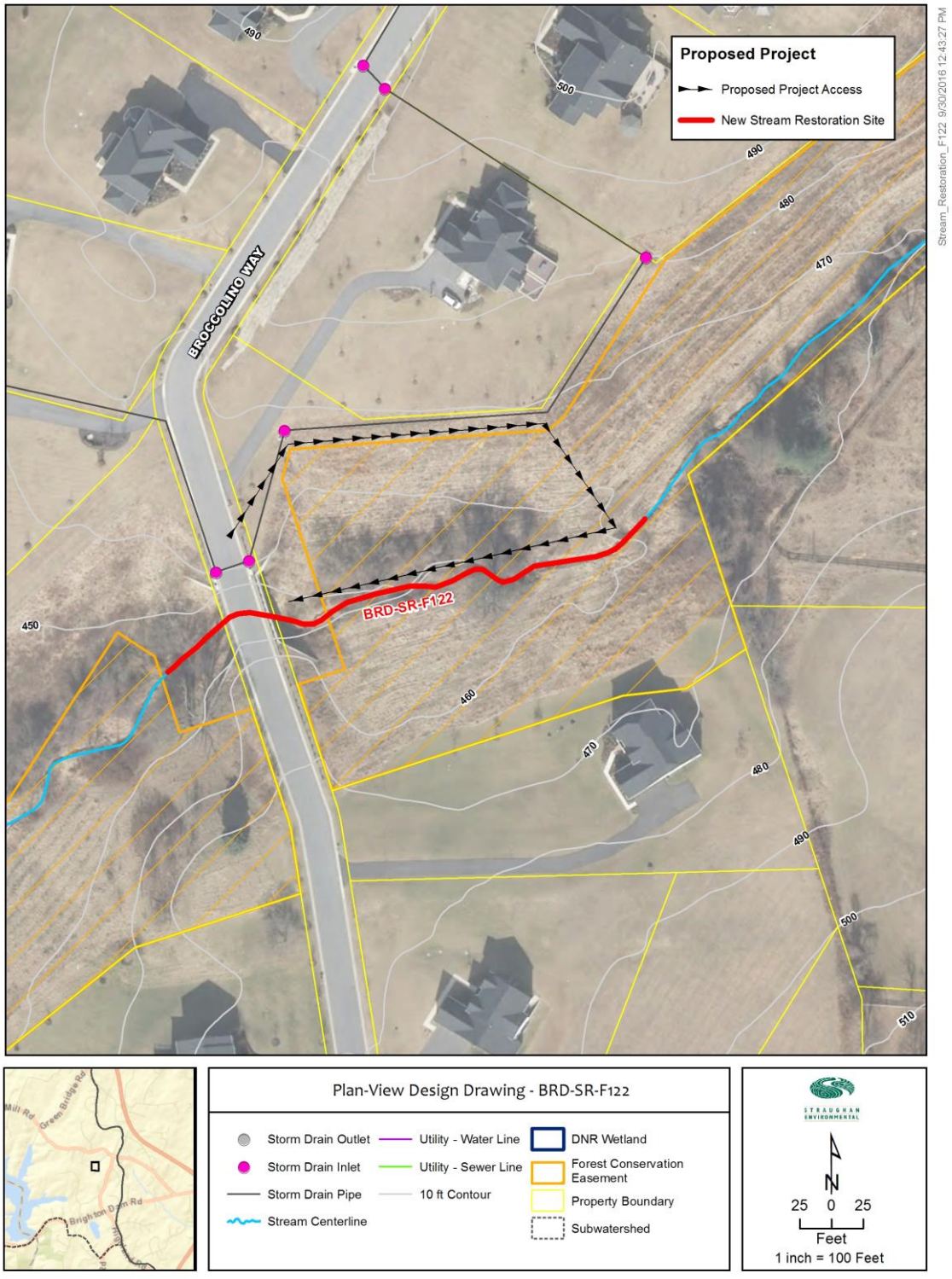
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F122

Site Name: Broccolino Way - Stream

Contractor: Straughan

Watershed: Brighton Dam



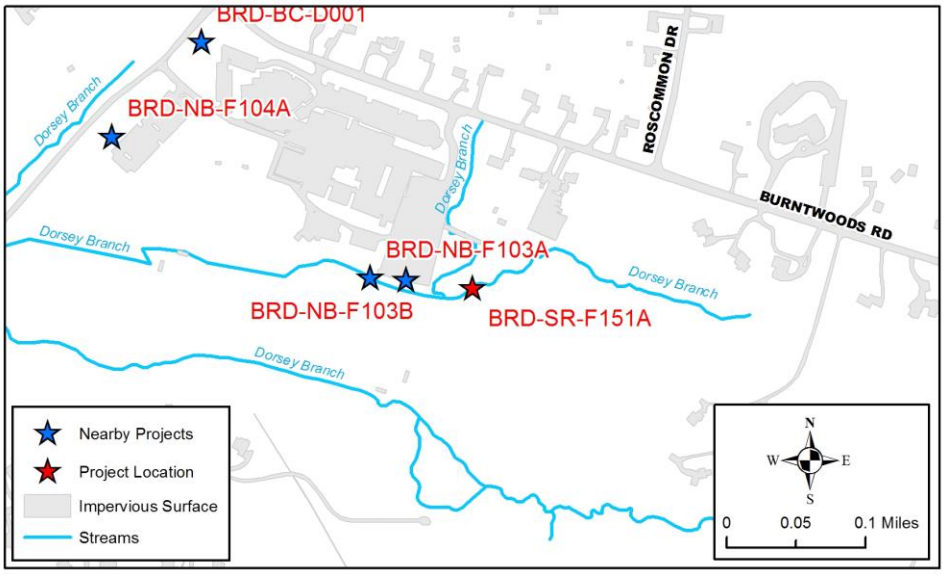
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F151A
Site Name: Glenelg High School
Contractor: Straughan
Watershed: Brighton Dam

Ownership: County School
Single Owner

Existing Conditions:

The proposed stream restoration project is located on Glenelg High School property and the adjacent Howard County Board of Education Property with a forest conservation easement. The forested upstream half has high sinuosity and active bank erosion between 2.5 and 4 ft. in height, primarily on the outside of bends. An in-stream habitat assessment of the upstream portion resulted in marginal ratings for epifaunal substrate (20-40% stable habitat), velocity/depth regime (only 2 of 4 habitat regimes present), sediment deposition (moderate deposition of fine material, 30-50% of bottom affected), and channel flow (riffle substrates are mostly exposed). Downstream of the forest conservation easement, the stream flows over a wide concrete channel that allows most of the sediments to fall out. Immediately downstream of the concrete channel, the stream cross section quickly narrows and flows through a channel with aquatic grasses between the ball fields and a school parking lot, after which it drops down an energy dissipator into a culvert under the ballfields. Over the last 100 ft. of above-ground flow, bank erosion height increases to roughly 2 ft.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F151A
Site Name: Glenelg High School
Contractor: Straughan
Watershed: Brighton Dam

The upstream portion of the restoration site, through the forest conservation easement, has erosion between 2.5 ft. and 4 ft.

The downstream portion of the restoration site has bank erosion before it drops down an energy dissipator. Its location adjacent to the school parking lot and ball fields makes it a good location for a demostration site.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F151A
Site Name: Glenelg High School
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Constraints include: timing of work to minimize negative impacts to parking and sportsfields, potential wetlands at the upstream end, moderate tree impact (including a few specimen trees), and potential utilities along ball fields. Active bank erosion threatens a number of trees, including specimen trees.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms. Within the forest conservation easement, a stable cross-section and more natural sinuosity should be established. Where possible, banks will be graded back to a stable angle and/or bioengineering techniques will be employed. Impacts to trees should be minimized, but any trees that are removed should be used during construction for structures or habitat features. The addition of woody debris, cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. Along the ball fields, work should focus on the erosion in the last 100 ft. before flow enters the energy dissipationstructure. Given the project's proximity to the school and ball fields, there is an opportunity for student education and public demonstration. After construction, a portion of the access road could be used as a trail for pedestrian access to the site. There may be an opportunity for additional stream restoration upstream of this project reach to the other border of the Howard County Board of Education property. New BMP BRD-NB-F103 is nearby but does not need to be implemented concurrently. There are two access points. The first is easy, from the southeast corner of the parking lot. There is also an access route through the forest conservation easement that is clear of trees. Access along the project length in the upstream half will be moderately difficult in order to minimize tree impacts. There is space for staging on and near the school parking lot, but area may be limited during high-use periods.

Nearby Opportunities:

BRD-BC-D001, BRD-NB-F103A, BRD-NB-F103B, BRD-NB-F103C, BRD-NB-F104A

Proposed Project Credit		Costs	
Length Restored (ft):	671	Estimated Design Cost:	$200,000
Impervious Area Treated Credit (ac.):	6.71	Estimated Construction Cost:	$301,950
Cost per Impervious Credit Acre:	$97,248	30% Contingency:	$150,585
		Estimated Total Cost:	$652,535

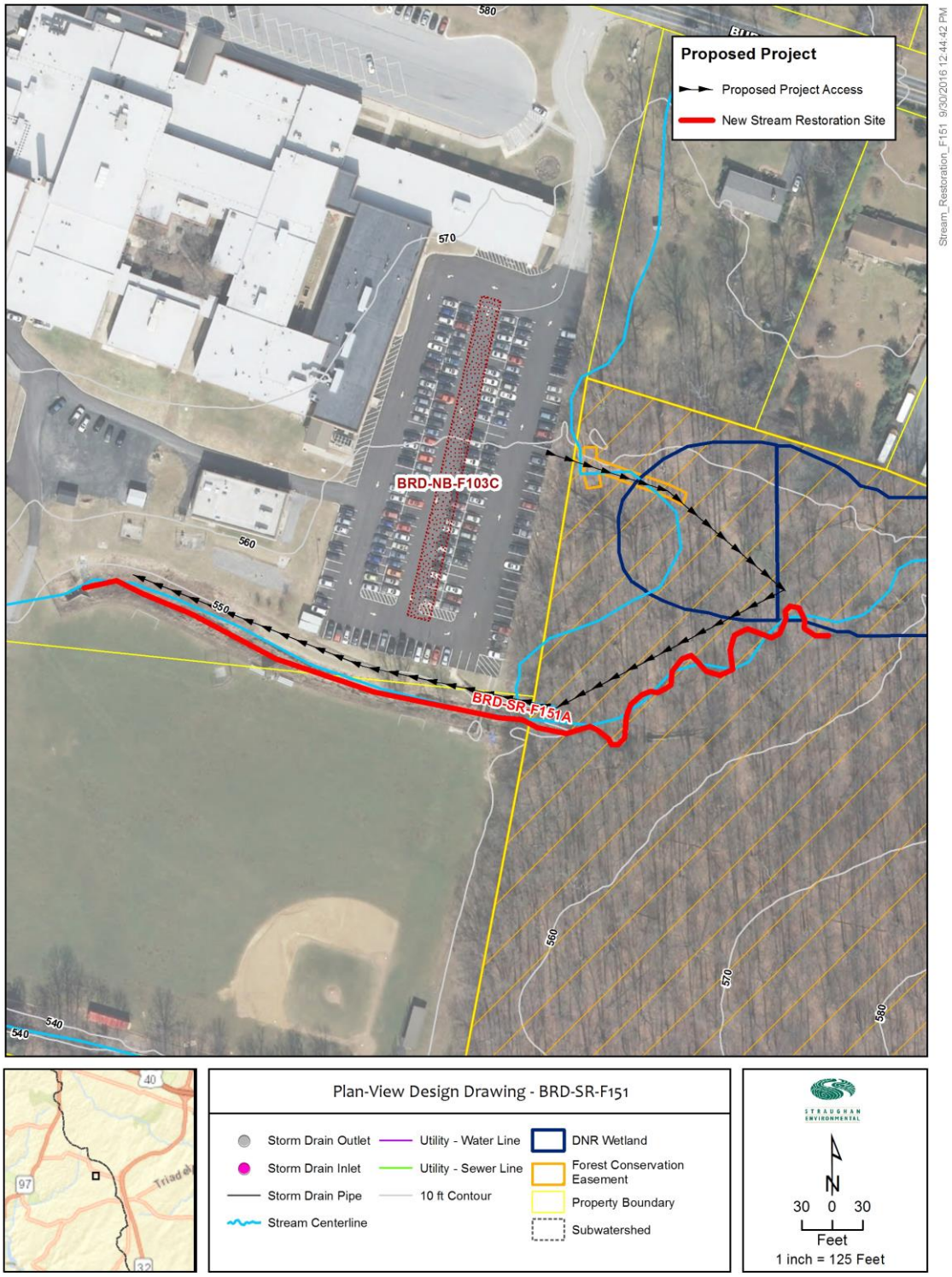
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: BRD-SR-F151A

Site Name: Glenelg High School

Contractor: Straughan

Watershed: Brighton Dam



Plan-View Design Drawing - BRD-SR-F151

- Storm Drain Outlet
- Storm Drain Inlet
- Storm Drain Pipe
- Stream Centerline
- Utility - Water Line
- Utility - Sewer Line
- 10 ft Contour
- DNR Wetland
- Forest Conservation Easement
- Property Boundary
- Subwatershed

STRAUGHAN ENVIRONMENTAL

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30 0 30

Feet

1 inch = 125 Feet

Howard County Watershed Assessment Concept Plan: Tree Planting

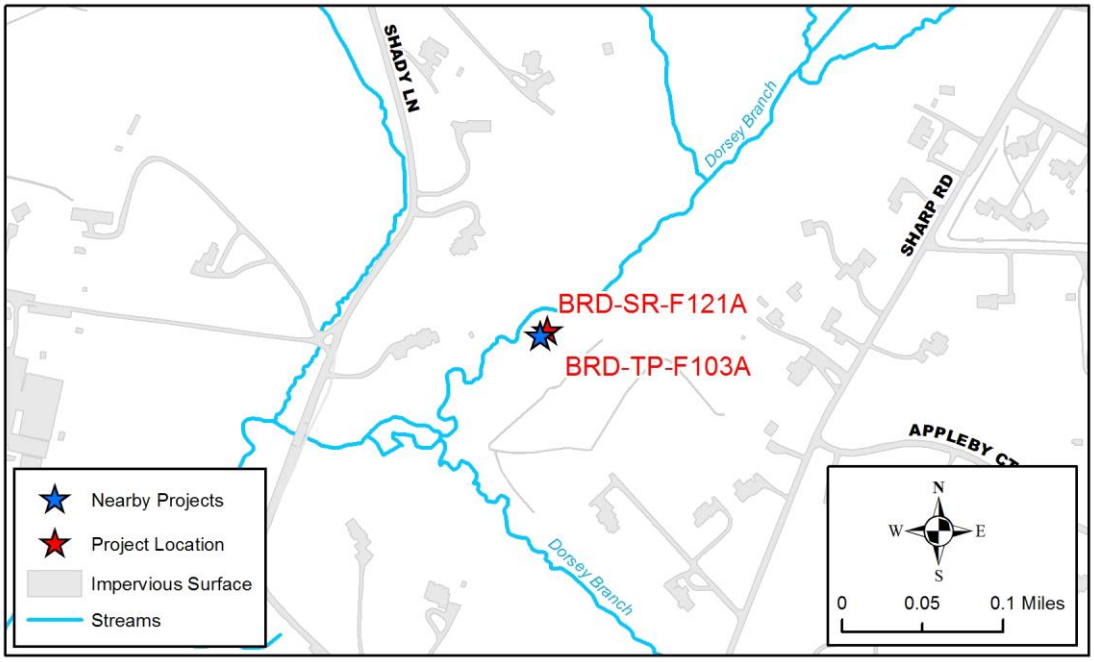
Site ID: BRD-TP-F103A
Site Name: Shady Lane - Trees
Contractor: Straughan
Watershed: Brighton Dam

Project Type: Tree Planting

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

The proposed tree planting project spans 3 large-lot residential properties along stream assessment site BRD-SR-F121A. Additional planting may be possible on adjacent properties further upstream with permission of landowners (fences prevented access during assessments). The proposed planting area is a generally flat, grassed area that receives full sun and only has small pockets of invasives (including Japanese honeysuckle, porcelain berry, bittersweet, autumn olive, and bush honeysuckle) near existing trees. Trees in the area appear healthy and include maple, cherry, sycamore, dogwood, and ash trees; previous tree planting on adjacent properties have been successful. Low-lying and wetland areas are present, and species should be selected accordingly.



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: BRD-TP-F103A
Site Name: Shady Lane - Trees
Contractor: Straughan
Watershed: Brighton Dam

Typical condition of mowed area with skunk cabbage; much of the area had signs of a high water table.

Isolated existing trees surrounded by patches of invasive plants.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: BRD-TP-F103A
Site Name: Shady Lane - Trees
Contractor: Straughan
Watershed: Brighton Dam

Constraints/Utilities:

Constraints include: the presence of wetlands, the need to gain buy-in from landowners, and ensuring landowners limit mowing. There is a potential for deer in the area, though no significant grazing was noted.

Concept Description:

If stream restoration at site BRD-SR-F121A is performed, approximately 3.6 ac. of residential property can be planted with suitable tree species. During species selection, it is important to keep in mind that low-lying and wetland areas are present. Additional planting may be possible on adjacent agricultural (active or former grazing) properties further upstream with permission of landowners, though assessments could not be conducted due to fence lines.Access to the site is easy and runs along the southern property line of 3725 Shady Ln. More than half of the planting opportunity is located on this property, and there is space for temporary storage on the property. Heavy equipment could access the site but would require a stream crossing. Permission for work and access will need to be gained from three residential property owners.

Nearby Opportunities:

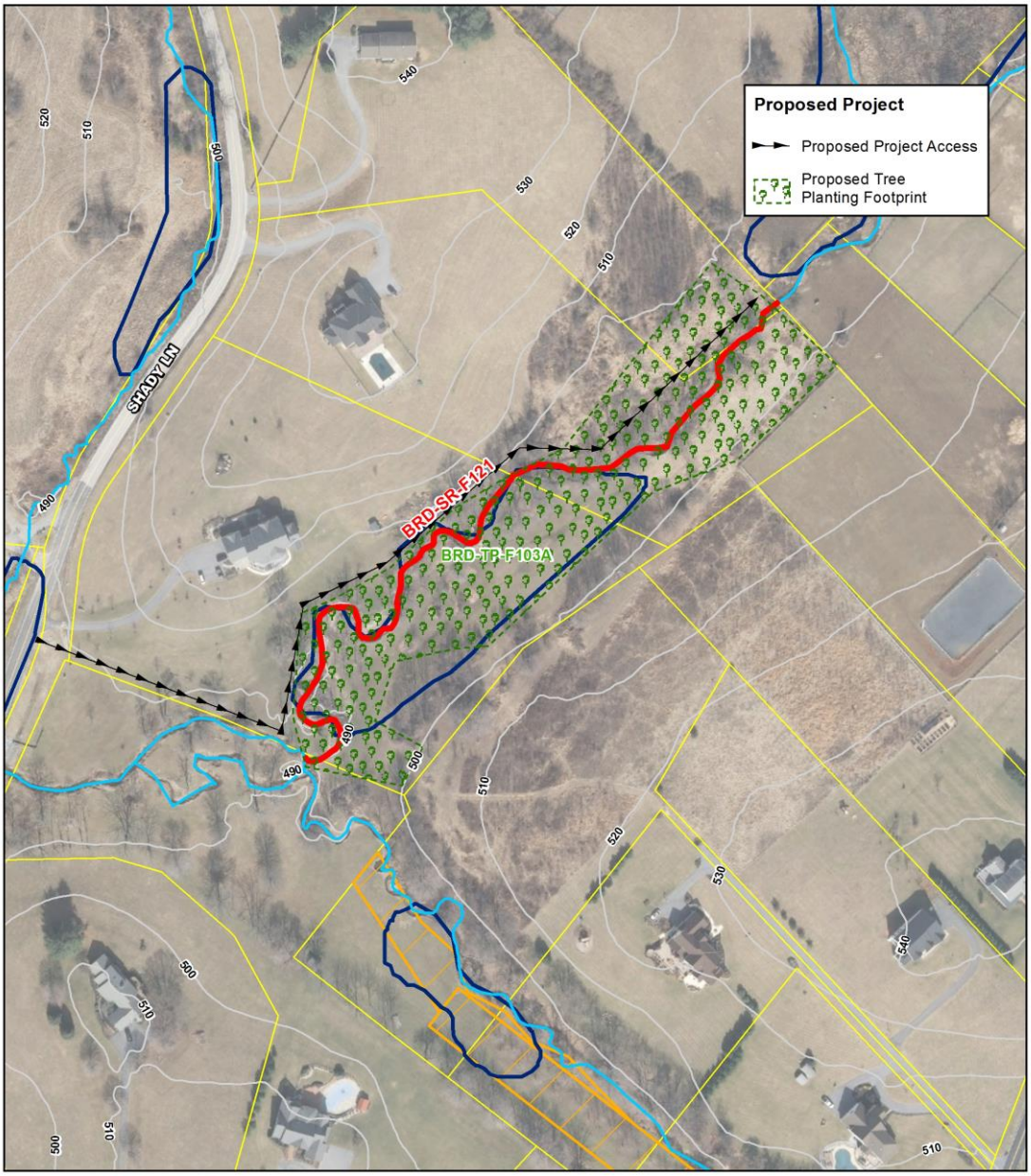
BRD-SR-F121A

Proposed Project Credit	
Planting Acres:	3.6
Impervious Area Treated Credit (ac.):	1.37
Cost per Impervious Credit Acre:	$118,803

Costs	
Estimated Design Cost:	$10,000
Estimated Construction Cost:	$115,200
30% Contingency:	$37,560
Estimated Total Cost:	$162,760

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: BRD-TP-F103A
Site Name: Shady Lane - Trees
Contractor: Straughan
Watershed: Brighton Dam



Plan-View Design Drawing - BRD-TP-103A

- Storm Drain Outlet
- Storm Drain Inlet
- Storm Drain Pipe
- Stream Centerline
- Utility - Water Line
- Utility - Sewer Line
- 10 ft Contour
- DNR Wetland
- Forest Conservation Easement
- Property Boundary
- Subwatershed

STRAUGHAN ENVIRONMENTAL

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Feet
1 inch = 200 Feet

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F302
Site Name: North Laurel Road

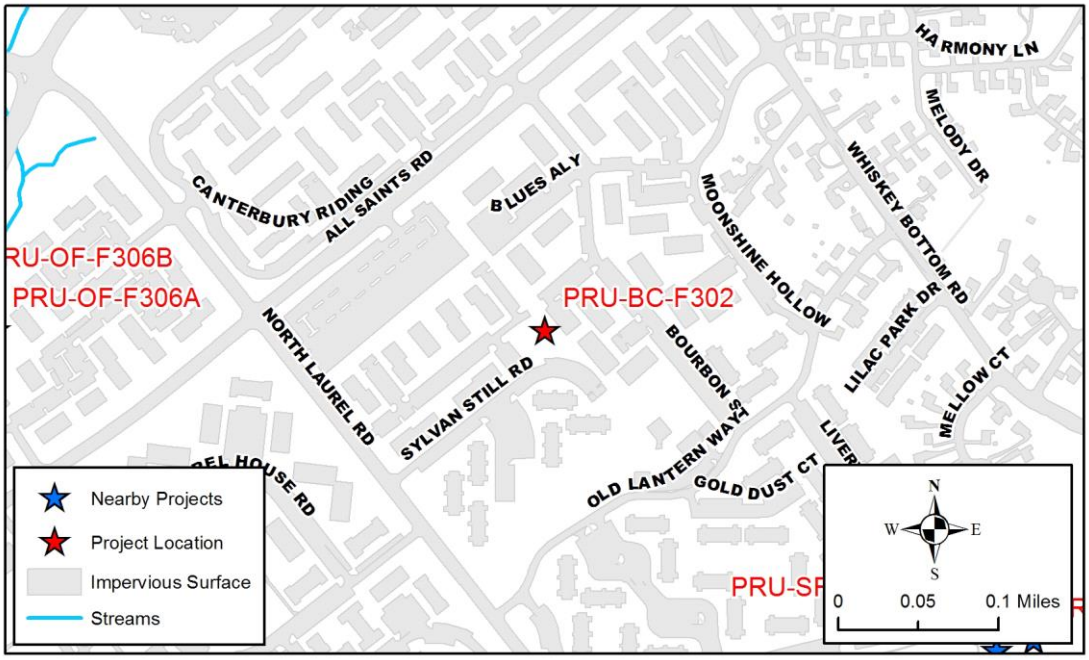
Contractor: Biohabitats
Watershed: Patuxent River Upper

Proposed BMP Type: Bioretention
Ownership: Private- Residential
Single Owner

BMP Structure ID: HO103431
Existing BMP Type: EDSD

Existing Conditions:

The current facility is a dry pond with two storm drain inlets that manage a 8.65 ac., largely residential, drainage area containing 60% impervious surface. Each storm drain inlet discharges into a riprap pilot channel that directs flow to the riser outfall structure. The riser outfall structure discharges to a 30 in. reinforced concrete pipe (RCP) which then discharges into an adjacent storm drain system and, ultimately, a tributary to the Patuxent River running to the east of the property. The property to the north and south is primarily residential and the area to the west is composed of residential properties and the Whiskey Bottom Shopping Center commercial area. The pond itself is located on privately owned property. The pond is approximately 6 ft. deep with a surface area of 6,160 sf.



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F302
Site Name: North Laurel Road

Contractor: Biohabitats
Watershed: Patuxent River Upper

Overview of the facility, including outlet riser structure, looking northwest

Overview of the facility, including inlet headwall and outlet riser structure, looking northeast

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F302
Site Name: North Laurel Road
Contractor: Biohabitats
Watershed: Patuxent River Upper

Constraints/Utilities:

The pond may need to be brought up to MD-378 standards as part of the conversion design. Work will require permission from the applicable property owners.

Concept Description:

The existing dry pond could be converted to a bioretention with an optional sand filter layer by excavating down 4 ft. from the existing pond bottom and replacing the excavated material with 4 ft. of bioretention media. Sediment forebays would be excavated, complete with weirs and forebay berms, at each inlet to control flow into the facility and to serve as pretreatment areas. The riser structure will need to be modified, further analysis will be required during schematic design. In addition, the need for an emergency spillway will need to be evaluated.

Nearby Opportunities:

None recommended

Proposed Project Credit	
Drainage Area (ac.):	8.65
Impervious Area within Drainage (ac.):	5.17
Impervious Area Treated (ac.):	5.17
Impervious Area Treated Credit (ac.):	5.17

Water Quality Volume	
WQVolume Target (cft.):	18,460
Max Treated (cft.):	18,460
Percent Treated:	100%
Rainfall Depth Treated (in.):	1

Costs	
Estimated Design Cost:	$200,000
Estimated Construction Cost:	$356,400
30% Contingency:	$166,920
Estimated Total Cost	$723,320
Cost per Impervious Credit Acre:	$139,907

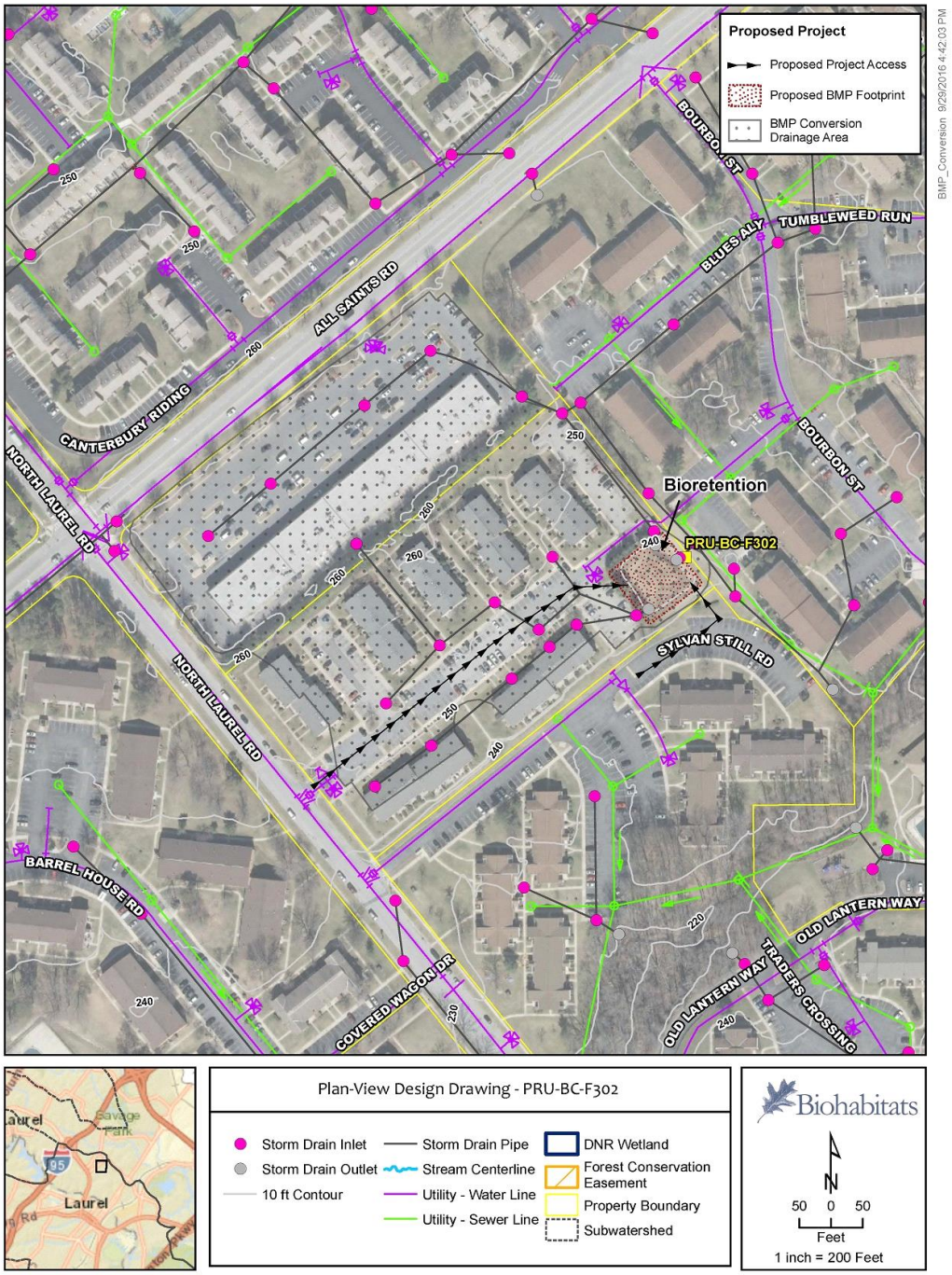
Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F302

Site Name: North Laurel Road

Contractor: Biohabitats

Watershed: Patuxent River Upper



Plan-View Design Drawing - PRU-BC-F302

- Storm Drain Inlet
- Storm Drain Outlet
- 10 ft Contour
- Storm Drain Pipe
- Stream Centerline
- Utility - Water Line
- Utility - Sewer Line
- DNR Wetland
- Forest Conservation Easement
- Property Boundary
- Subwatershed

Biohabitats

N

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Feet

1 inch = 200 Feet

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F304
Site Name: Industrial Park - Davis Avenue

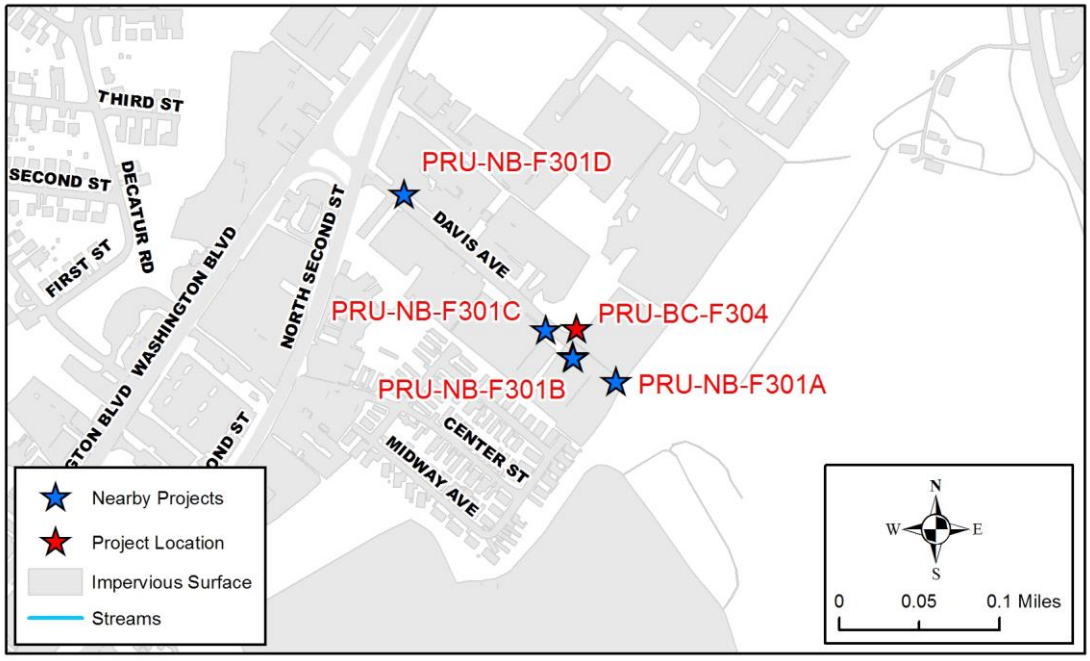
Contractor: Biohabitats
Watershed: Patuxent River Upper

Proposed BMP Type: Retention Pond (Wet Pond)
Ownership: Private- Commerical/Industrial
Multiple Owners

BMP Structure ID: HO105449
Existing BMP Type: DP

Existing Conditions:

The existing site is an industrial park consisting primarily of impervious area. The overall drainage for the site is split at a high point at approximately 9377 Davis Ave, with a portion of site runoff flowing to a swale along US-1 and the remainder flowing to the existing county-owned stormwater management dry pond. This stormwater management pond was identified as a potential retrofit opportunity during a site visit to the Davis Ave industrial park to assess New BMP opportunities for the separate concept "PRU-NB-F301". The existing dry pond receives drainage from two inlets draining 17.06 ac. containing 49% impervious surface from a largely commercial and industrial area. The northern inlet drains into the facility into a sediment forebay. The western inlet, a 15 in. reinforced concrete cylinder pipe (RCCP), discharges into a small rip-rap lined channel. Flow is directed along the length of the facility, from the sediment forebay to a 12 in. RCCP acting as the primary outfall for the pond, via a 4 ft. wide channel. A 55 ft. weir spanning the southern width of the pond serves as a secondary outfall for the pond. The 12 in. RCCP and the overflow from the weir both discharge into a storm drain system flowing southwestward away from the site.



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F304
Site Name: Industrial Park - Davis Avenue
Contractor: Biohabitats
Watershed: Patuxent River Upper

Existing pond weir and concrete embankment

Overview of existing dry pond and phragmites

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F304
Site Name: Industrial Park - Davis Avenue
Contractor: Biohabitats
Watershed: Patuxent River Upper

Constraints/Utilities:

The pond may need to be brought up to MD-378 standards as part of the conversion design. As this is a largely industrial/commercial site with heavy truck and vehicular traffic, construction will require permission from and coordination with the applicable property owners.

Concept Description:

The existing dry pond could be converted to a retention pond (wet pond) by excavating to original ground by removing the existing 2 ft. phragmites mat. The existing outfall structure, a headwall and 12 in. RCCP, would need to be replaced with a riser structure and new outfall barrel. The existing sediment forebay would need to be excavated and the surrounding berm and gabion weir rebuilt.

Nearby Opportunities:

PRU-OF-F302

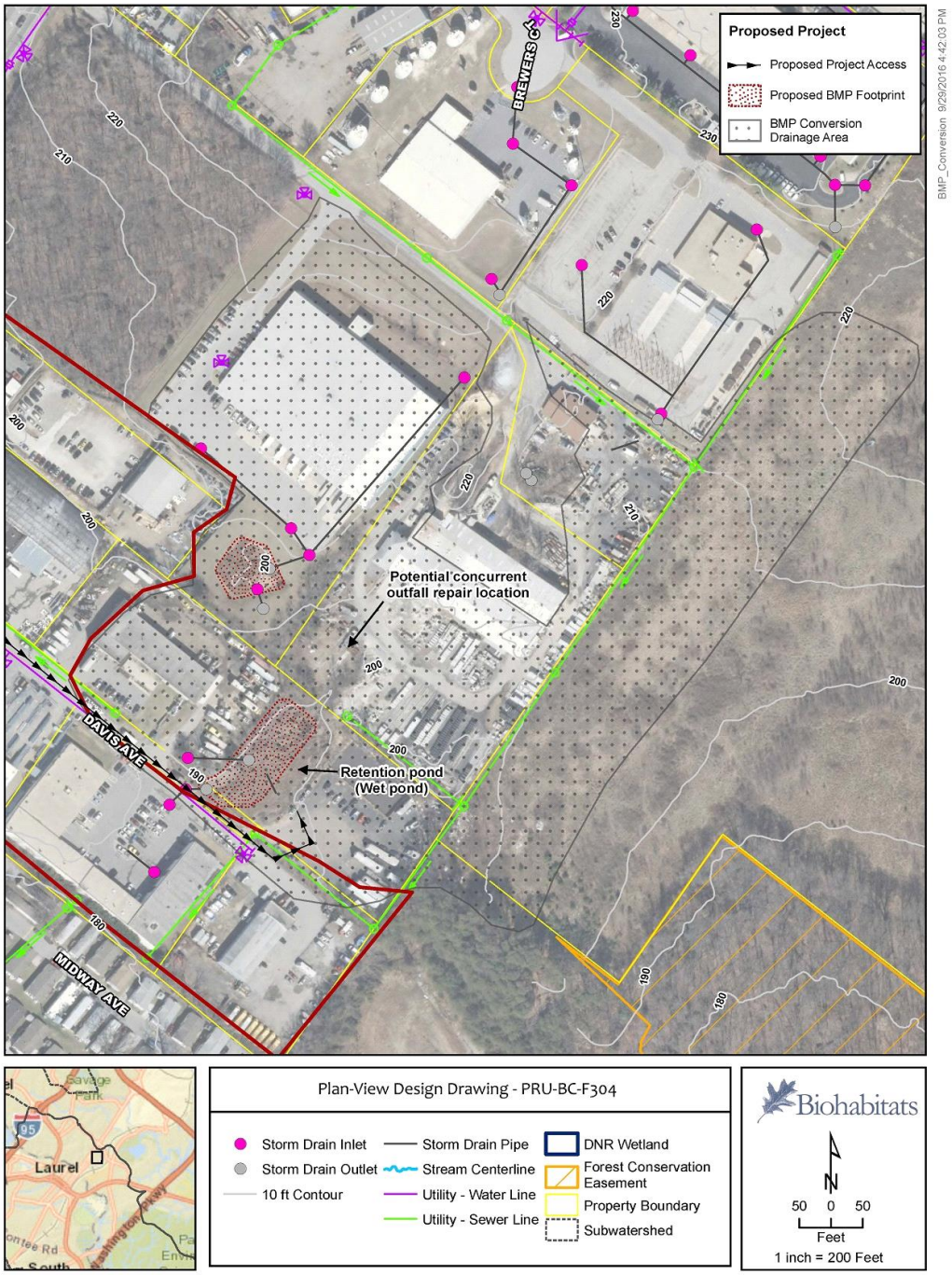
Proposed Project Credit	
Drainage Area (ac.):	17.06
Impervious Area within Drainage (ac.):	8.39
Impervious Area Treated (ac.):	8.39
Impervious Area Treated Credit (ac.):	8.39

Water Quality Volume	
WQVolume Target (cft.):	30,507
Max Treated (cft.):	30,507
Percent Treated:	100%
Rainfall Depth Treated (in.):	1

Costs	
Estimated Design Cost:	$200,000
Estimated Construction Cost:	$331,725
30% Contingency:	$159,518
Estimated Total Cost	$691,243
Cost per Impervious Credit Acre:	$82,389

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: PRU-BC-F304
Site Name: Industrial Park - Davis Avenue
Contractor: Biohabitats
Watershed: Patuxent River Upper



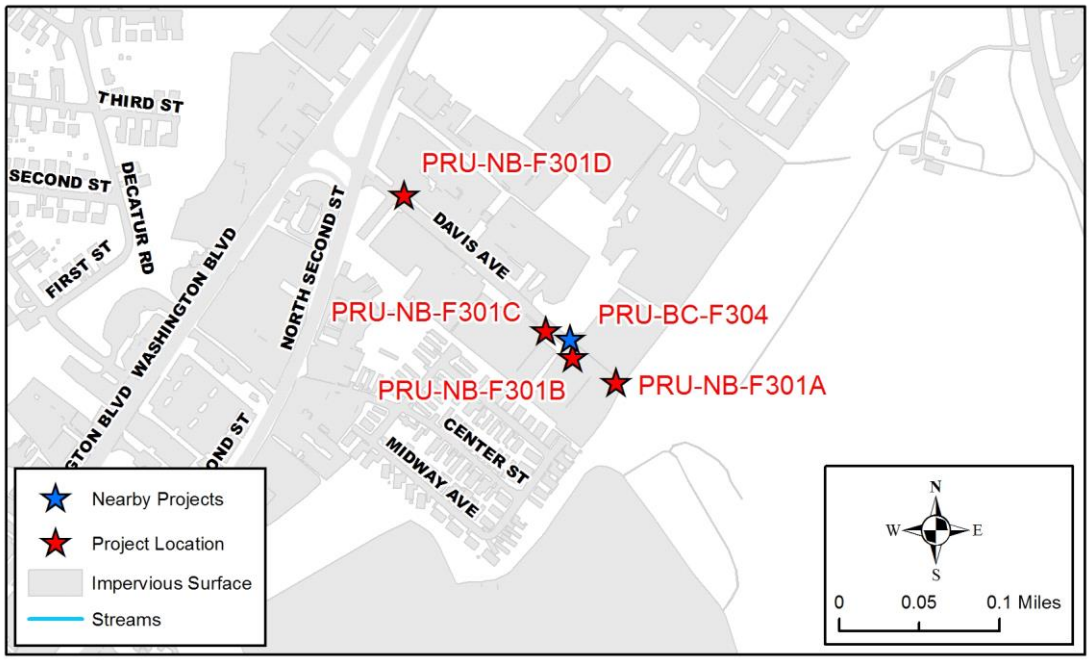
Howard County Watershed Assessment Concept Plan: New BMP

Site ID: PRU-NB-F301
Site Name: Industrial Park - Davis Avenue
Contractor: Biohabitats
Watershed: Patuxent River Upper

Proposed BMP Type: Micro-Bioretention, Bioswale
Ownership: Private- Commerical/Industrial
Multiple Owners

Existing Conditions:

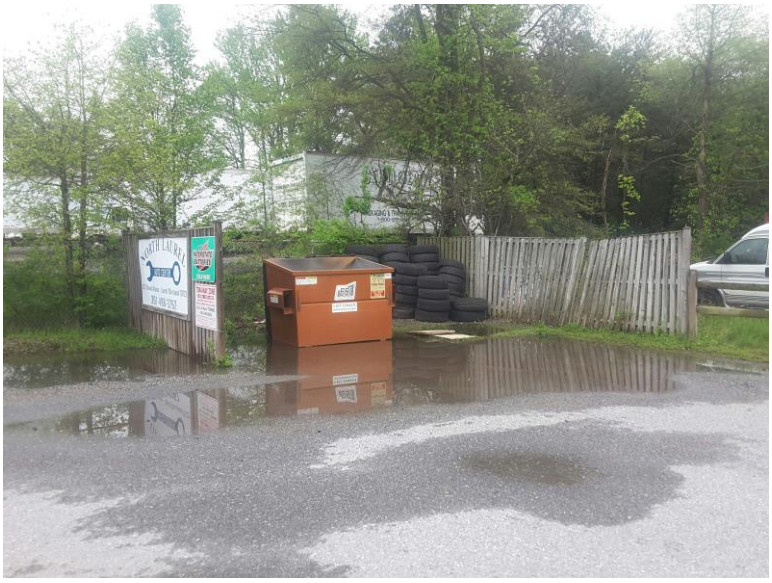
The existing site is an industrial park consisting primarily of impervious area. The overall drainage for the site is split at a high point at approximately 9377 Davis Avenue, with a portion of site runoff flowing to a swale along North Second Street and the remainder flowing to an existing county-owned stormwater management pond. This stormwater management pond was identified on site as a potential retrofit opportunity and is assessed in a separate concept found under "PRU-BC-F304". A series of concrete swales along the northernmost 300 ft. of Davis Avenue capture runoff from the roadway and adjacent parking lots and convey it to the grassed swale running along North Second Street, which ultimately discharges into a tributary to the Patuxent River. The swales show significant erosion and inadequate conveyance, as evidenced by ponding along the length of the swales. The remainder of the site is heavily paved and poorly drained, notably at the southern end of the site. The surrounding areas are primarily commercial and industrial.



Howard County Watershed Assessment Concept Plan: New BMP

Site ID: PRU-NB-F301
Site Name: Industrial Park - Davis Avenue
Contractor: Biohabitats
Watershed: Patuxent River Upper

Overview of existing swale showing examples of drainage issues



Potential micro-bioretention site with ponding evident

Howard County Watershed Assessment Concept Plan: New BMP

Site ID: PRU-NB-F301
Site Name: Industrial Park - Davis Avenue
Contractor: Biohabitats
Watershed: Patuxent River Upper

Constraints/Utilities:

Work will require permission from all adjacent property owners. The proposed facilities should be located to minimize interference with commercial and industrial traffic during construction.

Concept Description:

During a second site visit, each proposed new BMP was reevaluated for feasibility. The two proposed swale retrofits, PRU-NB-F301C and PRU-NB-F301D, were found to be too spatially constrained to provide adequate treatment in the form of a bioswale or grassed swale, as initially proposed. Due to these site constraints, it is recommended that the northern end of the site instead be treated with a bioswale extending from the intersection of Davis Avenue and North Second Street along North Second Street to the existing inlet. The swale would provide safe conveyance from the existing swale running along Davis Avenue to the existing inlet. Given the space constraints imposed by steep slopes on the eastern side of this proposed swale, the swale will need to be fairly narrow, between 2 and 4 ft. in bottom width. Additionally, repairs should be made to the existing drainage swale running along Davis Avenue to improve conveyance. This would be accomplished by stabilizing the bottom and adding stone check dams so as to reduce the velocity and resulting erosion throughout the channel. The two poorly drained areas located at the southern end of the site, PRU-NB-F301A and PRU-NB-F301B, were both determined to be feasible treatment locations during the second site visit. PRU-NB-F301A is proposed as a micro-bioretention with a surface area of 2,000 sf. and a drainage area of 0.53 ac., 0.29 ac. of which is impervious. PRU-NB-F301A is proposed as a micro-bioretention with a surface area of 250 sf. and a drainage area of 0.25 ac., 0.05 ac. of which is impervious. Both facilities would have underdrains outfalling to the adjacent stormwater management pond, the installation of which would require some temporary pavement excavation.

Nearby Opportunities:

PRU-BC-F304

Proposed Project Credit		Water Quality Volume	
Drainage Area (ac.):	3.23	WQVolume Target (cft.):	7,480
Impervious Area within Drainage (ac.):	2.11	Max Treated (cft.):	7,480
Impervious Area Treated (ac.):	2.11	Percent Treated:	100%
Impervious Area Treated Credit (ac.):	2.11	Rainfall Depth Treated (in.):	1

Costs

Estimated Design Cost:	$200,000
Estimated Construction Cost:	$118,110
30% Contingency:	$95,433
Estimated Total Cost	$413,543
Cost per Impervious Credit Acre:	$195,992

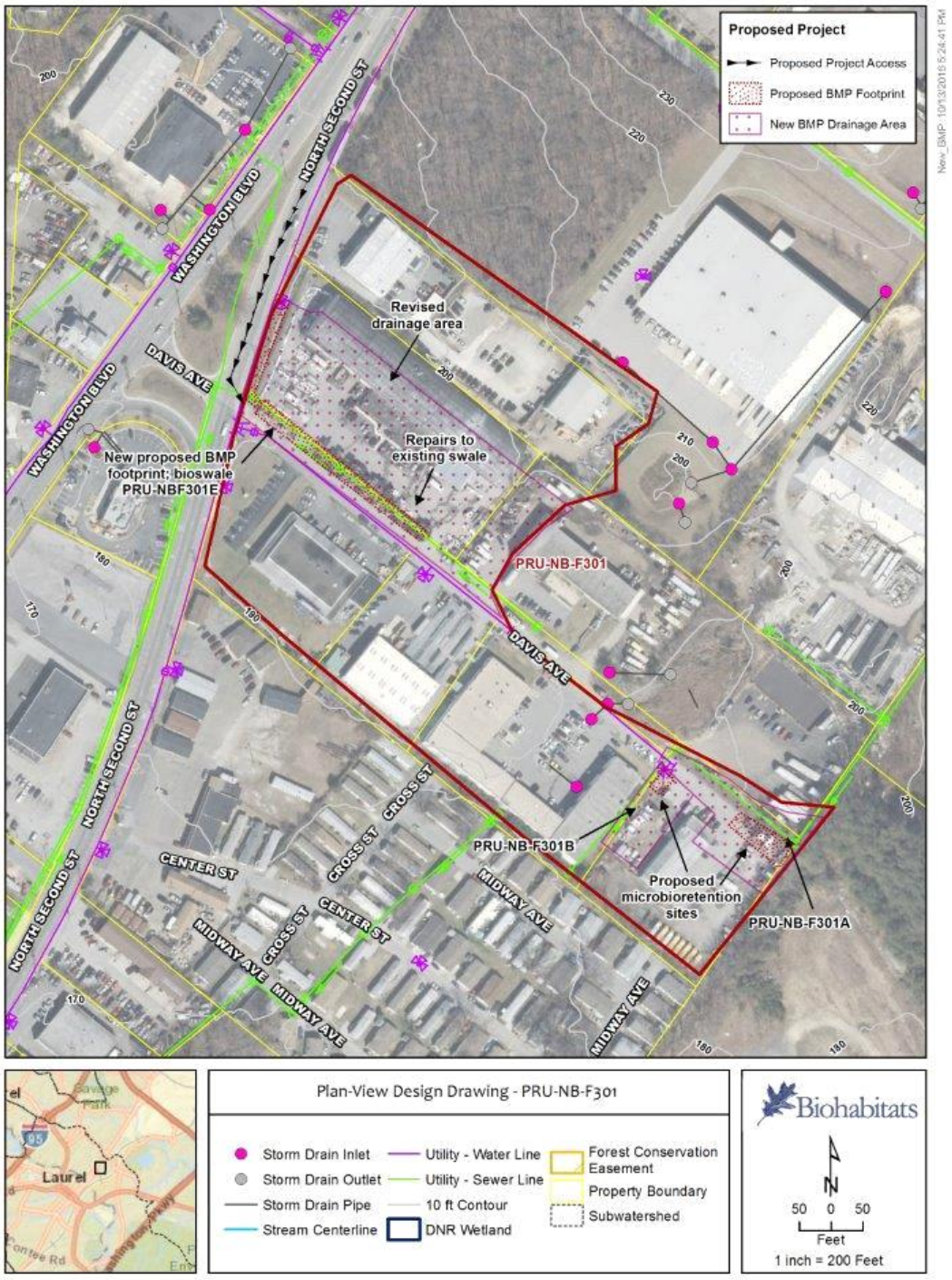
Howard County Watershed Assessment Concept Plan: New BMP

Site ID: PRU-NB-F301

Site Name: Industrial Park - Davis Avenue

Contractor: Biohabitats

Watershed: Patuxent River Upper



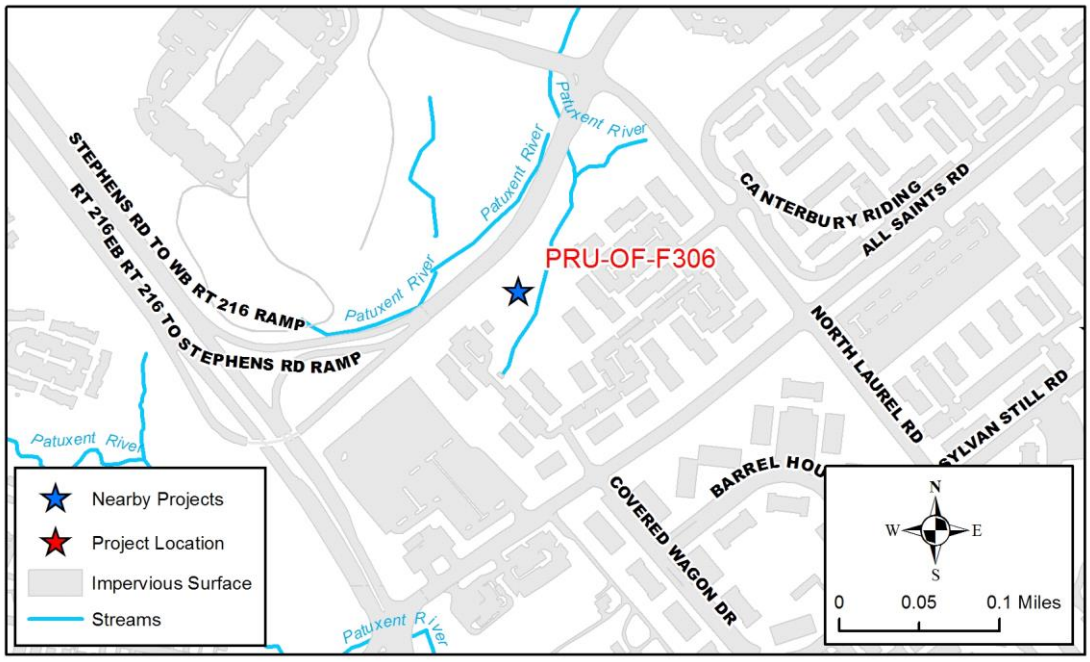
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-OF-F306
Site Name: Whiskey Bottom West
Contractor: Biohabitats
Watershed: Patuxent River Upper

Proposed BMP Type: Outfall Stabilization
Stabilization Type: Step Pool Stormwater Conveyance
Ownership: Private- Residential Single Owner

Existing Conditions:

Outfalls PRU-OF-F306A and PRU-OF-F306B are located within a residential neighborhood off Maryland 216 on the corner of N Laurel Road and All Saints Rd. Outfall PRU-OF-F306A is a 27 in. RCP pipe that discharges to a wooded area. The outfall receives stormwater runoff from a 5.3 ac. drainage area, almost half of which is impervious. According to the as-built drawing (SDP-78-071), the outfall was designed to discharge onto a 20 ft. rip rap apron, which then discharges into a ditch leading to the stream. Since this was installed in 1978, the outfall has eroded and created an entrenched gully that is approximately 120 ft. long and drops in elevation roughly 8.4 ft. This entrenched gully was created due to a 5 ft. headcut located near the outfall, which has created both left and right bank erosion at an eroded bank height of 4 ft. Outfall PRU-OF-F306B, a 36 in. pipe, discharges onto a riprap apron that is stable; however, as the apron approaches the stream, riprap has been displaced and a 3.5 ft. headcut is forming just before the confluence with the stream. Although the upstream end of the channel is stable, the headcut is indicative of the potential for future instability and an entrenched gully similar to PRU-OF-F306A.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-OF-F306
Site Name: Whiskey Bottom West
Contractor: Biohabitats
Watershed: Patuxent River Upper

Photo facing upstream at the existing 5 ft. headcut caused from outfall PRU-OF-F306A.

Photo facing upstream at the existing 3.5 ft. headcut caused from outfall PRU-OF-F306B.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-OF-F306
Site Name: Whiskey Bottom West
Contractor: Biohabitats
Watershed: Patuxent River Upper

Constraints/Utilities:
The site is located on private property in a residential area. Tree and wetland impacts would be minimal.

Concept Description:
This proposed concept combines outfalls PRU-OF-F306A and PRU-OF-F306B. Due to its existing conditions, a hybrid SPSC/outfall stabilization is recommended for PRU-OF-F306A. For the upstream end, the entrenched channel will allow for creation of an SPSC with minimal additional excavation. Three pools may be installed – one pool with both pool storage and filtering material, and two pools with pool storage only. Cascades may be necessary in between the pools as grade control. The SPSC would transition into an outfall stabilization project at the downstream limits of the channel. The proposed stabilization of outfall PRU-OF-F306B is a combination of repairing the existing riprap channel as well as addressing the headcut near the stream confluence. The riprap channel may be stabilized with properly sized riprap material that can either continue the entire length of the outfall channel or transition into a step pool conveyance system to stabilize the existing headcut. For this concept plan, outfall stabilization using riprap is recommended since the existing channel is not severely eroded and is not an entrenched gully like PRU-OF-F306A. Associated bank grading with the installation of riprap may impact surrounding trees. The outfall channel length for restoration for PRU-OF-F306A is 120 ft. and the restoration length for PRU-OF-F306B is 100 ft.; therefore, the combined outfall channel length for restoration for PRU-OF-F306 is 220 ft. The cost estimate considers 120 ft. of SPSC outfall stabilization for PRU-OF-F306A and 100 ft. of riprap outfall stabilization for PRU-OF-F306B.

Nearby Opportunities:
None recommended

Proposed Project Credit

Drainage Area (ac.):	5.27
Impervious Area within Drainage (ac.):	2.46
Impervious Area Treated (ac.):	0.8
Impervious Area Treated Credit (ac.):	2.2

Water Quality Volume

WQVolume Target (cf.):	9,000
Max Treated (cf.):	3,048
Percent Treated:	34%
Rainfall Depth Treated (in.):	0.34

Costs

Estimated Design Cost:	$200,000
Estimated Construction Cost:	$145,000
30 % Contingency:	$103,500
Estimated Total Cost:	$448,500
Cost per Impervious Credit Acre:	$203,864

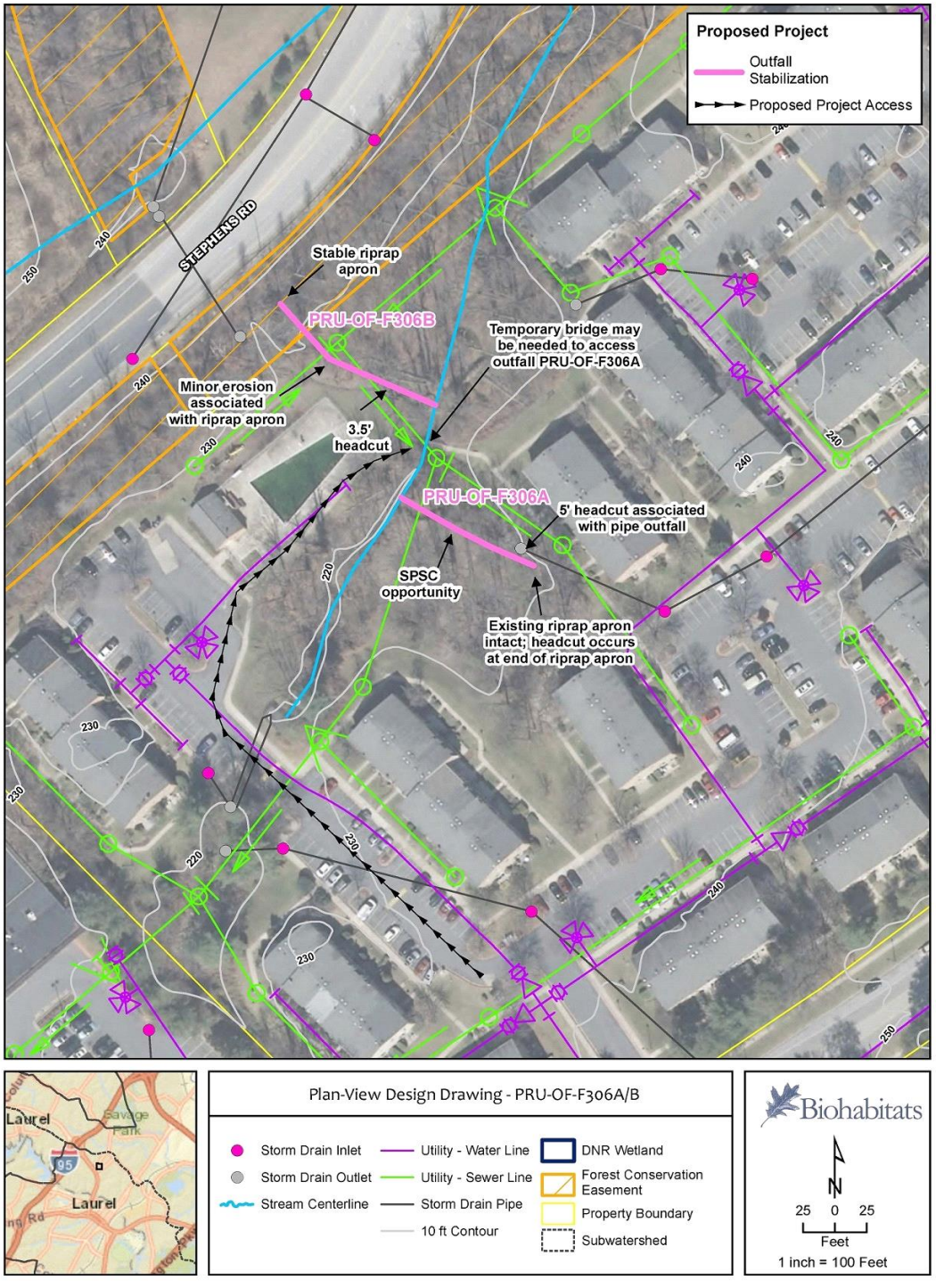
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-OF-F306

Site Name: Whiskey Bottom West

Contractor: Biohabitats

Watershed: Patuxent River Upper



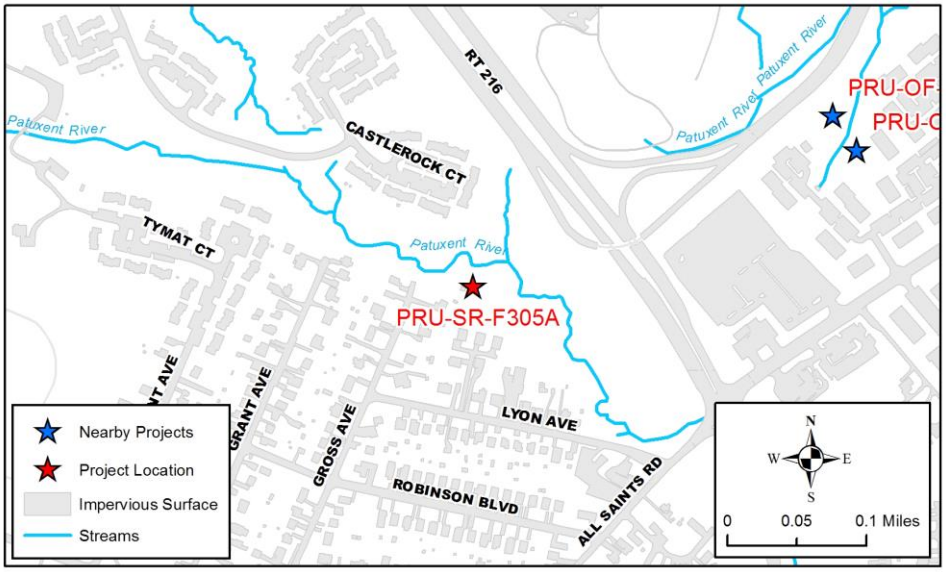
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305A
Site Name: Lyon Avenue - A
Contractor: Biohabitats
Watershed: Patuxent River Upper

Ownership: County Owned
Multiple Owners

Existing Conditions:

The site is located within Howard County property and is classified as Howard County Open Space in Laurel, MD. The stream is located within a medium density residential area; however, the riparian zone is forested with Maryland 216 adjacent to the left and residential homes adjacent to the right (while looking downstream). The existing mainstem channel has persistent erosion throughout its extent, with alternating stream bank erosion between the left and right banks; however, the severity varies depending on location. The assessed stream has a small tributary that joins it about half way throughout its extents. This tributary is a pipe outfall channel from Maryland 216 and it was not assessed; however, the tributary was observed at its confluence with the assessed stream and was later revisited during the concept phase. The tributary is a 360 ft. long incised channel currently disconnected with its floodplain and exhibits an eroded bank height between 4 ft. and 5 ft. along both the left and right bank. Upstream of this tributary, alternating left and right bank erosion occurs at an average eroded bank height between 2 ft. and 3 ft.; however, this erosion is spotty and is healing over throughout the upstream extents. A sewer line crossing is also observed directly upstream of the tributary. The sewer line is not exposed, but the sewer line protection has been shifted and could possibly expose the pipe over time. Directly downstream of this tributary, the mainstem exhibits some of the worst erosion throughout the stream channel. The mainstem is widening and is disconnected from its floodplain directly downstream of the tributary for approximately 125 lf. at an average height of 5 ft. along the left bank. The mainstem then enters tight meanders creating high eroded banks. Downstream of these tight meanders, the mainstem bank erosion becomes less severe, with more spotty areas of erosion that are in the process of healing. The most downstream limits of the mainstem become very sinuous and steep with bank erosion shifting from the left and right banks with the average eroded bank heights between 2 ft. and 3 ft. Moderate sediment deposition throughout the channel is evident based on recent bank failure which is creating alternating bars along the toe of the banks. Riparian vegetative zone for both the upstream and downstream limits of the stream are optimal, with human activities (homes and roads) being more of an impact in the upstream limits. Shading along the existing channel is optimal (80%).



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305A
Site Name: Lyon Avenue - A
Contractor: Biohabitats
Watershed: Patuxent River Upper

Photo facing downstream assessing the left bank and depicts a typical stream bank within the downstream limits of the assessed stream.

Photo facing upstream assessing the right bank and depicts a typical stream bank within the upstream limits of the assessed stream.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305A
Site Name: Lyon Avenue - A
Contractor: Biohabitats
Watershed: Patuxent River Upper

Constraints/Utilities:

Access to the stream poses an issue due to steep side slopes and surrounding private properties, but the site can be accessed from the sewer line easements along Old Scaggsville Road or Gross Ave. A water line crosses the stream at the upstream limits of the stream, while a sewer line runs adjacent to the stream and crosses the stream at several locations. Moderate impact to trees and wetlands could be an issue during construction due to the close proximity of these natural resources to the stream itself. The tributary is located with a forest conservation easement.

Concept Description:

The objective for this project is to reduce bank erosion and improve instream habitat for aquatic organisms. This project proposes the restoration of 1,650 lf. of stream channel which encompasses 1,290 lf. of the mainstem and 360 lf. of a tributary/outfall channel that was added during the concept reconnaissance. Because the tributary is currently entrenched with 4 ft. to 5 ft. eroding banks, the channel should be reconnected to its floodplain through stream restoration as well as safely convey into the mainstem to prevent further downstream erosion. Upstream of the tributary is a sewer crossing that is not currently exposed, but the existing sewer protection needs to be stabilized. This area also provides a logical tie-in point for the proposed restoration. Directly downstream of the sewer crossing and the tributary is a section of stream that is currently overwide and needs to be restored. Opportunities for the restoration of this reach include: 1.) raising the invert of the stream to provide better access to the existing broad floodplain, or 2.) create a nested channel with a shallow hyporheic bench within the over-widened channel while grading back the eroded banks to a stable angle, which will better align the channel cross section within the urban channel's flow regime. Moving downstream from this overwide section, the mainstem alignment should be realigned to reduce bank erosion occurring along the tight bends. Minor bank stabilization throughout the downstream limits of the mainstem and possible grade control structures could increase stability of the mainstem. Adding woody debris, cobble riffles, pools, and other nature-like habitat structures will reinforce the stream bed and banks, improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat throughout the mainstem. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment may be necessary at the tight meander bends at the downstream limits of the mainstem. This channel restoration has the potential to reduce sediment supply, improve habitat and provide opportunities for nutrient uptake.

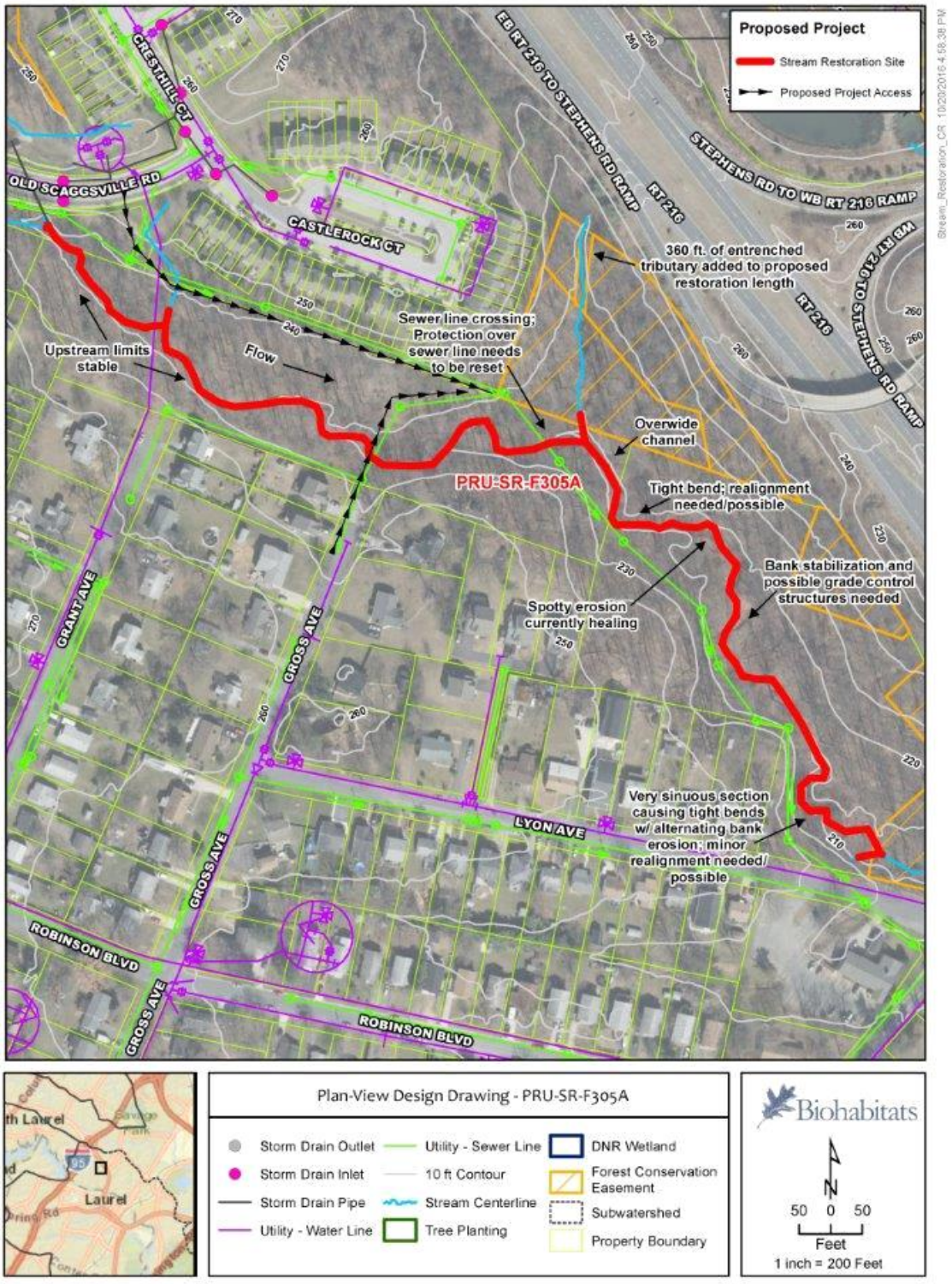
Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	1,650	Estimated Design Cost:	$300,000
Impervious Area Treated Credit (ac.):	16.5	Estimated Construction Cost:	$742,500
Cost per Impervious Credit Acre:	$82,136	30% Contingency:	$312,750
		Estimated Total Cost:	$1,355,250

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305A
Site Name: Lyon Avenue - A
Contractor: Biohabitats
Watershed: Patuxent River Upper



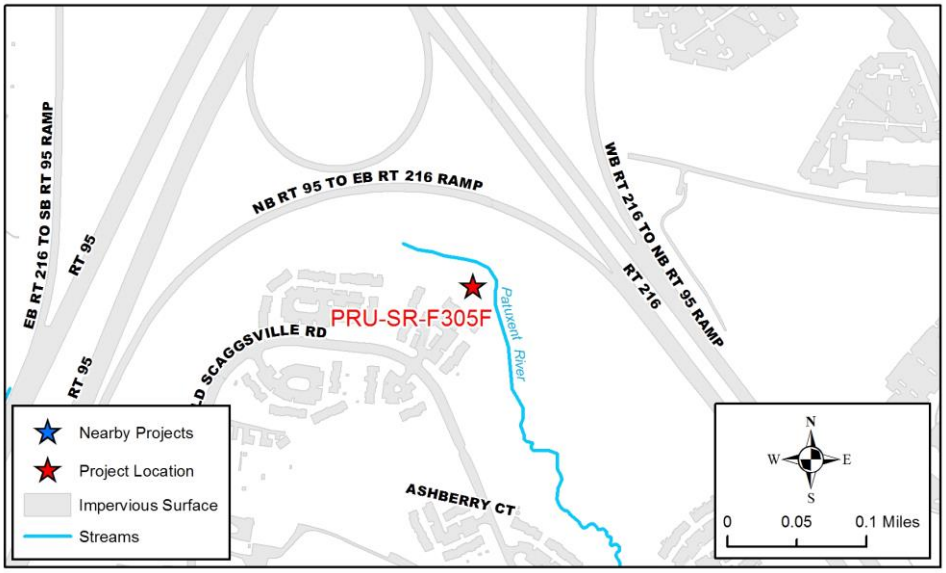
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305F
Site Name: Lyon Avenue - F
Contractor: Biohabitats
Watershed: Patuxent River Upper

Ownership: County Owned
Single Owner

Existing Conditions:

The site is located in Laurel, MD in a forested section between the northbound I-95 to eastbound Route 216 ramp and Old Scaggsville Road. The site is located on county property, but is in close proximity to private condominium housing. The stream is within a healthy coastal plain forest; therefore, access to the stream is not easy. This site is upstream of site PRU-SR-F305A, which was also selected for restoration. Minor erosion was assessed at the downstream limits of PRU-SR-F305F, but more erosion was evident moving upstream. In general, the severity of erosion is limited by high root densities and vegetation in the upper bank and in many locations eroded areas showed evidence of healing over. Short, moderate erosion was captured before long stretches of minor erosion were observed. The short, moderate erosion was no longer than 30 ft. in length and between an eroding height of 3.5 ft. to 5 ft. After this short, moderate erosion, over 200 ft. of alternating minor bank erosion was observed on both the left and right banks at an average eroding bank height of 2.5 ft. Continuing upstream from this erosion, more erosion was discovered, but this erosion was minor and was showing signs of healing. The stream ends randomly in the middle of the forest at a 3 ft. headcut. Upstream of the headcut, no pipe outfall was found. The surrounding forest and wetland species are currently helping stabilize the banks downstream of the headcut. A pipe outfall was found during the assessment along the left bank that drains runoff from the highway off ramp; however, the outfall channel was stable and no evidence of erosion was noted. The instream habitat within the existing channel scored in the suboptimal range, with moderate deposition of sediment throughout the channel noted as the limiting habitat feature. The riparian vegetative zone is optimal. Shading along the existing channel is optimal (80%).



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305F
Site Name: Lyon Avenue - F
Contractor: Biohabitats
Watershed: Patuxent River Upper

Photo facing downstream of bank erosion along the right bank.

Photo facing downstream of minor bank erosion along the left bank. Forest and vegetative protection helping stabilize the bank.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305F
Site Name: Lyon Avenue - F
Contractor: Biohabitats
Watershed: Patuxent River Upper

Constraints/Utilities:

Access to this stream is one of the biggest constraints on this site. The site is on county property, but the site is deep into the forest; therefore, a lot of clearing would be needed in order to access the stream during construction. The site can be entered along a water line easement line at the upstream limits of the stream, but clearing along the stream would need to occur. Damage to the surrounding trees and wetland areas could be a major constraint, since both are helping stabilize the banks currently.

Concept Description:

The objective for this project is to reduce bank erosion. This project proposes 800 lf. of stream restoration/floodplain reconnection. The stream banks showed evidence of minor bank erosion throughout the stream length; however, this bank erosion was spotty and inconsistent. Because of this inconsistency, the proposed in stream work would consist of strategically placed riffle structures to stabilize the existing headcut and raising the stream invert to reconnect the channel to its historic floodplain. Based on the valley slope, raising the stream invert would require as many as 20 riffle structures spaced at approximately 40 foot intervals. Bank grading and treatments outside of the proposed riffle footprints are not recommended due to the potential impacts to existing forest providing stability to the stream. In order to access and construct along the stream, multiple mature trees would be lost. In addition, the surrounding wetlands could be impacted. Due to the patchy and minor nature of problems within the reach, the intensive effort required to raise the channel invert may not warranted, but spot repairs and/or channel grading will impact the forest conditions that are currently limiting the severity of erosion within the reach.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	800	Estimated Design Cost:	$200,000
Impervious Area Treated Credit (ac.):	8	Estimated Construction Cost:	$360,000
Cost per Impervious Credit Acre:	$91,000	30% Contingency:	$168,000
		Estimated Total Cost:	$728,000

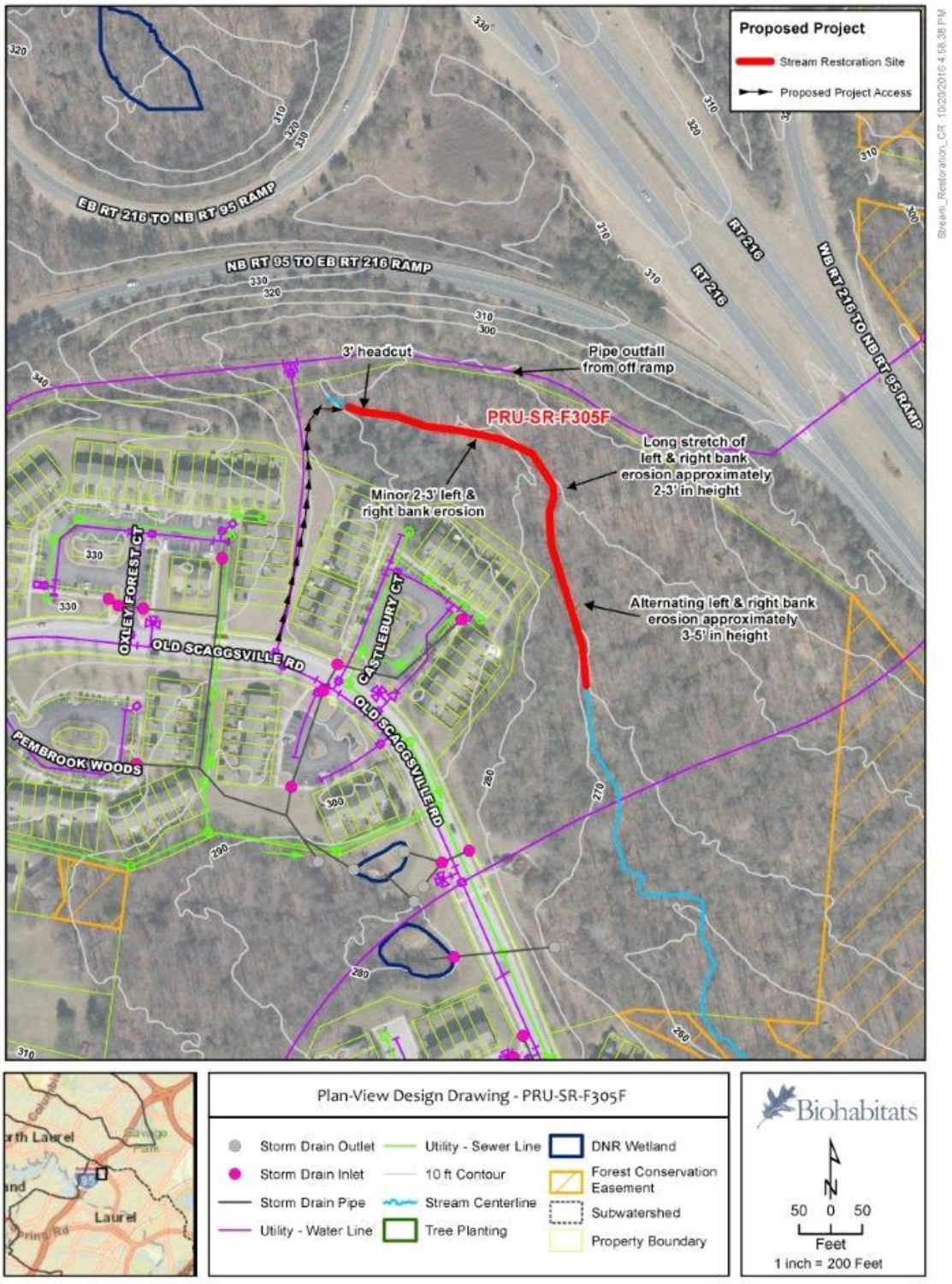
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F305F

Site Name: Lyon Avenue - F

Contractor: Biohabitats

Watershed: Patuxent River Upper



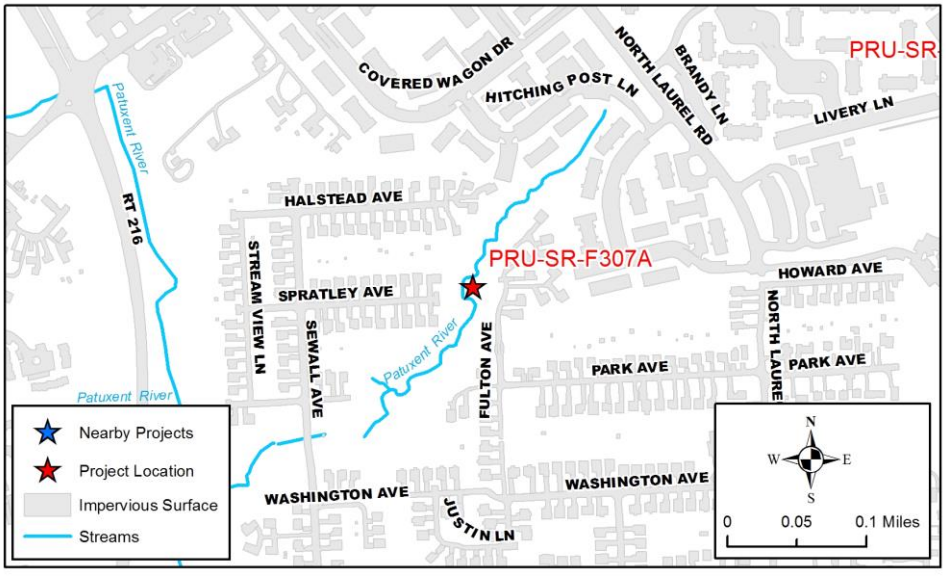
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F307A
Site Name: Patuxent Lane
Contractor: Biohabitats
Watershed: Patuxent River Upper

Ownership: County Owned
Multiple Owners

Existing Conditions:

The site is located within Howard County property (Department of Public Works and Howard County Open Space) in Laurel, MD and discharges into the Patuxent River. The stream is located within a medium density residential area with several townhomes and condominiums close to its proximity. The stream is fed through a 66 inch stormwater outfall pipe at the upstream end near Hitching Post Lane. As the stream flows downstream, four other stormwater outfalls discharge into the stream. One of the four outfalls is approximately 30 ft. away from the stream and currently has an incised outfall channel resulting in the outfall being 2 ft. above the outfall channel invert. Due to this outfall headcut, the left and right banks have 4-6 ft. eroding bank heights. This outfall and the assessed stream exhibited refuse that was abundant and unsightly with multiple shopping carts, appliances, and other trash (plastic bottles, bags, etc.) being discarded and contaminating the water. Sewer lines including a trunk line paralleling the stream and 5 laterals connect within the project area. During the assessment, two exposed sewer lines were found and documented. The average stream bank height is around 4 ft.; however, in problem areas, most of the stream banks are greater than 5 ft. with an eroded bank of also 5 ft. or greater. A couple of areas, typically associated with tight meanders, resulted in an eroded bank height of 8 ft. or greater and an overall bank height of 15 ft. or greater. These areas where high eroded banks are occurring are beginning to cut into private property and nearing homes. The instream habitat within the existing channel scored in the low suboptimal range overall. Embeddedness throughout the stream is low with only 25-50% of the stream particles being covered and/or surrounded by sediment. Riparian vegetative zone width is marginal at the upstream end of the stream with human activities having a greater impact on the stream compared to the downstream end of the stream where the riparian vegetative zone width is optimal. The shading within this area is marginal to suboptimal with 40% to 70% of the stream being shaded.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F307A
Site Name: Patuxent Lane
Contractor: Biohabitats
Watershed: Patuxent River Upper

Photo facing upstream showing raw left bank around tight meandering bend.

Photo facing downstream showing high left bank at tight meandering bend. Photo shows exposed sewer line and trash in-stream.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F307A
Site Name: Patuxent Lane
Contractor: Biohabitats
Watershed: Patuxent River Upper

Constraints/Utilities:

The site is located within Howard County property. The site can be accessed along an existing pond easement/access road near Patuxent Lane. No significant/specimen trees or wetlands were observed during the site assessment despite existing forest cover surrounding the stream corridor. The existing forest and surrounding vegetation is in poor to fair condition and contains various invasive species. The site is in close proximity to private properties and homes, in which construction and noise could be a nuisance. Sewer lines cross the stream and run along the stream corridor. These lines will need to be protected during construction. Non-native invasive species are prevalent throughout the project area and may impact plant establishment without management efforts.

Concept Description:

The objective for this project is to reduce bank erosion in problem areas while preserving and enhancing the instream habitat for aquatic organisms. By reducing this bank erosion, a reduction in high sediment load being sent downstream would also be reduced, allowing a reduction in the maintenance cycle for the pond. The proposed restoration will extend from pond riser at Sewall Ave upstream approximately 1,800 lf. to the pipe outfall at Hitching Post Lane. In addition to the mainstem work, one eroded outfall will be repaired and retrofit as a Step Pool Storm Conveyance (SPSC), due to the outfall being a dry stormwater outfall with no baseflow. The proposed restoration encompasses grading banks back to a stable angle and stabilizing them with native vegetation and/or boulders to hold soil in place. Due to the narrow valley width, excavating a narrow hyporheic bench for the entire restoration reach is not practical; however, it could be explored where the valley is wider in the lower part or the reach. It is expected that earthwork cannot be balanced, but excavated materials could be used to raise the channel invert in locations to provide better access to the narrow floodplain. Woody debris, cobble riffles, pools, and other nature-like habitat structures will be necessary to reinforce the stream bed and banks. Consequently, these elements will improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment may be necessary at tight meander bends and/or where the existing channel alignment is impending on existing structures (sewer lines, homes, etc.). Cobble riffles will be strategically placed to protect and cover both exposed sewer lines. In addition, enhancing the existing riparian buffer will increase the shading to reduce the stream temperature and provide needed litter inputs and woody debris to the channel overtime to maintain the habitat complexity and quality. Large debris should also be removed from the stream as well as upstream controls should be installed to reduce the amount of floatables found within the stream channel. This channel restoration has the potential to reduce the sediment supply, improve habitat, and provide opportunities for nutrient uptake.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	1,800	Estimated Design Cost:	$300,000
Impervious Area Treated Credit (ac.):	18	Estimated Construction Cost:	$810,000
Cost per Impervious Credit Acre:	$80,167	30% Contingency:	$333,000
		Estimated Total Cost:	$1,443,000

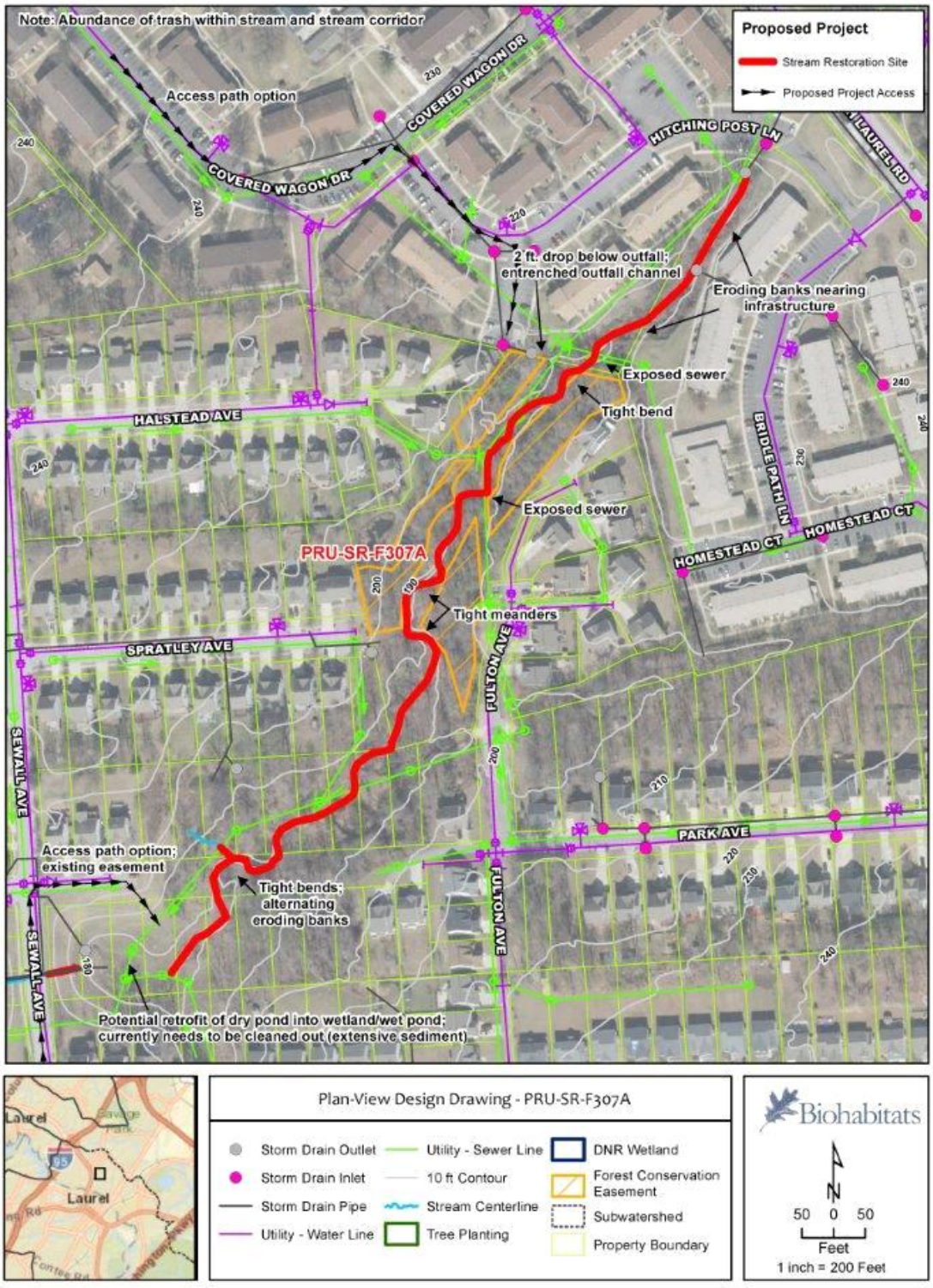
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F307A

Site Name: Patuxent Lane

Contractor: Biohabitats

Watershed: Patuxent River Upper



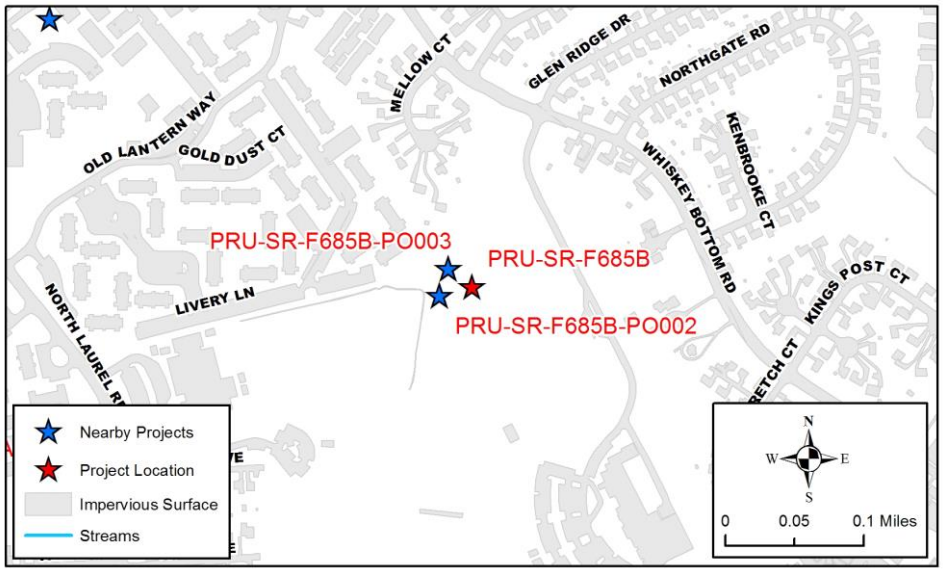
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F685B
Site Name: North Laurel Park
Contractor: KCI
Watershed: Patuxent River Upper

Ownership: County Owned
Single Owner

Existing Conditions:

This site is located on an unnamed tributary to the Patuxent River and is owned by Howard County Department of Parks and Recreation. The stream at this site originates at a storm drain outfall and is experiencing downcutting, widening, and headcutting. The eroded banks along this reach are near vertical and have an average height of 4 ft. throughout the site but reach a maximum height of 10 ft. towards the upper end of the site. The banks are primarily composed of silt and have moderate root density and low root depth. Multiple small headcuts totaling 1 ft. are located within the site. Stream habitat is poor throughout this site, lacking both suitable cover for fish and stable substrates for stream insects. Sand and gravel comprised most of the stream substrate at this site. Bank stability was low, likely contributing fine sediment to the channel and impairing the habitat by filling the interstitial spaces of the stream bed.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F685B
Site Name: North Laurel Park
Contractor: KCI
Watershed: Patuxent River Upper

Facing downstream at typical left bank erosion

Facing upstream at typical site conditions

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F685B
Site Name: North Laurel Park
Contractor: KCI
Watershed: Patuxent River Upper

Constraints/Utilities:

Access to the site may be a constraint at this location; the stream is 290 ft. from the closest road. The site is located in a forest and will require the removal of many trees to facilitate access and construction. The field crew noted specimen trees in the area of the site and potential wetland impacts.

Concept Description:

The proposed stream restoration design will focus on stabilizing eroding banks and reconnecting the stream to its floodplain. The bed elevation may be raised to reconnect the stream to its previous floodplain and to address the headcuts. Bank protection will include natural channel design and bioengineering techniques, but may need stone treatments in some areas. Cobble brought in from off-site will be added to the existing sand and gravel substrates in constructed riffles to increase velocity and habitat diversity. Existing rootwads will be retained when possible to provide habitat and overhead cover for fish and benthic macroinvertebrates. A planting plan will be developed for the site to revegetate the stream banks and areas disturbed during construction using native plant species.

Nearby Opportunities:

PRU-SR-F685B-PO002, PRU-SR-F685B-PO003

Proposed Project Credit		Costs	
Length Restored (ft):	600	Estimated Design Cost:	$200,000.00
Impervious Area Treated Credit (ac.):	6	Estimated Construction Cost:	$270,000.00
Cost per Impervious Credit Acre:	$101,833	30% Contingency:	$141,000.00
		Estimated Total Cost:	$611,000.00

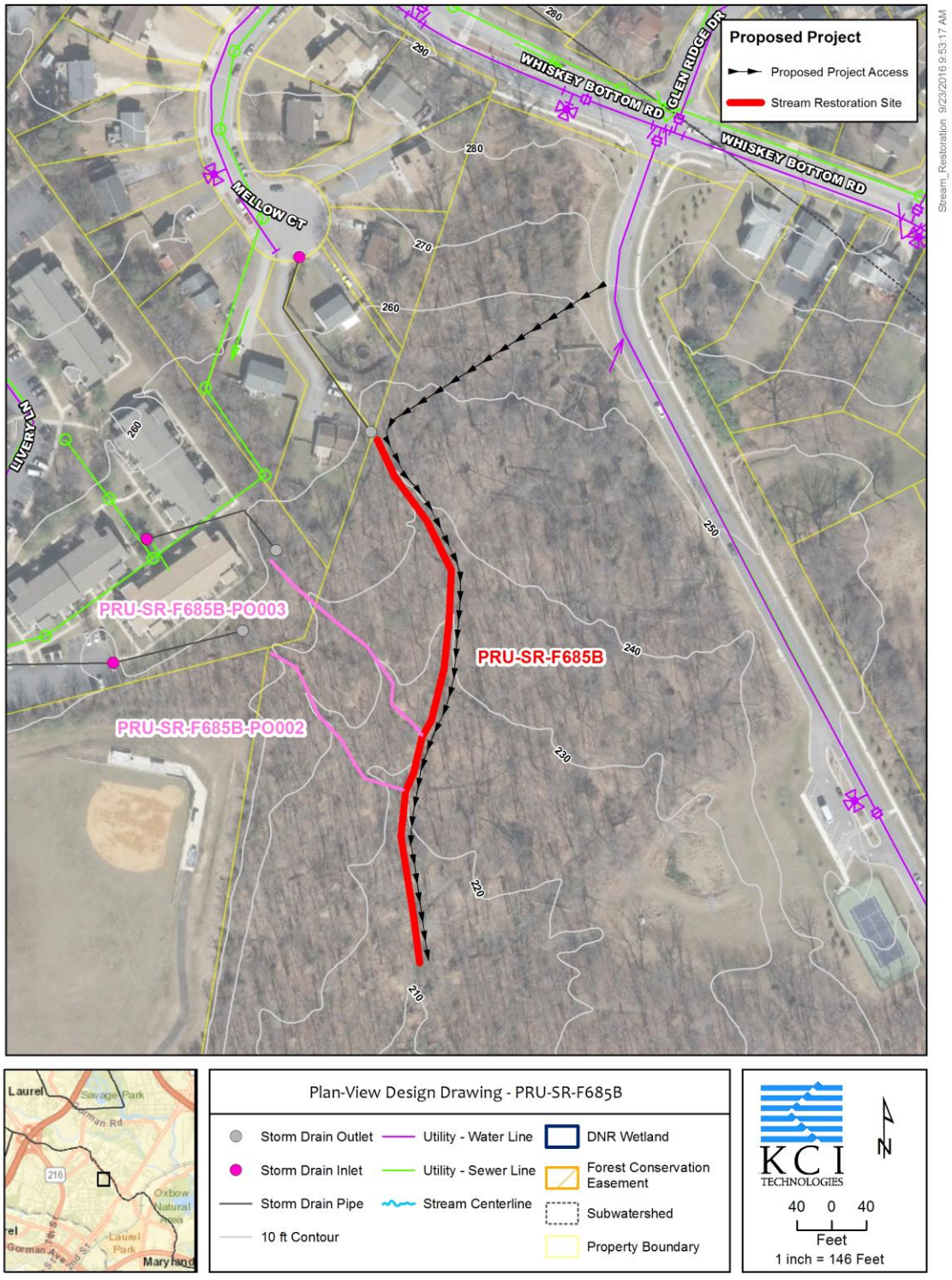
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: PRU-SR-F685B

Site Name: North Laurel Park

Contractor: KCI

Watershed: Patuxent River Upper



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO002

Site Name: Livery Lane A

Contractor: KCI

Watershed: Patuxent River Upper

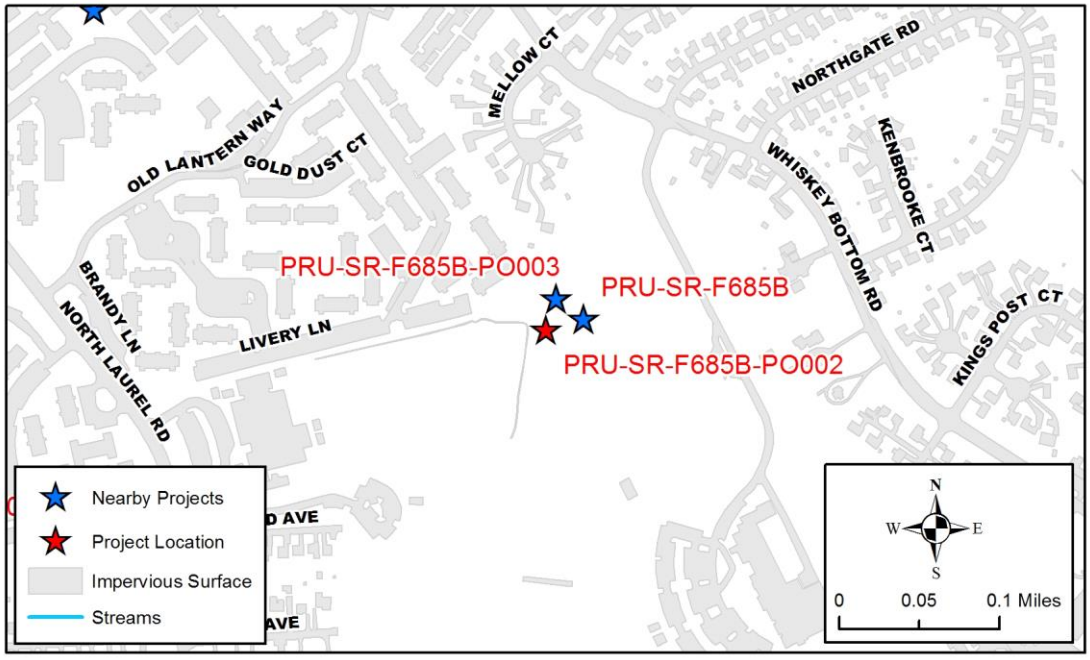
Proposed BMP Type: Outfall Stabilization

Stabilization Type: Step Pool Stormwater Conveyance

Ownership: County Owned
Single Owner

Existing Conditions:

The proposed outfall stabilization is a severely eroded channel originating from a storm drain pipe with no stormwater management treatment. The channel erosion starts immediately downstream of the outfall and extends the entire length of the outfall channel of approximately 230 ft. downstream until it meets an unnamed tributary to the Patapsco River. The channel has approximately 10 ft. high banks and a 15 ft. wide channel. Site access is moderately easy from the adjacent apartment complex parking lot off Livery Ln.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO002
Site Name: Livery Lane A
Contractor: KCI
Watershed: Patuxent River Upper

View of headcut at outfall pipe.

View facing upstream in the middle of the reach.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO002
Site Name: Livery Lane A
Contractor: KCI
Watershed: Patuxent River Upper

Constraints/Utilities:
Constraints include significant impact to trees. Access could be difficult due to the adjacent properties and valley slope.

Concept Description:
The proposed stabilization BMP is a Step Pool Storm Conveyance system (SPSC) with 3 cascades, 9 pools, and 9 riffles. The SPSC will be 10 ft. wide and span the full 230 ft. of erosion starting from the outfall structure. This project should be completed in conjunction with PRU-SR-F685B-PO003 and PRU-SR-F685B.

Nearby Opportunities:
PRU-SR-F685B-PO003, PRU-SR-F685B

Proposed Project Credit	
Drainage Area (ac.):	3.85
Impervious Area within Drainage (ac.):	2.25
Impervious Area Treated (ac.):	3.15
Impervious Area Treated Credit (ac.):	3.15

Water Quality Volume	
WQVolume Target (cf.):	8,050
Max Treated (cf.):	20,929
Percent Treated:	260%
Rainfall Depth Treated (in.):	2.6

Costs	
Estimated Design Cost:	$200,000
Estimated Construction Cost:	$248,000
30 % Contingency:	$134,400
Estimated Total Cost:	$582,400
Cost per Impervious Credit Acre:	$184,889

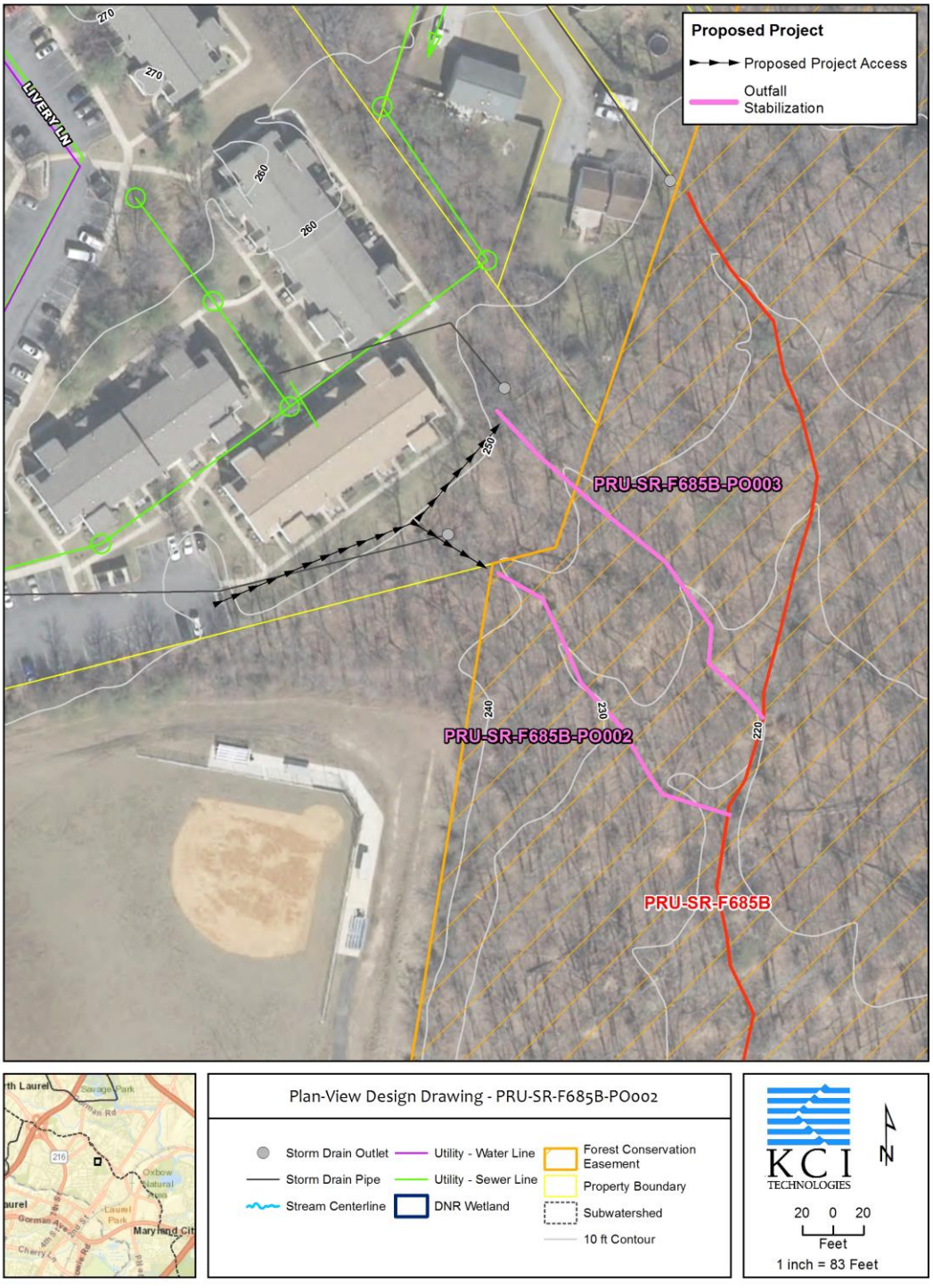
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO002

Site Name: Livery Lane A

Contractor: KCI

Watershed: Patuxent River Upper



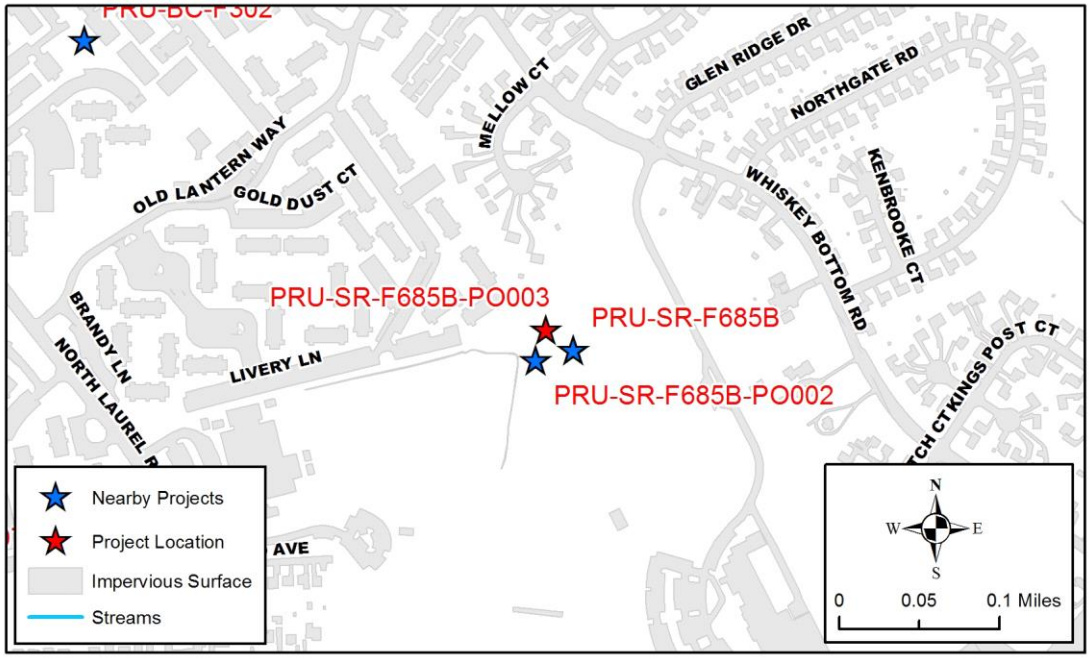
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO003
Site Name: Livery Lane B
Contractor: KCI
Watershed: Patuxent River Upper

Proposed BMP Type: Outfall Stabilization
Stabilization Type: Step Pool Stormwater Conveyance
Ownership: County Owned
Single Owner

Existing Conditions:

The proposed outfall stabilization is a severely eroded channel originating from a storm drain pipe with no stormwater management treatment. The channel erosion starts immediately downstream of the outfall and extends the entire length of the outfall channel of approximately 275 ft. downstream until it meets an unnamed tributary to the Patapsco River. The channel has approximately 10 ft. high banks and a 8 ft. wide channel. Site access is moderately easy from the adjacent apartment complex parking lot off Livery Lane.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO003
Site Name: Livery Lane B
Contractor: KCI
Watershed: Patuxent River Upper

View of headcut at outfall pipe.

View facing upstream in the middle of the reach.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO003
Site Name: Livery Lane B
Contractor: KCI
Watershed: Patuxent River Upper

Constraints/Utilities:
Constraints include significant impact to trees. Access could be difficult due to the adjacent properties and valley slope.

Concept Description:
The proposed stabilization BMP is a Step Pool Storm Conveyance system (SPSC) with 3 cascades, 10 pools, and 10 riffles. The SPSC will be 8 ft. wide and span the full 275 ft. of erosion starting from the outfall structure. This project should be completed in conjunction with PRU-SR-F685B-PO002 and PRU-SR-F685B.

Nearby Opportunities:
PRU-SR-F685B-PO002, PRU-SR-F685B

Proposed Project Credit	
Drainage Area (ac.):	2.43
Impervious Area within Drainage (ac.):	0.59
Impervious Area Treated (ac.):	0.83
Impervious Area Treated Credit (ac.):	0.83

Water Quality Volume	
WQVolume Target (cf.):	2,369
Max Treated (cf.):	6,158
Percent Treated:	260%
Rainfall Depth Treated (in.):	2.6

Costs	
Estimated Design Cost:	$200,000
Estimated Construction Cost:	$293,000
30 % Contingency:	$147,900
Estimated Total Cost:	$640,900
Cost per Impervious Credit Acre:	$772,169

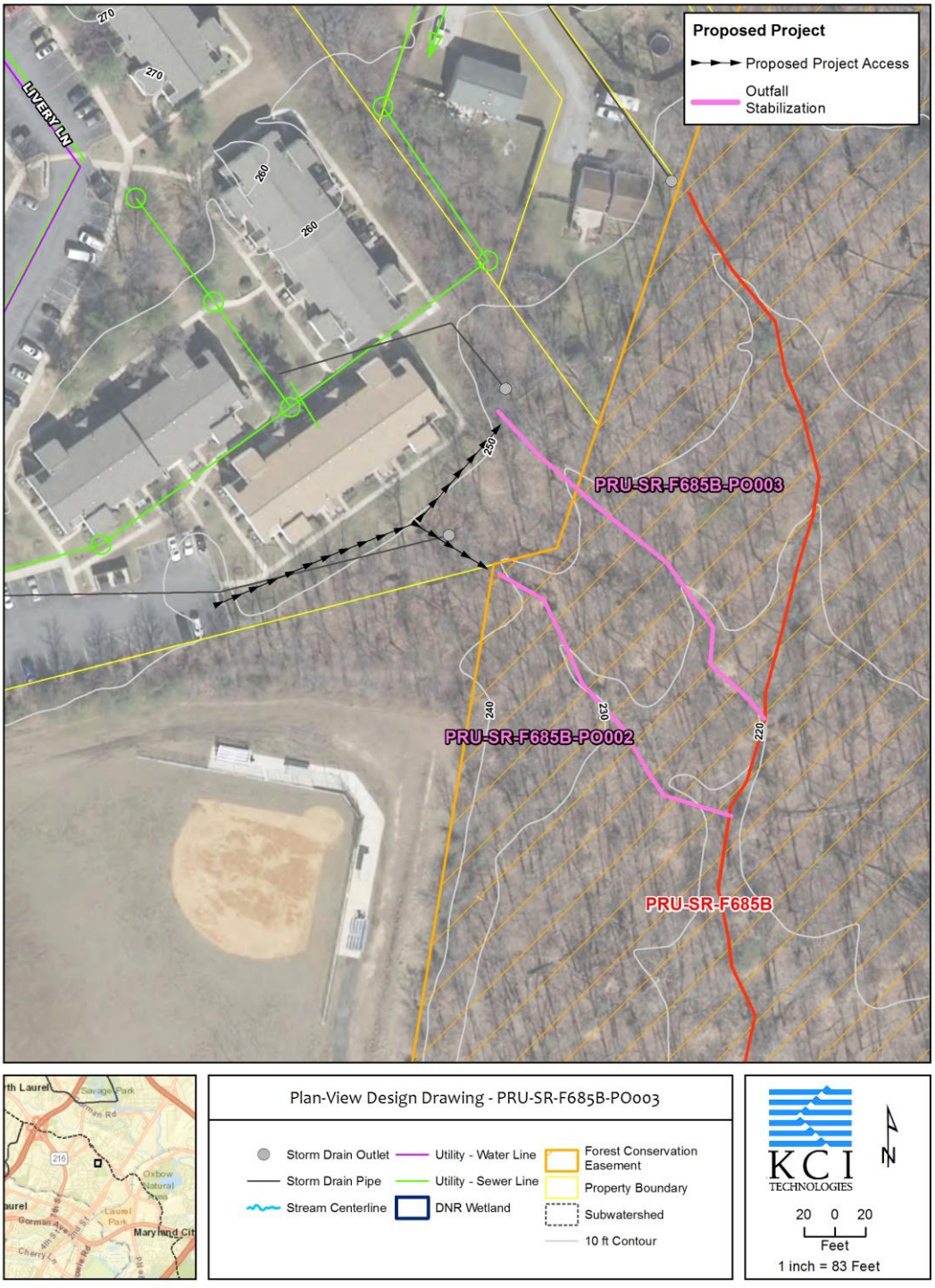
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: PRU-SR-F685B-PO003

Site Name: Livery Lane B

Contractor: KCI

Watershed: Patuxent River Upper



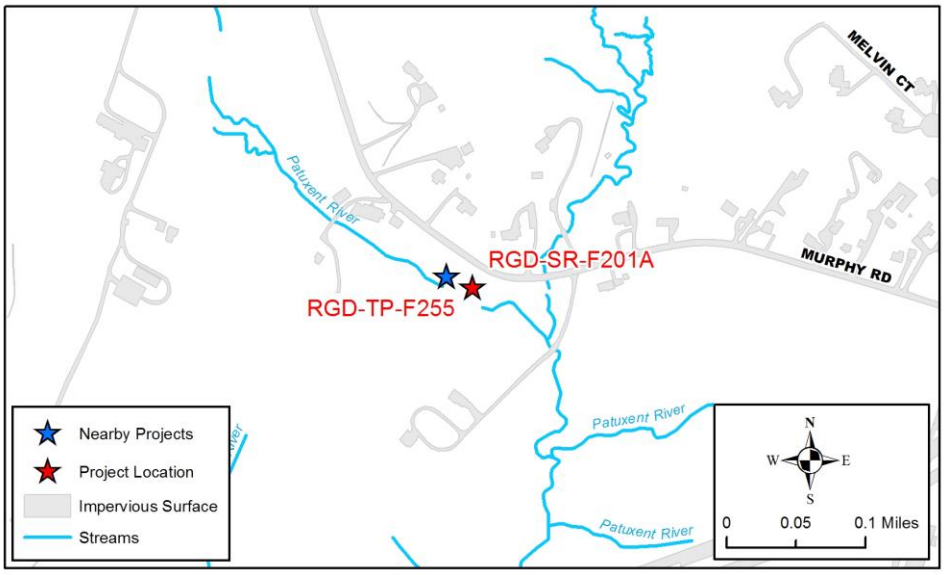
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F201A
Site Name: Scagg's Farm - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Ownership: County Owned
Single Owner

Existing Conditions:

The proposed stream restoration project is located through two fields on a formerly agricultural property that is now owned by Howard County. The eastern field is primarily an agricultural pond. The stream is actually piped through a large CMP culvert for 250 ft. along the south side of the pond. This pipe is a probable fish blockage. Downstream, the stream and pond outfall discharges are causing active erosion (2 to 3.5 ft. height) from the outlets to the stream's confluence with a direct tributary to the Patuxent River. This area also has heavy dense invasive cover among the patch of trees. West of the pond there is an estimated 0.5 ac. of land with shallow overland flow and other indicators of wetland hydrology. The stream, generally stable, runs to the south of this area before entering the pipe, though it has been channelized along the fence line resulting in little habitat variation. A habitat assessment could not be performed on the upstream portion, but the downstream portion had all in-stream physical habitat parameters rated as optimal or suboptimal.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F201A
Site Name: Scagg's Farm - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Agricultrual pond in eastern field will be filled in to create wetlands. The stream is currently piped for approximately 250 ft. along the far (southern) side of the pond.

Stream exits piped reach in forested area just southeast of the agricultural pond; 2 to 3.5 ft. bank erosion was noted downstream.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F201A
Site Name: Scagg's Farm - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Constraints/Utilities:

Constraints include: Potential undesirable sediment within pond (more information below), presence of wetland soils.

Concept Description:

The objective for this project is to restore connectivity to the Patuxent River along this stream. To accomplish this, the 250 ft. of currently piped stream will be daylighted. Banks downstream of the current CMP will be stabilized as an appropriate channel cross section and slope are restored along the entire project reach. The upstream project limit can be extended as necessary to achieve a suitable grade for fish passage. The addition of woody debris, cobble riffles, pools, and other habitat structures can be used to reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. The existing agricultural pond should be filled in and developed into a wetland area. The adjacent wetland to the west should also be enhanced. Prior to doing this, the accumulated sediments within the pond need to be tested to determine if it would be acceptable for the daylit channel cross section to extend into the current pond cross section. If sediments are deemed undesirable, a step pool system should be designed for the stream in this area to keep the cross section narrower along the southern bank of the pond. RGD-TP-F255 is also located at this property and should be implemented in conjunction with the stream restoration. Access to the site is easy, an existing gravel driveway runs between the red and white barn from Murphy Road to a gate into the western field. Heavy equipment can easily access the site, but operators should be aware of areas where the soil is saturated to the west of the agricultural pond. Estimate cost reflects fill for pond and may be reduced if borrow material is available on site.

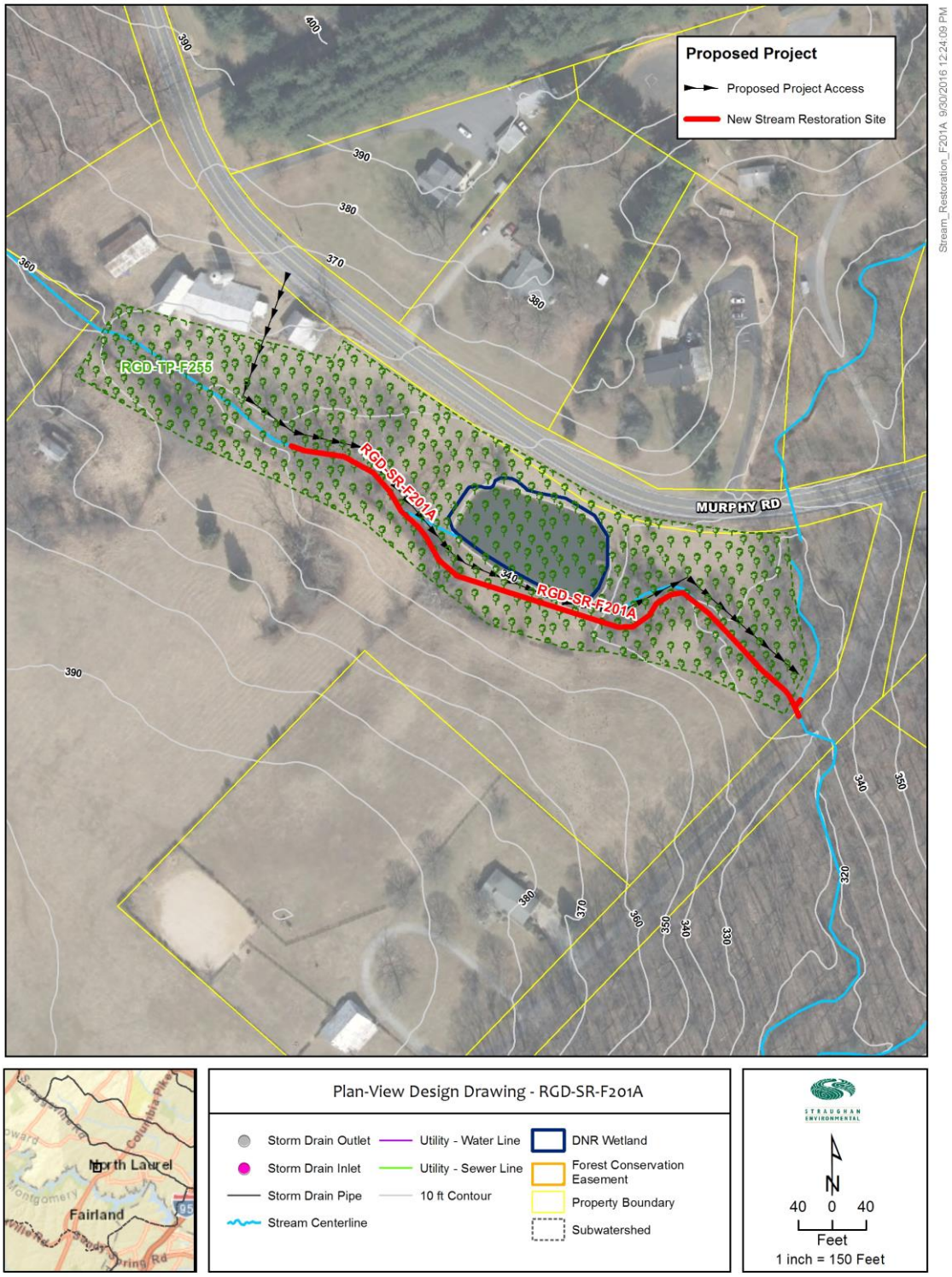
Nearby Opportunities:

RGD-TP-F255

Proposed Project Credit		Costs	
Length Restored (ft):	372	Estimated Design Cost:	$320,000
Impervious Area Treated Credit (ac.):	3.72	Estimated Construction Cost:	$640,790
Cost per Impervious Credit Acre:	$335,760	30% Contingency:	$288,237
		Estimated Total Cost:	$1,249,027

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F201A
Site Name: Scagg's Farm - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam



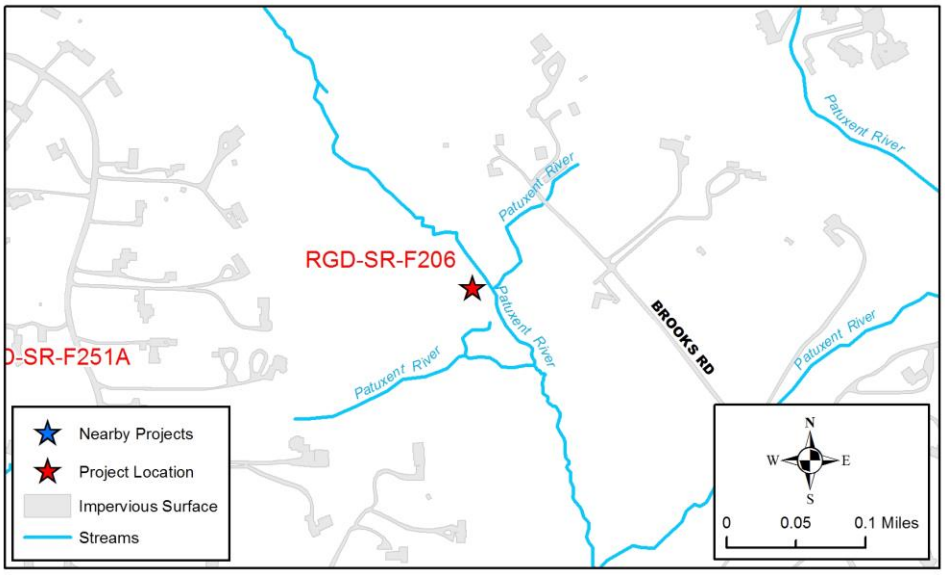
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F206
Site Name: Willow Pond Farm - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Ownership: Private- Mixed Use
Multiple Owners

Existing Conditions:

The proposed stream restoration project is located along 4 private properties (length on the most downstream property is only approximately 75 ft.). The two downstream properties are heavily forested private residential properties; the other two properties are agricultural properties, two-thirds of which is fenced for present or former horse grazing and one of which is simply an open field. The stream is forested along nearly the entire right bank, there are riding trails through the woods and a failed pond with a small portion of one bank, now open to the stream, located roughly in the middle of the upstream portion of the project site. This pond appears to be creating a wetland. Another pond is located just downstream, though off the left bank. In the downstream forested portion of the project reach, active erosion has created a wide, entrenched (approximately 3 ft.) cross section with shallow baseflow and poor epifaunal substrate (<20% stable habitat). The upstream portion is experiencing spots of bank erosion (primarily on the left bank, encroaching into fields) between 2 and 4 ft. in height, the rest has low banks with minimal erosion. Most of the reach has a wide, shallow cross section with slow flow. Moderate sediment deposition is occurring throughout the project.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F206
Site Name: Willow Pond Farm - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

The downstream portion of the project site typically has a widended entrenched cross section and shallow flow.

Erosion along the horse fields in the upstream portion.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F206
Site Name: Willow Pond Farm - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Constraints/Utilities:

Constraints include: ownership, tree impacts (including specimen trees), potential wetlands, and a pond embankment.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms. Along the fields and where possible in forested areas, banks will be graded back to a stable angle and/or bioengineering techniques will be implemented. Where this is not feasible, especially in the downstream portion, a more efficient channel will be established within the existing cross section to minimize tree impacts. The addition of woody debris, cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. The failed stormwater pond can be enhanced to an established wetland or altered to function as an oxbow wetland. Impacts to trees, especially specimen trees, should be minimized and invasives should be removed. Any trees that are removed should be used during construction for structures or habitat features. A vegetative buffer should be established in the fields bordering the stream, though no trees should be planted near the embankment for the active downstream pond. Horses should be excluded from the stream and buffer. Access is easy to moderately difficult for the upstream portion along the fields, but difficult for the downstream forested portion. Staging and laydown areas are possible in the adjacent fields. A tree planting assessment was completed at RGD-TP-F254, which is a small, isolated field; this could be used for staging along the right bank if needed.

Nearby Opportunities:

BGD-TP-F254

Proposed Project Credit		Costs	
Length Restored (ft):	1,119	Estimated Design Cost:	$300,000
Impervious Area Treated Credit (ac.):	11.2	Estimated Construction Cost:	$503,550
Cost per Impervious Credit Acre:	$93,353	30% Contingency:	$241,065
		Estimated Total Cost:	$1,044,615

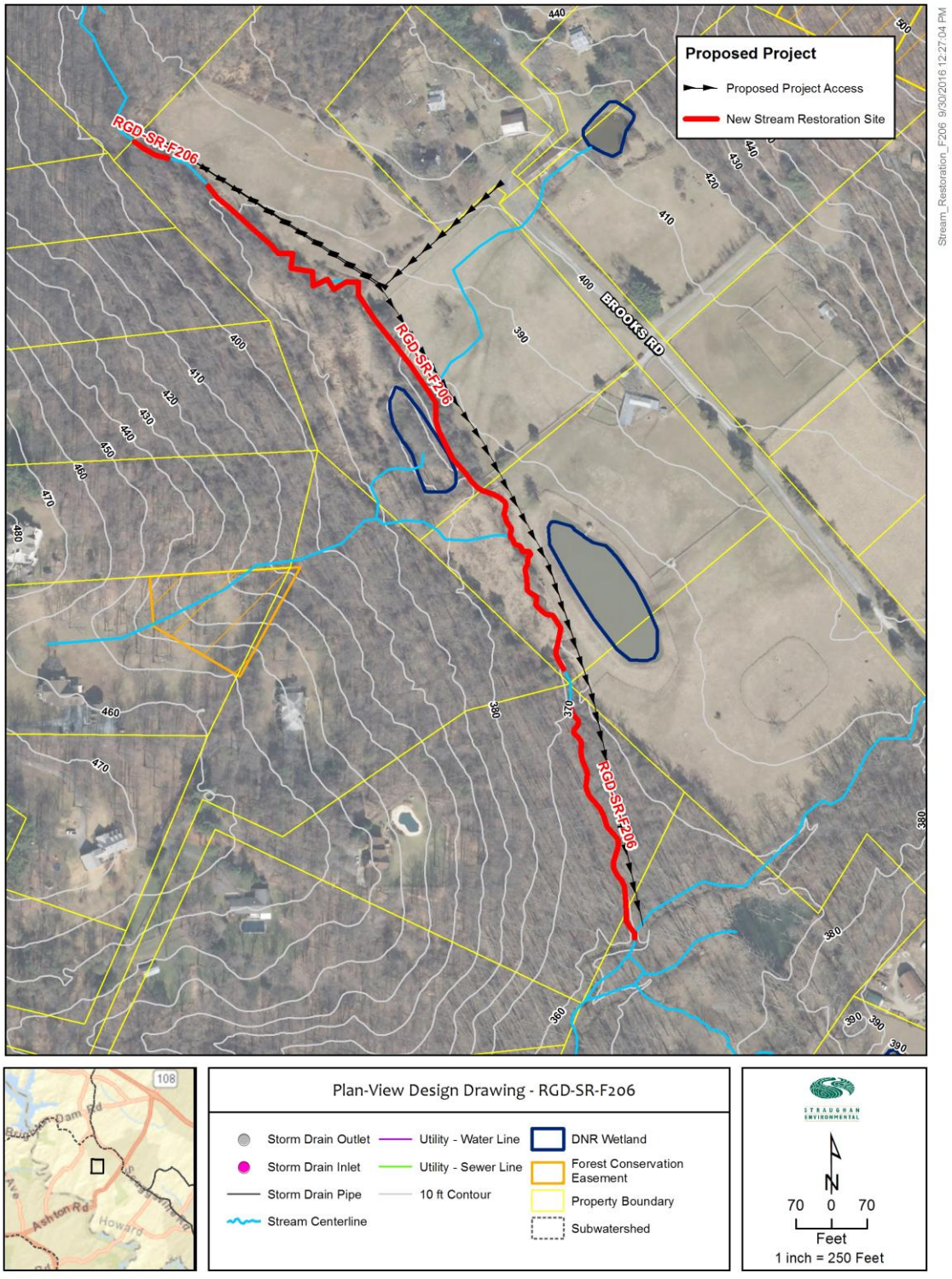
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F206

Site Name: Willow Pond Farm - Stream

Contractor: Straughan

Watershed: Rocky Gorge Dam



Howard County Watershed Assessment Concept Plan: Stream Restoration

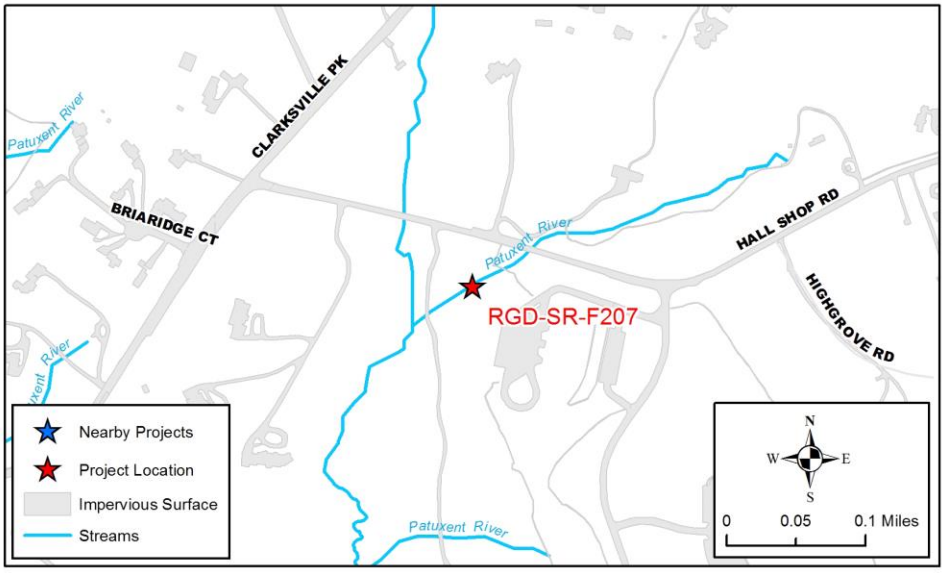
Site ID: RGD-SR-F207
Site Name: Paternal Farm - east branch
Contractor: Straughan
Watershed: Rocky Gorge

Ownership: Private- Mixed Use
Multiple Owners

Existing Conditions:

The proposed stream restoration project is located along 3 or 4 properties—one private agricultural (horse boarding) property, one county-owned park and equestrian property, one private residential, and possibly one owned by a developer or HOA (precise stream location appears to follow along the property line). The latter two properties are located on the western branch of the stream, and the former two are on the eastern branch. There is a forest conservation easement also on the county property that parallels the stream but does not appear to extend to it. The private horse boarding property is located upstream (north) of Hall Shop Rd. Both the west and east branches travel through 24 in. and 36 in., respectively, pipes under Hall Shop Rd. and drop approximately 2 ft. into large scour holes (6 x 6 ft. and 10 x 10 ft.) creating barriers to fish migration. Downstream of these culverts, both branches are experiencing bank erosion typically 3 to 4 ft. high, but some up to 5 ft. in the eastern branch, which also has two riding trail crossings. Both branches have construction debris and trash in the stream, and areas of wide, shallow flow. They also have marginally rated epifaunal substrate (20-40% stable habitat), and the western branch is experiencing moderate sediment deposition and marginal channel flow status (riffle substrates mostly exposed).

The upstream extent of the eastern branch is a wet pond outfall. Below this, the stream has steep banks approximately 7 ft. high on both sides for most of its length. Erosion up to 5 ft. in height is present along much of this portion. It also has marginally rated epifaunal substrate (20-40% stable habitat) and velocity/depth regime (only 2 of 4 habitat regimes present). An asphalt walking path runs along the left bank almost the entire length of this stream segment and there is at least one area where its integrity is threatened by the bank erosion.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F207
Site Name: Paternal Farm - east branch
Contractor: Straughan
Watershed: Rocky Gorge

Typical conditions (construction debris, bank erosion, and wide, shallow flow) along both branches of the downstream portion.

The portion of site upstream of Hall Shop Rd. is highly entrenched.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F207
Site Name: Paternal Farm - east branch
Contractor: Straughan
Watershed: Rocky Gorge

Constraints/Utilities:

Constraints include: ownership, utilities along the downstream portion, tree impacts (specimen trees can likely be avoided), high and steep bank slopes in the upstream portion.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms. In the downstream portion, this would be accomplished by creating a more efficient channel cross section, grading banks to a stable angle wherever possible while minimizing tree impacts, and stabilizing banks with bioengineering techniques. Impacts to trees, especially specimen trees, should be minimized, and invasives should be removed. Any trees that are removed should be used during construction for structures or habitat features. The addition of cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. The outfalls from Hall Shop Rd. should be stabilized, and fish passage should be provided on the western branch, especially if the property owner is amenable for tree planting at RGD-TP-F202 in conjunction with the upstream eastern branch restoration. This restoration effort should also include reestablishing an appropriate riparian buffer along the western branch.

In the upstream portion of the eastern branch, bank stabilization should be implemented along the entire reach using bioengineering techniques. Grade should be stabilized using in-stream structures, and vegetative debris and invasives should be removed. Optimally, the vegetative buffer should be increased and the pond should be dredged to reduce impacts from nutrient-rich sediment accumulation in it. Optimally, the asphalt path should be replaced with vegetation or a pervious surface. This site has the potential for demonstration value at the County property and the private horse boarding property. The site could be broken into components if there are difficulties obtaining permission from the various property owners. Access for the downstream portions is easy to moderate and will likely impact some trees. The western branch could be accessed from either private property, but the developer/HOA property has more room for staging and is therefore the recommended route. For the eastern branch, access should come from the county facility's parking area, which has room for a staging area. Access to the stream within the upstream portion is difficult due to the high, steep banks, but access along this portion could follow the paved trail

Nearby Opportunities:

RGD-TP-F202

Proposed Project Credit		Costs	
Length Restored (ft):	1,639	Estimated Design Cost:	$300,000
Impervious Area Treated Credit (ac.):	16.4	Estimated Construction Cost:	$747,150
Cost per Impervious Credit Acre:	$83,056	30% Contingency:	$314,145
		Estimated Total Cost:	$1,361,295

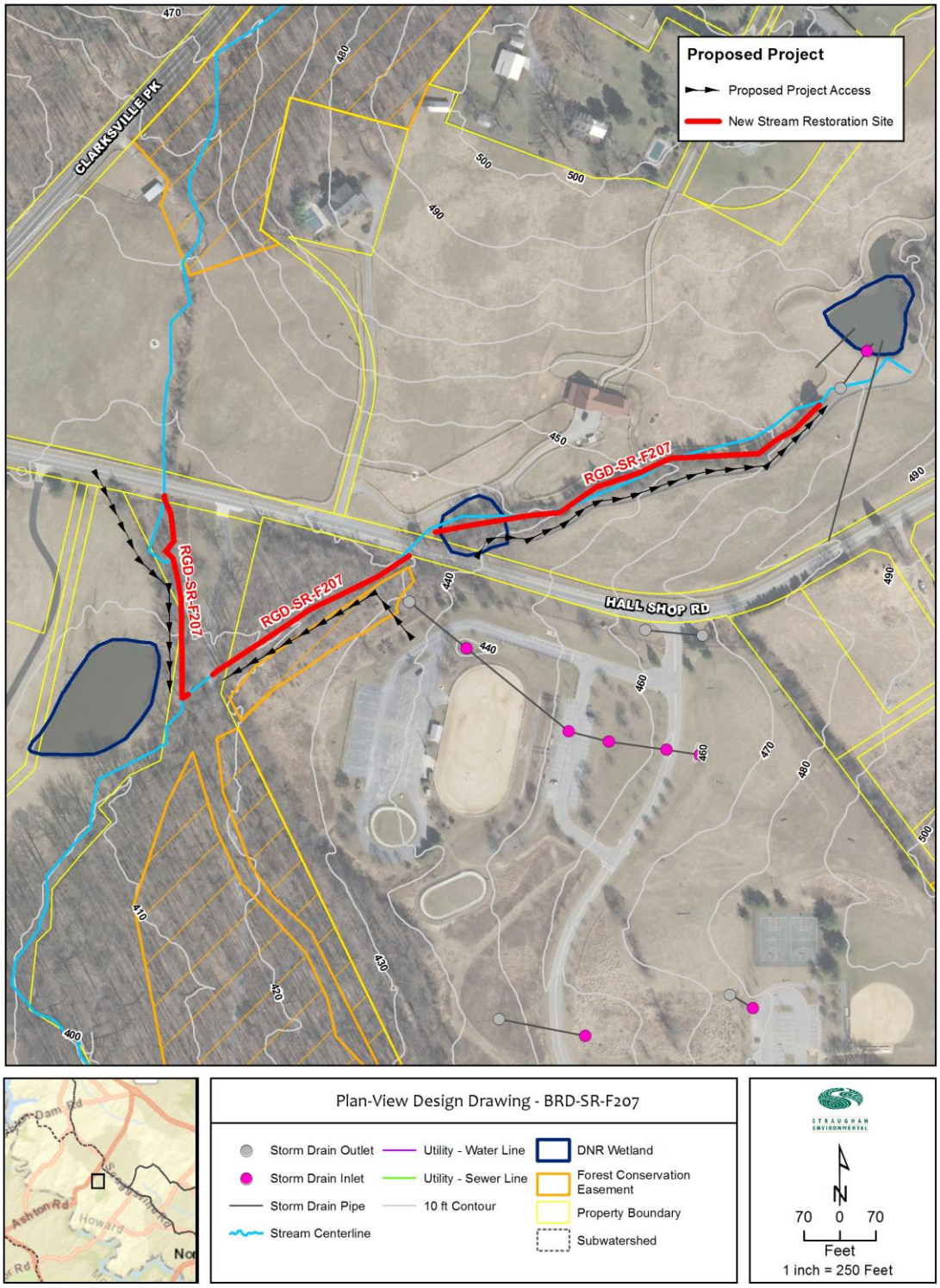
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F207

Site Name: Paternal Farm - east branch

Contractor: Straughan

Watershed: Rocky Gorge



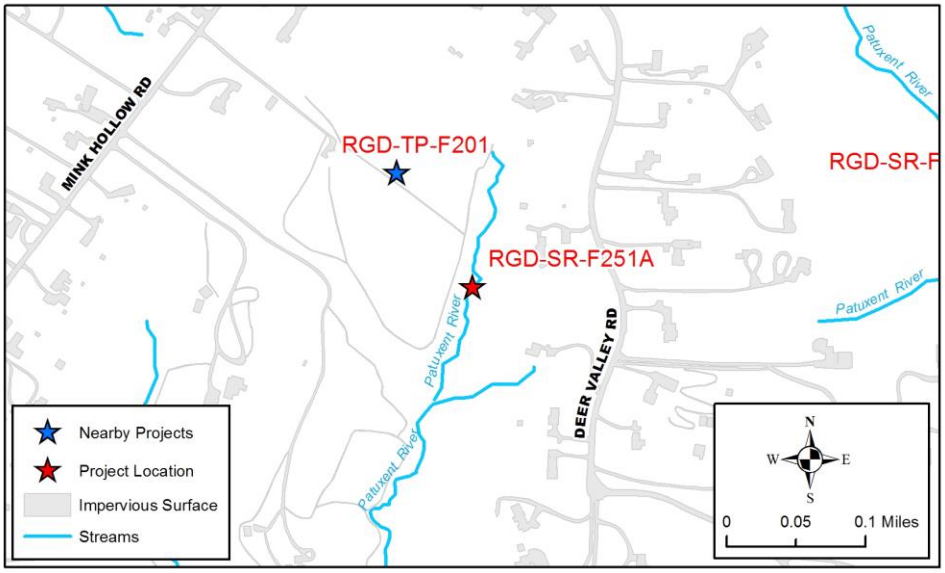
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F251A
Site Name: Mink Hollow - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Ownership: Private- Residential
Single Owner

Existing Conditions:

The proposed stream restoration project is located almost entirely along the back (eastern) border of a large agricultural lot, but meanders may encroach onto the back of one or two large residential lots for a short length. The agricultural property is primarily used for horseback riding through trails mowed in the grasses. A tree planting project (RGD-TP-F201) is proposed in this area. The stream is located in an established forest, and almost the entire length of the stream is entrenched (4 ft. average, but up to 8 ft.) with active erosion. Many trees have fallen into or across the channel, and several more are threatened by the active erosion, especially in middle section where there is high sinuosity. Bank heights vary from 3 ft. to 10 ft. An assessment of in-stream habitat parameters marginally rated epifaunal substrate (20-40% stable habitat), velocity/depth regime (only 2 of 4 habitat regimes present), and channel flow (riffle substrates are mostly exposed) for the project. There is some evidence of a potential shallower side channel that may carry flow during particularly large storms just west of the stream along the middle portion of the project reach.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F251A
Site Name: Mink Hollow - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Bank erosion and exposed bed material near the downstream end of the project reach.

Severe bank erosion on the outside of a meander bend in the highly sinuous portion near the middle of the project reach.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F251A
Site Name: Mink Hollow - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam

Constraints/Utilities:

Constraints include: ownership, tree impacts, potential wetlands, and access.

Concept Description:

The objective for this project site is to stabilize the banks and improve in-stream habitat for aquatic organisms. A stable cross-section and more natural sinuosity should be established throughout the project reach. Where possible, banks will be graded back to a stable angle and/or bioengineering techniques will be employed. Impacts to trees should be minimized, and it is possible that impacts to specimen trees may be avoidable; however, any trees that are removed should be used during construction for structures or habitat features. The addition of woody debris, cobble riffles, pools, and other habitat structures will reinforce the streambed and banks and improve the flow diversity and structural complexity of the stream bed, improving the instream habitat. Access to the site is mostly easy, an existing gravel driveway runs from Mink Hollow Rd to the edge of the tree planting area, after which a field is traversed for the rest of the distance. Access within the tree line and along the stream, though, would be moderately difficult as the forest edge is thick with invasives and trees are well established. Space for temporary storage is located on the same primary property, provided this is completed prior to the tree planting of the fields.

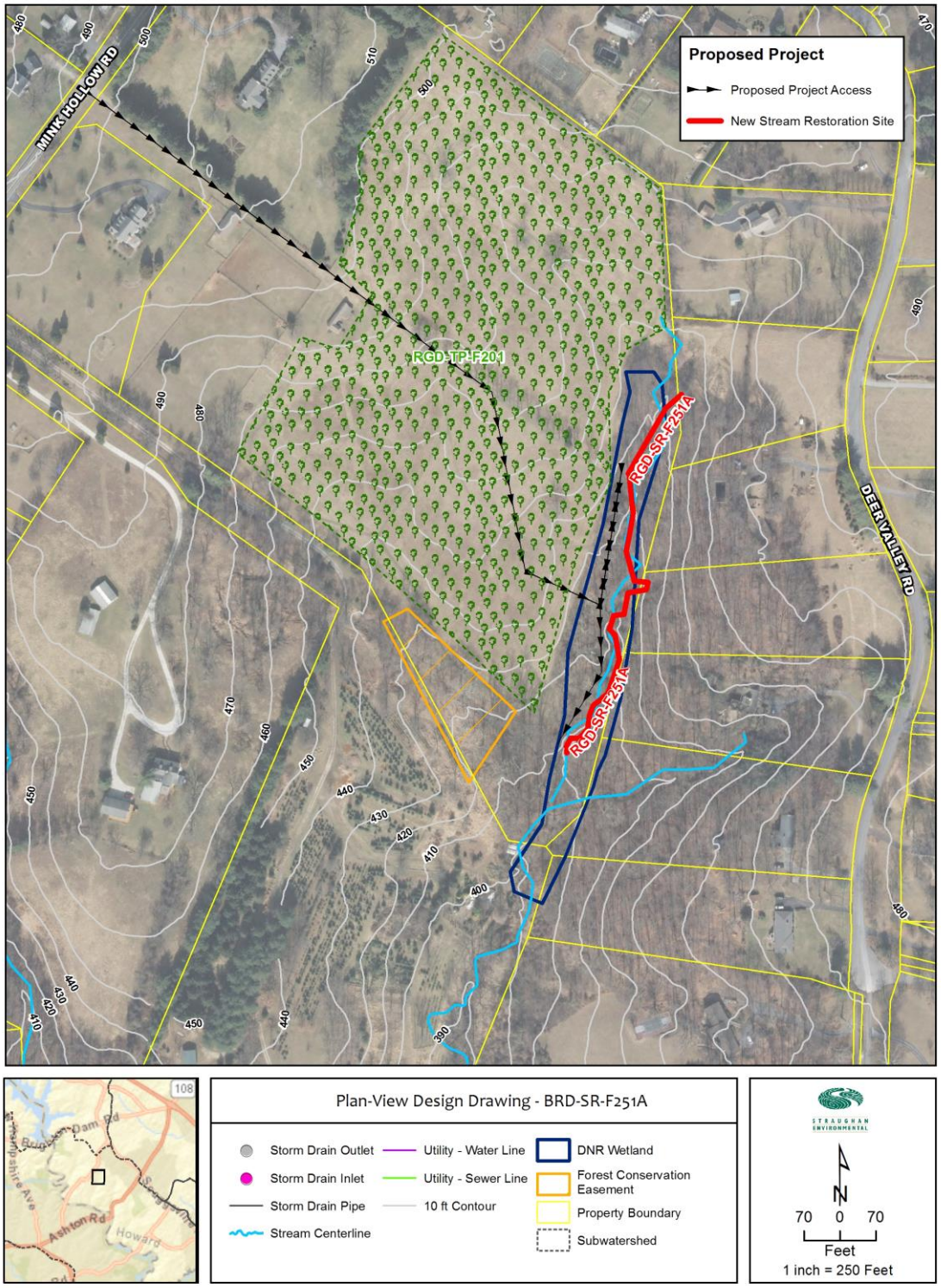
Nearby Opportunities:

RGD-TP-F201

Proposed Project Credit		Costs	
Length Restored (ft):	844	Estimated Design Cost:	$200,000
Impervious Area Treated Credit (ac.):	8.44	Estimated Construction Cost:	$379,800
Cost per Impervious Credit Acre:	$89,306	30% Contingency:	$173,940
		Estimated Total Cost:	$753,740

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: RGD-SR-F251A
Site Name: Mink Hollow - Stream
Contractor: Straughan
Watershed: Rocky Gorge Dam



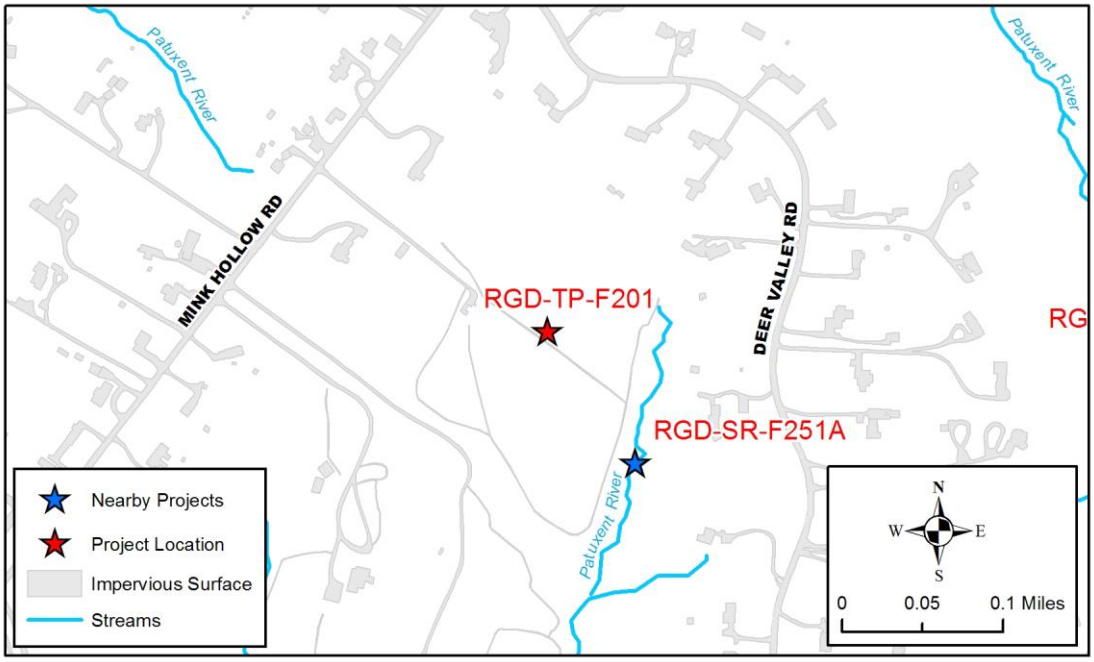
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F201
Site Name: Mink Hollow - Trees
Contractor: Straughan
Watershed: Rocky Gorge Dam

Project Type: Tree Planting
Ownership: Private- Residential
Single Owner

Existing Conditions:

The proposed tree planting project is located on the back half of a large agricultural lot. The property is primarily used for horseback riding through trails mowed in the grasses. The planting area has rolling topography, with typical slopes between 10% and 15% but some slopes near 30%. Current vegetative cover is almost entirely grasses that are mowed on a semi-regular basis. A row of trees stretches down the center of the property and there are a few other isolated trees within the planting area, primarily cherry and sycamore. Dominant species of the adjacent wooded area is sycamore, and there is a heavy invasive presence along the forest edge (dominant invasive species: multiflora rose, garlic mustard, oriental bittersweet, and honeysuckle). This plot receives full sun and has no riparian connection.



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F201
Site Name: Mink Hollow - Trees
Contractor: Straughan
Watershed: Rocky Gorge Dam

The western half of the proposed planting area; current vegetative cover is primarily grass with a few trees.

View towards the eastern back half of the proposed planting area. Photo shows the higher slopes present in some areas and the existing forest edge to the right of the picture.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F201
Site Name: Mink Hollow - Trees
Contractor: Straughan
Watershed: Rocky Gorge Dam

Constraints/Utilities:

Constraints include: some areas with slopes >15% (approx 30%), the need to gain buy-in from landowner, ensuring landowner limits mowing. While no obvious indicators were noted during the assessment, there is a possibility for grazing by deer.

Concept Description:

Approximately 13.8 ac. of agricultural property can be planted with a suitable tree species. High slopes are present in some of the planting area, which may limit the use of heavy equipment in some areas. Preserving the ability of the landowners to go trail-riding on the land should be considered; so it is recommended that there be adequate spacing of trees for this to take place. No invasive removal is required in the planting area, but it is highly recommended that invasives be removed from the edge of the existing forest to prevent spreading into the planting area. While no obvious indicators were noted during the assessment, there is a possibility for grazing by deer.Access to the site is easy, an existing gravel driveway runs from Mink Hollow Rd to the edge of the planting area. The access and space for temporary storage are located on the same property as the planting. There is a water hook-up on the building at the end of the gravel access road.

Nearby Opportunities:

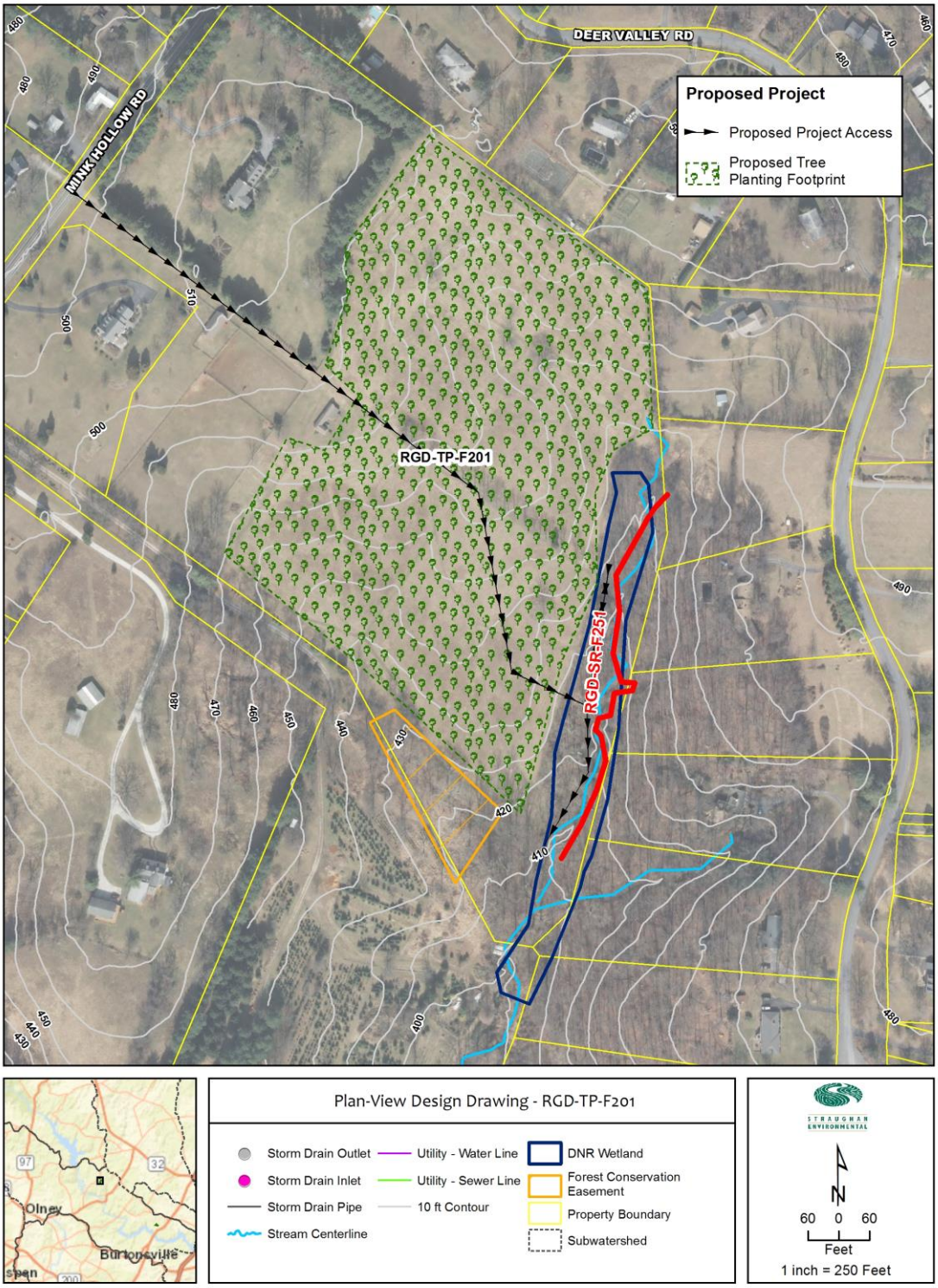
RGD-SR-F251A

Proposed Project Credit	
Planting Acres:	14
Impervious Area Treated Credit (ac.):	5.24
Cost per Impervious Credit Acre:	$112,038

Costs	
Estimated Design Cost:	$10,000
Estimated Construction Cost:	$441,600
30% Contingency:	$135,480
Estimated Total Cost:	$587,080

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F201
Site Name: Mink Hollow - Trees
Contractor: Straughan
Watershed: Rocky Gorge Dam



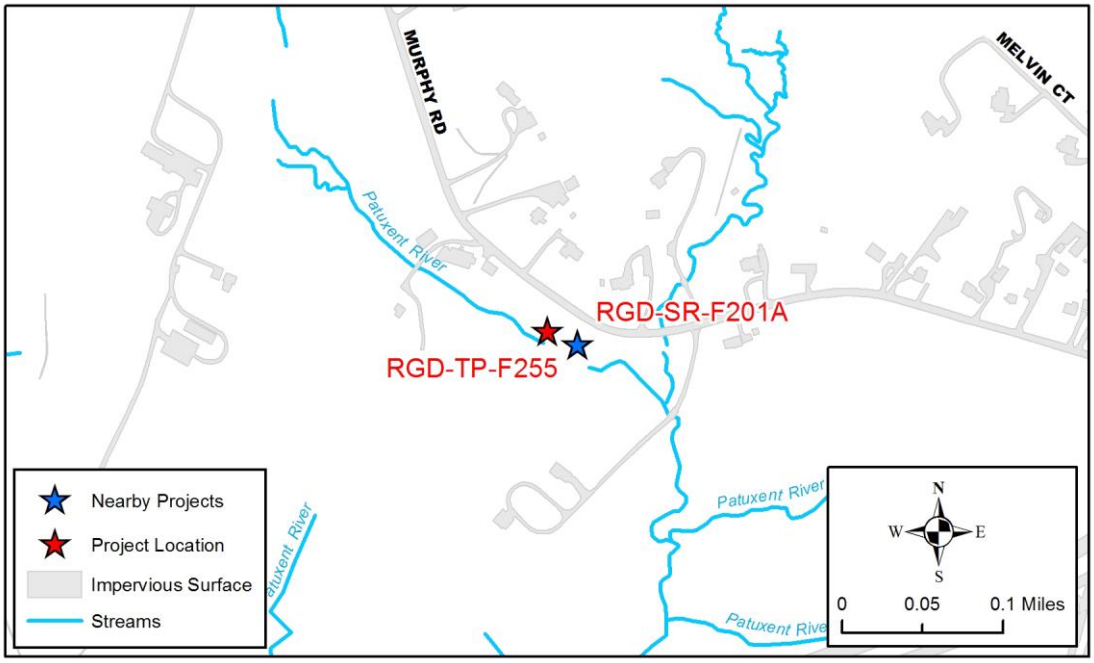
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F255
Site Name: Scagg's Farm
Contractor: Straughan
Watershed: Rocky Gorge Dam

Project Type: Tree Planting
Ownership: County Owned
Single Owner

Existing Conditions:

The proposed tree planting project is located on a formerly agricultural property that is now owned by Howard County; it borders stream restoration reach RGD-SR-F201A. The planting area is riparian and currently has an agricultural pond. The stream restoration project proposes to daylight the piped stream running adjacent to the pond and fill in the pond to create forested wetlands. A portion of the planting area just upstream of the pond has shallow overland flow and other indicators of wetland hydrology, but the planting area also appears to contain areas of upland hydrology. Most of the proposed planting area has grass cover, but there are some existing trees along the stream and fence line. Trees within tree planting area and the adjacent forested area are primarily maple and sycamore. Invasives are present around the existing trees, including oriental bittersweet, multiflora rose, and Japanese honeysuckle.



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F255
Site Name: Scagg's Farm
Contractor: Straughan
Watershed: Rocky Gorge Dam

Typical conditions within the western field.

Agricultural pond in the eastern field, which will be filled in as part of stream restoration reach RGD-SR-F201A to allow for wetland planting.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F255
Site Name: Scagg's Farm
Contractor: Straughan
Watershed: Rocky Gorge Dam

Constraints/Utilities:

Constraints include: the presence of wetlands and the agricultrual pond emankment within the planting area and barns adjacent to the planting area.

Concept Description:

If stream restoration at site RGD-SR-F201A is performed, approximately 3.4 ac. of former agricultural property can be planted with suitable tree species. The proposed planting area contains riparian, wetland, and upland hydrology, so tree species will need to be selected appropriately. Some existing trees in the area may need removal, and invasives should be removed from around existing trees and along the edge of the adjacent forest. Planting trees on the pond embankment (east side of the pond) is not recommended, but certain brush species may be allowed provided the pond is filled in.Access to the site is easy, an existing gravel driveway runs between the red and white barn from Murphy Road to a gate into the western field. Heavy equipment can easily access the site, but operators should be conscious of areas where the soil is saturated to the west of the agricultural pond.

Nearby Opportunities:

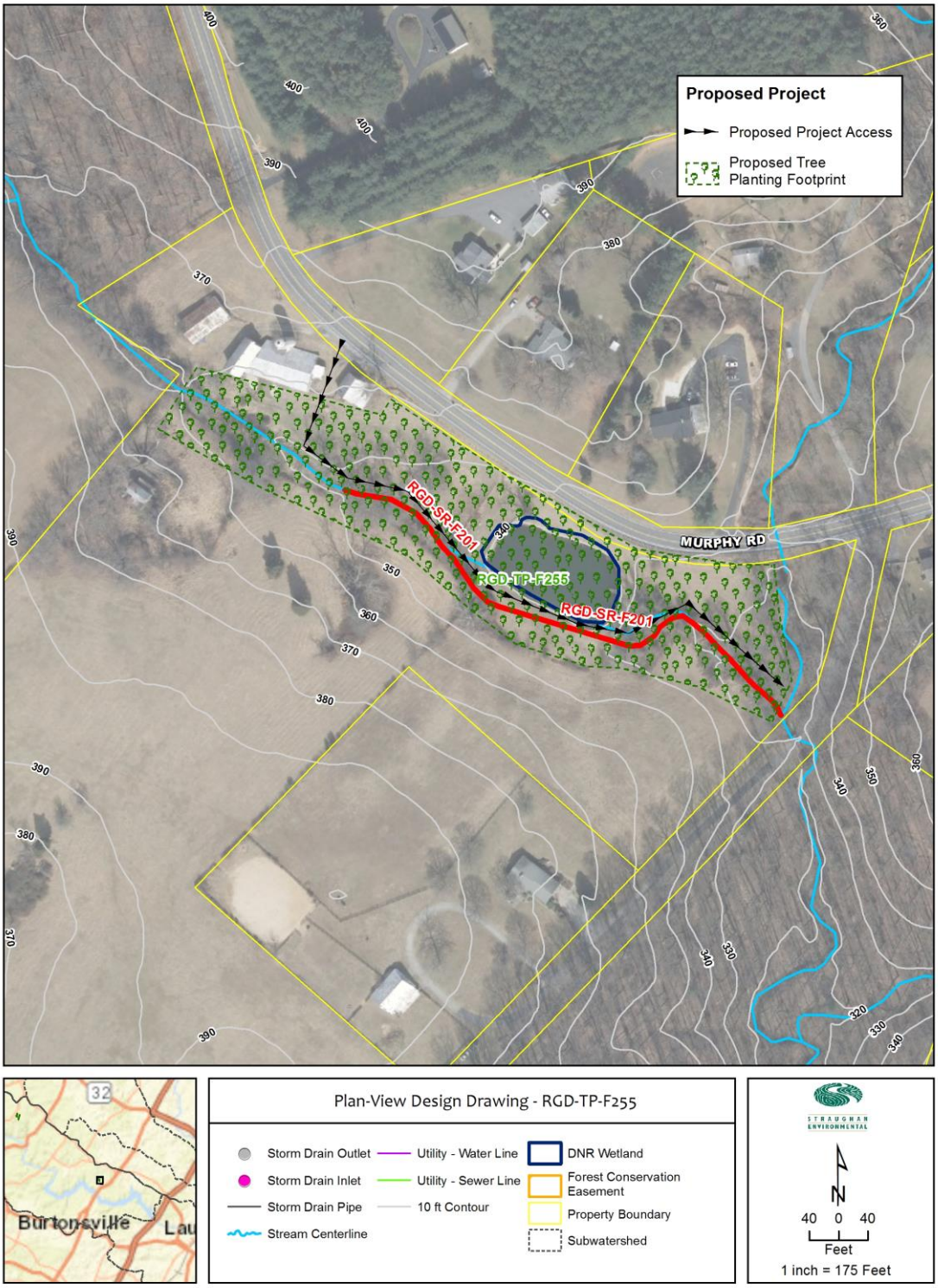
RGD-SR-F201A

Proposed Project Credit	
Planting Acres:	3.4
Impervious Area Treated Credit (ac.):	1.29
Cost per Impervious Credit Acre:	$119,721

Costs	
Estimated Design Cost:	$10,000
Estimated Construction Cost:	$108,800
30% Contingency:	$35,640
Estimated Total Cost:	$154,440

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: RGD-TP-F255
Site Name: Scagg's Farm
Contractor: Straughan
Watershed: Rocky Gorge Dam



Plan-View Design Drawing - RGD-TP-F255

- Storm Drain Outlet
- Storm Drain Inlet
- Storm Drain Pipe
- Stream Centerline
- Utility - Water Line
- Utility - Sewer Line
- 10 ft Contour
- DNR Wetland
- Forest Conservation Easement
- Property Boundary
- Subwatershed

STRAUGHAN ENVIRONMENTAL

N

40 0 40
Feet
1 inch = 175 Feet

APPENDIX H: POLLUTANT LOAD REDUCTION CALCULATIONS FOR CONCEPT PLAN SITES

Appendix H- Pollutant Load Reduction Calculations for Concept Plan Sites

Patuxent River Upper

Site ID	Site Name	Proposed BMP Type	Land Use (Urban)		Length (ft)	Existing Load (EOS lbs)			Removal Rate (% and lbs/LF)			Load Reduction (EOS lbs)			Impervious Credit	Estimated Total Cost
			Pervious (ac)	Impervious (ac)		TN	TP	TSS	TN	TP	TSS	TN	TP	TSS		
PRU-BC-F302	North Laurel Road	Bioretention	3.5	5.2		110.9	9.8	4,455.3	0.60	0.70	0.75	66.3	6.9	3,337.5	5.2	$723,320
PRU-BC-F304	Industrial Park - Davis Avenue	Retention Pond (Wet Pond)	8.7	8.4		210.0	16.9	7,570.8	0.35	0.55	0.70	73.4	9.3	5,292.0	8.4	$691,243
PRU-NB-F301	Industrial Park - Davis Avenue	Micro-Bioretention, Bioswale	1.1	2.1		42.3	3.9	1,784.5	0.60	0.70	0.75	25.3	2.7	1,336.8	2.1	$413,543
PRU-OF-F306	Whiskey Bottom West	Step Pool Storm Conveyance	2.8	2.5	220	64.2	5.0	2,250.0	0.20	0.32	0.41	13.1	1.6	921.1	2.2	$448,500
PRU-SR-F685B-PO002	Livery Lane A	Step Pool Storm Conveyance	1.6	2.3	230	49.1	4.3	1,948.6	0.40	0.62	0.79	19.4	2.7	1,545.1	3.2	$582,400
PRU-SR-F685B-PO003	Livery Lane B	Step Pool Storm Conveyance	1.8	0.6	275	27.0	1.5	671.1	0.40	0.62	0.79	10.7	0.9	532.1	0.8	$640,900
PRU-SR-F305A	Lyon Avenue - A	Stream Restoration			1,650	0.0	0.0	0.0	0.075	0.068	45.0	123.8	112.2	74,250.0	16.5	$1,355,250
PRU-SR-F305F	Lyon Avenue - F	Stream Restoration			800	0.0	0.0	0.0	0.075	0.068	45.0	60.0	54.4	36,000.0	8.0	$728,000
PRU-SR-F307A	Patuxent Lane	Stream Restoration			1,800	0.0	0.0	0.0	0.075	0.068	45.0	135.0	122.4	81,000.0	18.0	$1,443,000
PRU-SR-F685B	North Laurel Park	Stream Restoration			600	0.0	0.0	0.0	0.075	0.068	45.0	45.0	40.8	27,000.0	6.0	$611,000
		TOTAL	19.5	21.0	5,575	503.5	41.4	18,680.3				572.0	353.9	231,214.60	70.4	$7,637,156

Brighton Dam

Site ID	Site Name	Proposed BMP Type	Land Use (Urban)		Length (ft)	Existing Load (EOS lbs)			Removal Rate (% and lbs/LF)			Load Reduction (EOS lbs)			Impervious Credit	Estimated Total Cost
			Pervious (ac)	Impervious (ac)		TN	TP	TSS	TN	TP	TSS	TN	TP	TSS		
BRD-BC-F101	Cattail Creek Country Club	Wet Pond - Wetland	76.46	13.51		958.8	45.3	31,646.1	0.37	0.58	0.73	350.9	26.0	23,161.1	13.51	$907,093
BRD-BC-F102	Glenwood Middle School BMP	Bioretention	5.59	2.77		96.4	6.4	4,626.3	0.60	0.71	0.76	58.2	4.5	3,502.3	2.77	$620,880
BRD-BC-F104	Ridge Hunt Dr	Bioretention	7.34	0.61		81.9	3.2	2,146.6	0.61	0.72	0.77	50.1	2.3	1,648.1	0.61	$496,217
BRD-BC-D001	Burntwoods Roads	Infiltration Basin	1.1	2.55		48.6	4.7	3,511.9	0.66	0.77	0.83	32.2	3.6	2,916.6	3.06	$420,472
BRD-NB-F102A	WH Boyer BMP	Bio-Swale	0.03	0.06		1.2	0.1	83.4	0.67	0.78	0.84	0.8	0.1	70.0	0.07	$219,960
BRD-NB-F102B	WH Boyer BMP	Rain Garden	0.05	0.07		1.5	0.1	100.1	0.63	0.73	0.79	0.9	0.1	78.8	0.07	$164,853
BRD-NB-F102C	WH Boyer BMP	Rain Garden	0.12	0.01		1.3	0.1	35.1	0.67	0.78	0.84	0.9	0.1	29.6	0.01	$171,919
BRD-NB-F102F	WH Boyer BMP	Bio-Swale	0.71	0.29		11.3	0.7	507.4	0.67	0.78	0.84	7.6	0.5	425.9	0.35	$247,572
BRD-NB-F103C	Glenelg High School East	Bioretention	0.61	1.45		27.5	2.7	1,994.1	0.60	0.70	0.75	16.5	1.9	1,501.9	1.45	$601,595
BRD-NB-F104A	Glenelg High School West	Infiltration Trench	0.32	0.44		9.7	0.8	630.0	0.64	0.74	0.80	6.2	0.6	502.8	1.1	$235,859
BRD-NB-F105A	Lisbon Elementary	Bio-Swale	0.45	0.29		8.8	0.6	459.4	0.66	0.78	0.83	5.8	0.5	382.8	0.35	$228,326
BRD-OF-F151	Farm View Ct	Step Pool Storm Conveyance	19.49	3.14	118	239.9	11	7,672.6	0.35	0.55	0.70	83.8	6.0	5,363.1	3.14	$413,400
BRD-SR-F102A	Woodbine Rd - Stream	Stream Restoration			787	0	0	0	0.075	0.068	45	59.0	53.5	35,415.0	7.87	$757,835
BRD-SR-F109A	AE Mullinix Rd	Stream Restoration			1,696	0	0	0	0.075	0.068	45	127.2	115.3	76,320.0	16.96	$1,382,160
BRD-SR-F120	Boyer Landscaping	Stream Restoration			663	0	0	0	0.075	0.068	45	49.7	45.1	29,835.0	6.63	$1,064,895
BRD-SR-F121A	Shady Lane - Stream	Stream Restoration			986	0	0	0	0.075	0.068	45	74.0	67.0	44,370.0	9.86	$836,810
BRD-SR-F122	Broccolino Way - Stream	Stream Restoration			762	0	0	0	0.075	0.068	45	57.2	51.8	34,290.0	7.62	$705,770
BRD-SR-F151A	Glenelg High School	Stream Restoration			671	0	0	0	0.075	0.068	45	50.3	45.6	30,195.0	6.71	$652,535
BRD-TP-F103A	Shady Lane - Trees	Tree Planting	3.6			35.7	1	664.6	0.66	0.77	0.57	23.6	0.8	378.8	1.37	$162,760
		TOTAL	115.87	25.19	5,683	1,522.6	76.7	54,077.6				1,054.9	425.4	290,386.8	83.51	$10,290,909

Rocky Gorge Dam

Site ID	Site Name	Proposed BMP Type	Land Use (Urban)		Length (ft)	Existing Load (EOS lbs)			Removal Rate (% and lbs/LF)			Load Reduction (EOS lbs)			Impervious Credit	Estimated Total Cost
			Pervious (ac)	Impervious (ac)		TN	TP	TSS	TN	TP	TSS	TN	TP	TSS		
RGD-SR-F201A	Scagg's Farm - Stream	Stream Restoration	0		372	0	0	0	0.075	0.068	45	27.9	25.3	16,740.0	3.72	$1,249,027
RGD-SR-F206	Willow Pond Farm - Stream	Stream Restoration	0		1,119	0	0	0	0.075	0.068	45	83.9	76.1	50,355.0	11.19	$1,044,615
RGD-SR-F207	Paternal Farm - east branch	Stream Restoration	0		1,639	0	0	0	0.075	0.068	45	122.9	111.5	73,755.0	16.39	$1,361,295
RGD-SR-F251A	Mink Hollow - Stream	Stream Restoration	0		844	0	0	0	0.075	0.068	45	63.3	57.4	37,980.0	8.44	$753,740
RGD-TP-F201	Mink Hollow - Trees	Tree Planting	13.8			137.0	4	5,604.2	0.66	0.77	0.57	90.4	3.1	3,194.4	5.24	$587,080
RGD-TP-F255	Scagg's Farm	Tree Planting	3.4			33.8	1	1,380.7	0.66	0.77	0.57	22.3	0.8	787.0	1.29	$154,440
		TOTAL	17.2	0	3,974	170.8	5.0	6,984.9				410.8	274.1	182,811.4	46.3	$5,150,197