


Stormwater Retrofit Opportunities on Public Land in Bridgewater

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FINAL

PREPARED FOR:
Town of Bridgewater, VA

PREPARED BY:

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This study received additional support from the following:

Rick Altizer (Harrisonburg)
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Danny DeLong (Harrisonburg)
Tanya Denckla-Cobb (UVA Institute for Environmental Negotiation)
Jeremy Harold (Harrisonburg)
Tom Hartman (Harrisonburg)
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Dan Rublee (Harrisonburg)
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Tara Sieber (VADEQ)
John Ware (Bridgewater)
Tara Willging (VADEQ)

The CWP project team consisted of the following individuals:

Joe Battiata
David Hirschman
Lisa Fraley-McNeal
Chris Swann
Laurel Woodworth

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SECTION 1. PROJECT BACKGROUND

1.1 Purpose

The intent of this project was to conduct a stormwater retrofit inventory for three neighboring communities in Virginia's Shenandoah Valley: the City of Harrisonburg, James Madison University, and the Town of Bridgewater. This study will help each of these communities determine the level to which stormwater retrofits on public properties can reduce urban nutrients and sediment. This report is tailored specifically to the study findings for Harrisonburg. In addition to serving as an inventory of potential retrofits, the report also quantifies costs of retrofit construction and pollutant removal, and suggests several scenarios for incorporating retrofits into the Small Municipal Separate Storm Sewer System (MS4) program and TMDL Action Plans.

"Stormwater retrofitting" refers to the practice of installing stormwater management features in places where development has already occurred. In some cases, existing developed land has no stormwater treatment to begin with. In others, older facilities, such as detention ponds, can be upgraded to enhance pollutant removal. A stormwater retrofit study provides an opportunity to look at the developed landscape, analyze how it changed as properties were developed, and imagine how it can be modified to better manage the flow of water that runs off it and to local streams.

This is not just an academic exercise. Runoff from existing developed properties is a major source of pollutants and increased storm flow that leads to the erosion of stream banks and degradation of waterways. Beyond these purposes, stormwater retrofits also foster innovation and create excitement in a community and are often used for educational purposes. People become excited about taking simple actions to promote clean water and to "green up" school campuses, parks, and other public buildings. Often, a few stormwater retrofits on public land can shift the way that stormwater is managed across the entire community, with developers and even homeowners adapting ideas to their own uses.

Controlling urban runoff is also the goal of evolving regulatory programs, such as the EPA-driven Chesapeake Bay Total Maximum Daily Load (TMDL) effort to reduce non-point sources of pollution to the Bay. In an effort to achieve the goals of the Bay TMDL, Virginia's Small MS4General Permit calls for regulated jurisdictions to achieve 5% of the total phosphorous, nitrogen, and sediment load reductions outlined as part of Virginia's Watershed Implementation Plans (WIP) within the current MS4 permit cycle (2013 – 2018). The remaining pollutant reductions must be achieved in subsequent permit cycles.

In March 2013, field teams consisting of CWP staff and Harrisonburg/JMU/Bridgewater staff fanned out across nearly 100 publically-owned sites (51 in Harrisonburg, 35 at JMU, and 13 in Bridgewater,). The teams investigated how to use the landscape to reduce, capture, and filter runoff that otherwise flows directly to nearby streams. This report describes the field investigation process and the analysis that followed and presents a prioritized list of stormwater retrofit concepts for Harrisonburg to consider constructing in the near term and as part of long-range planning.

This retrofit assessment was made possible through a grant from the National Fish and Wildlife Foundation's Chesapeake Bay Local Government Assistance Program. The grant proposal was secured by the Central Shenandoah Planning District Commission on behalf of the City of Harrisonburg, Town of Bridgewater, and James Madison University. This grant secured technical assistance from the Center for Watershed Protection to work on retrofit investigations with each of these jurisdictions. As MS4s, Harrisonburg, JMU, and Bridgewater have benefitted from working together through this project as they have been able to communicate more frequently about stormwater program issues and retrofitting strategies.

SECTION 2. RETROFIT INVENTORY PROTOCOLS

2.1 Site Selection

Each partner first developed a list of potential public property retrofit sites in their jurisdiction to assess in the field. Based on available mapping layers and stormwater BMP data, CWP staff then identified additional retrofit sites. This screening was based on public ownership and/or presence of existing detention or extended detention basins that may benefit from retrofitting.

In Harrisonburg, additional sites identified by CWP included all schools, a majority of city-owned land, and detention basins identified as public from the City's BMP data. City-owned land with limited opportunities for retrofitting (i.e., parking garages and sites with limited space) were excluded. Each list of field sites was finalized in consultation with each partner and a unique ID was assigned to each site. A total of 48 sites in Harrisonburg were pre-identified for field inspection. At James Madison University, additional sites identified by CWP included detention and extended detention basins that may benefit from retrofitting. A total of 35 sites at JMU were pre-selected to visit during field work. Finally, the retrofit sites suggested by Bridgewater staff included all town and public properties and no additional sites were identified by CWP. A total of 13 sites were selected for field inspection in Bridgewater.

2.2 Field Methodology

Using geographic information systems (GIS) data provided by each partner, CWP staff created field maps with recent aerial images, roads, topography, stormwater infrastructure, utilities, and streams. (Note: Maps for Bridgewater only contained aerial imagery and road locations.) These maps were used to identify the specific drainage areas of each potential retrofit and to make note of details, such as the direction of flow and discharge points for runoff.

Fieldwork was conducted from March 19-21, 2013. Many people were involved in conducting the retrofit field assessments. The following is a list of participants:

- *Bridgewater:* David Nichols and John Ware
- *James Madison University:* Dale Chestnut and Abe Kaufman
- *Harrisonburg:* Rick Altizer, Ray Bailey, Thanh Dang, Danny DeLong, Jeremy Harold, Tom Hartman, Jerry Prey, Wes Runion
- *Central Shenandoah Planning District Commission:* CJ Mitchem
- *Virginia Department of Environmental Quality:* Tara Sieber and Tara Willging
- *Shenandoah Soil and Water Conservation District:* Megan O'Gorek
- *Institute for Environmental Negotiation (UVA):* Tanya Denckla-Cobb, Natalie Raffol
- *Center for Watershed Protection:* Joe Battiata, Lisa Fraley-McNeal, David Hirschman, Chris Swann, Laurel Woodworth

Each of five field teams was led by a CWP staff person experienced with retrofitting. The latest Retrofit Reconnaissance Investigation (RRI) form was used (see **Appendix A**), and methods outlined in CWP's *Urban Stormwater Retrofit Practices* were used as guidance (CWP, 2007). Using the RRI form, the teams evaluated the stormwater retrofit potential of each candidate site by analyzing existing drainage patterns, drainage areas, impervious cover, available space, and site constraints (e.g., conflicts with existing utilities and land uses, site access, and potential impacts to natural areas). Unless there were obvious site constraints and/or evidence that a particular stormwater retrofit would offer few or no watershed benefits, a stormwater retrofit concept was developed for each candidate project site, including a sketch plan when appropriate. Occasionally, other issues such as stream bank erosion, stormwater outfall pipe erosion, pollution hotspots, and impacted buffers were found in the field. The field crews noted these problems and potential solutions on different types of forms, also found in **Appendix A**.

Figure 1. *Field crews searching for potential stormwater retrofits.*

More detail on conducting the Retrofit Reconnaissance Inventory can be obtained directly from the guidance manual, Urban Stormwater Retrofit Practices (CWP, 2007). This publication contains extensive information on identifying and evaluating potential retrofit locations within a subwatershed as well as profile sheets on individual retrofit designs and guidance on construction, maintenance, and costs.

After field work was completed, CWP staff reviewed all field forms for completeness and compiled the data for each retrofit concept into a combined spreadsheet. This allowed evaluation of each retrofit to determine the nutrient and runoff reduction capabilities, planning-level cost, and cost efficiency. This spreadsheet also served as a platform for scoring and ranking each retrofit concept. See **Section 3** for more information about this evaluation process. Completed field forms for each site can be found in **Appendix C**, along with photos and maps of the project locations.

2.3 Retrofit Types

A wide variety of stormwater management retrofit options were considered while inventorying these public properties. This project followed the conventions in *Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects* (Schueler and Lane, 2012) by assigning retrofits to one of three categories:

New Retrofits: Retrofit projects that create storage to reduce nutrients from existing developed land that is not currently receiving any stormwater treatment.

BMP Conversions: Retrofits of older, existing stormwater ponds to employ more effective treatment mechanism(s), such as converting a dry pond to a constructed wetland.

BMP Enhancements: Retrofits that utilize the existing treatment mechanism in an existing BMP, but improve removal by increasing storage volume or hydraulic residence time.

The report includes a fourth category, BMP Restoration, which includes major maintenance upgrades to existing BMPs that have failed or lost their original treatment capacity. This category was not included in the study, since all projects involving an existing BMP aimed to maximize pollutant removal by including a conversion or enhancement of the existing practice. Some of the projects do include restoring treatment capacity, but that was factored into the conversion or enhancement concept design.

The project also had a category for Other Practices. These include practices such as pollution prevention, landscape maintenance, tree planting and reforestation, and outfall stabilization. **Table 1** shows examples and descriptions of the types of stormwater practices that were considered as options for retrofitting the subject properties.

Table 1. Examples of Stormwater Retrofit Practices

New Retrofits	**Bioretention or Bioswale**		Landscaped practice that uses plants, mulch, and soil to treat runoff. Most have underdrain pipes to ensure water only ponds temporarily. Common in parking lot islands and edges and as part of commercial site plans.
	Rain Garden		Similar to bioretention/bioswale, but generally smaller and less expensive. Designed to treat runoff from rooftops, driveways, and yard areas. To keep design and construction simple, underdrains and gravel are not generally used.
	Wet Swale		Linear wetland cells that intercept shallow groundwater to maintain a wetland plant community. Saturated soils support wetland vegetation, which provides an ideal environment for gravitational settling, biological uptake, and microbial activity.
	Dry Swale		Also similar to bioretention/bioswale. Main difference is that the dry swale has a longitudinal slope to fit site conditions and may be narrower than typical bioretention. Sometimes check dams are used to slow water down and create temporary ponding cells.
	Filter Strip		Vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils.
	Filtering Practice		Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting it in an underdrain and then returning it back to the storm drain system. The filter consists of two chambers; the first is devoted to settling, and the second serves as a filter bed (with sand or an organic filtering media).

Table 1. Examples of Stormwater Retrofit Practices

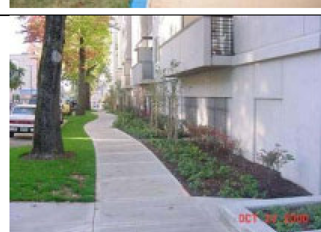
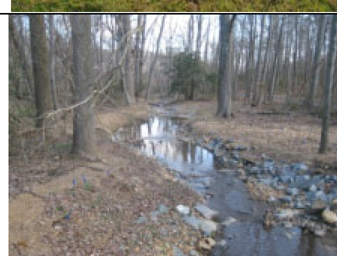
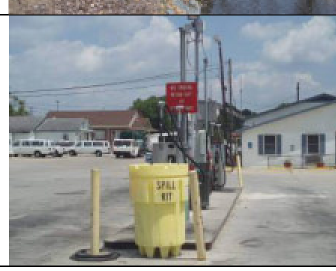
	Infiltration		Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to infiltrate into underlying soils. These practices are suitable for use in areas where *measured* soil permeability rates exceed 1/2 inch per hour.
	Constructed Wetland		Constructed wetlands are shallow depressions that receive stormwater inputs for treatment. Wetlands are typically less than one foot deep (although they have deeper pools at the forebay and micropool) and possess variable microtopography to promote dense and diverse wetland cover.
	"Regenerative Stormwater Conveyance" (for Outfall Protection) **(Photo by: Keith Underwood)**		Linear open channel systems used at stormwater outfalls that convey and treat stormwater runoff in a stable manner. A series of shallow pools, an underlying sand bed, and native vegetation provide stability, even during large storm events. These designs are currently being used for wooded ravine outfalls in Anne Arundel County, MD.
	Impervious Disconnection		Disconnecting rooftop or other impervious surfaces so that runoff goes through vegetated areas instead of directly to storm sewer, driveway, parking lot, etc. Can be "simple" disconnection to grass (as shown in photo), or disconnection to rain garden, rain barrel, or soil-amended area.
	Stormwater Planter		Stormwater planters (also known as vegetative box filters or foundation planters) take advantage of limited space available for stormwater treatment by placing a soil filter in a container, often along buildings at the bottom of roof downspouts.
	Rainwater Harvesting		Collection of rooftop water in tank or cistern for later use for outdoor or indoor applications, including irrigation, washing, cooling systems, toilet flushing, laundry, etc. Cisterns can be above-ground or underground.

Table 1. Examples of Stormwater Retrofit Practices			
	Permeable Pavement		Pavement made from permeable materials, such as interlocking paver blocks, permeable concrete, and permeable asphalt. Storage for runoff is provided below pavement surface in a stone or gravel layer, and water either infiltrates into the ground or drains out slowly through underdrain pipes.
BMP Conversion/Enhancement			Existing stormwater ponds are either converted into a different BMP that employs more effective treatment mechanisms, or enhanced by increasing treatment volume and/or increasing hydraulic retention time. Most pond retrofits involve the conversion of older ponds into a constructed wetland or wet pond.
Other Practices	**Re-Vegetation / Tree-planting**		Vegetating turf areas with trees and shrubs to restore water retention capacity and provide other services, such as shade and habitat. In some cases, soil amendments are needed prior to re-vegetation. Deep tilling, or “sub-soiling,” of soil prior to planting can also greatly improve infiltration.
	Outfall Protection		Adding stone, rip-rap, plunge pools, check dams, or vegetated conveyance channels to pipe outfalls that are eroding and causing damage to receiving streams.
	Stream Restoration		Repairing stream bank erosion and/or reconnecting stream flow to the floodplain.
	Pollution Prevention		Variety of management practices for spill response, materials storage, landscape maintenance, dumpster management, disposal of wash water and wastewater, vehicle maintenance, and employee training to keep pollutants out of stormwater runoff and waterways.

SECTION 3. EVALUATION & RANKING

3.1 Evaluation Method

Evaluation of the candidate retrofit projects involved:

1. Selecting "Screening Factors" that provide objective and subjective assessment of the relative value of candidate retrofit practices.
2. Scoring each candidate practice based on the Screening Factors.
3. Ranking the practices based on their respective scores.

This section will summarize the methodologies and computations involved in the scoring and ranking process. First, however, it is important to note several key objectives and caveats for this process:

- Since the overall intent of the project was to identify and evaluate retrofits in the context of numerical targets in the MS4 permits and Watershed Implementation Plans (WIPs), the scoring process, to the extent possible, used methods developed by the Chesapeake Bay Program to assign pollutant removal efficiencies to various BMPs. Of particular importance are the methods in *Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects* (Schueler and Lane, 2012). A potential significant caveat is that the state of Virginia (DEQ) has yet to define exactly the methods that MS4s are to use to report BMP pollutant removals (aside from inputting BMP implementation data into the VAST tool) and what role the Expert Panel methods will play in the Virginia system. As of the writing of this report, DEQ has assembled a Stakeholder Advisory Group to address this and other issues associated with the TMDL Action Plans. As such, the Expert Panel methods, as interpreted by the CWP project team, are the most up-to-date process for assigning retrofit pollutant removal rates.
- As noted, the Expert Panel report required some interpretation by the project team in order to apply the methods to specific projects. It was beyond the scope of the Expert Panel to envision every retrofit scenario, so the project team had to "fill in the blanks" in some cases. This section of the report documents the methods and computation procedures used to do this.

3.2 Ranking Process

The following sections provide detailed descriptions of each of the 3 steps outlined above.

Step 1: Selecting Screening Factors

Screening factors are metrics that define the overall value of a retrofit project. Since "overall value" is relative, the selection of screening factors involves careful vetting and analysis of the outcomes that are most important to a particular local program. Screening factors can fall into two general categories:

1. Calculated/Objective: Some screening factors are based on calculations derived from retrofit concepts. Calculation inputs can include drainage area and associated land cover to the retrofit site, potential storage volume provided by the retrofit (as measured in the field), and pollutant removal rates assigned to particular BMPs.
2. Subjective: Some screening factors are subjective and qualitative, but reflect important values for the program. Examples can include: value for education and outreach, public visibility, level of maintenance required, community acceptance, etc.

Generally, four to eight screening factors are selected. Often, the various factors are assigned "weights" so that each project can be scored on a 100-point scale.

In order to select screening factors for this project, a joint meeting was held with project representatives from Bridgewater, Harrisonburg, and JMU on April 25, 2013. At this meeting, potential screening factors were presented and discussed. There was a good deal of agreement among project participants, with only slight differences in the weighting of the various factors.

Table 2 portrays the screening factors selected for Bridgewater and how each factor is assigned a maximum score to produce a maximum possible overall score of 100 points. The first two factors – Cost Effectiveness and Total Phosphorus removal – are calculated and reflect the importance of pollutant removal and cost for the management of MS4 programs. As such, these two factors are weighted the heaviest ("primary" factors), with each having a maximum score of 35. The remaining three factors – Maintenance Burden, Utility and Site Constraints, and Aesthetics/Safety – are subjective, and can be considered "secondary" factors with maximum scores in the 5 to 15 point range.

Table 2. Screening Factors Used for Retrofit Scoring

Screening Factor	Description	Scoring
Pounds of Total Phosphorus (TP) Removed – TP used as indicator for other pollutants	Screening factor that combines influence of total drainage area treated and pollutant removal efficiency of proposed retrofit.	Each retrofit scored as % of best TP removal x 35 Maximum Score = **35**
Cost Effectiveness ($ per pound of TP removed)	Cost of construction per pound of total phosphorus removed by the retrofit	Each retrofit scored as % of best cost effectiveness x 35 Maximum Score = **35**
Maintenance Burden (Long-term)	Low maintenance retrofits rely on vegetation and passive treatment mechanisms (e.g., most stream restoration projects). It should be understood that ALL practices may have initial “high level” maintenance period to get plants established, control invasives, etc. As such, this metric measures long-term maintenance requirements. Retrofits with High maintenance burden may require removing debris after most storm events or have risk of heavy sediment loading, for example.	Low maintenance burden = **15**
		Medium maintenance burden = **7.5**
		High maintenance burden = **0**
Potential Utility or Site Constraints	Presence and significance of utility conflicts or other site constraints, such as limited space, required grading, or property issues	No apparent constraints = **10**
		Access somewhat constrained or utilities present but relatively easy to move (e.g., electric or phone lines) = **5**
		Poor access, major grading required, or major utilities must be moved (e.g., sewer) = **0**
Aesthetics and Safety	Since these projects are on public land, this factor considers issues such as standing water in close proximity to foot traffic, steep drop-offs or slopes, etc. The factor also considers projects that can enhance aesthetics by adding landscaping.	Practice adds landscaping and/or would enhance aesthetics at the site = **5**
		Practice neither detracts from aesthetic/safety nor adds much in the way of value = **2.5**
		Practice would pose an aesthetic or safety issue based on the practice type and location= **0**
		Total Maximum Score = 100

Step 2: Scoring Each Candidate Practice Based on the Screening Factors

Scoring each individual retrofit concept was accomplished by using a unique spreadsheet for each jurisdiction. The spreadsheet includes input cells populated by measurements taken in the field (e.g., potential practice surface area) and/or derived from GIS (e.g., drainage area, impervious cover). The spreadsheet uses these data to perform certain computations that relate to the screening factors discussed above. **Appendix B** contains a table of the significant fields from the completed spreadsheets.

The three tables that follow provide documentation for the calculations and scoring method:

- **Table 3** lists and describes the inputs to the spreadsheet. The table details inputs for all retrofit projects, plus additional inputs for BMP conversion and enhancement projects.
- **Table 4** documents the calculations performed by the spreadsheet and how these are used to assign scores for the selected screening factors.
- **Table 5** shows unit cost data used to score the cost-effectiveness screening factor, as well as whether the practice is categorized in the Expert Panel report as Runoff Reduction (RR) or Stormwater Treatment (ST).

Table 3. Description of Retrofit Spreadsheet Inputs	
ALL PRACTICES – GENERAL INPUT DATA	
CWP Lead Staff Person	Chris Swann (CPS), David Hirschman (DJH), Joe Battiata (JGB), Laurel Woodworth (LW), Lisa Fraley-McNeal (LFM).
Unique Site ID	Site identifier that starts with B (Bridgewater), H (Harrisonburg), J (JMU). For example, H8. Multiple retrofit projects on a single site are labeled H8-A, H8-B, etc.
Site Description	Site name and/or location within a larger site.
Drainage Area	Drainage area to the retrofit, in acres.
Impervious Cover	Impervious cover within the drainage area, in acres.
Proposed Practice	Generally practices from Table 2 in Expert Panel report (Schueler and Lane, 2012). Based on the report, practices are categorized as either "Runoff Reduction" (RR) or "Stormwater Treatment" (ST). JMU also had a stream restoration project, so this practice was added to the list of practice types.
Retrofit Practice Dimensions	Available surface footprint and depth to install the retrofit practice. Depending on the practice and site, this may include length, width, ponding depth, filter media depth (e.g., for bioretention), gravel depth (e.g., for underdrains). Depth can be constrained by the elevation of existing storm sewer inlets, topography, etc.
CONVERSIONS & ENHANCEMENTS – ADDITIONAL INPUT DATA	
Existing Practice	Choices include Dry Detention Pond (originally designed only for peak rate control) or Extended Detention (ED) Pond (designed for both peak rate control and water quality treatment).
Pre-Retrofit Performance Discount & Issue	Based on existing conditions, some ponds exhibit performance issues, such as short-circuiting or by-passing of the treatment area, storage filled with sediment, clogging, or the practice being undersized. Depending on the severity of the problem, a performance discount of 0, 0.25, 0.5, 0.75, or 1.0 can be assigned to existing ponds, with 0 being no performance issue and 1 being total practice failure. A column is also assigned to document the particular performance issue. Enhancement projects can also assign a Post-Retrofit Performance Discount (for example, even after the retrofit, the practice is undersized). The reason this Post-Retrofit discounts apply only to enhancements is that enhancement projects do not use the performance curves in the Expert Panel report, and thus treatment volume is not used to scale pollutant removal performance.

Table 4. Documentation of Calculations in the Spreadsheet

*NOTE: Items in bold are CALCULATED SCREENING FACTORS used in the scoring and ranking process (see **Table 2**)*

<table>
<tr><td>Target Water Quality Volume (WQ_V)</td><td>This represents the “target” storage volume for a retrofit, based on treating runoff from 1” of rainfall (standard for new development and redevelopment in Virginia stormwater regulations). While retrofits do not have the same regulatory obligation as new and redevelopment, establishing a target based on the regulatory standard can be an important screening factor.

Target WQV = 1” x Rv x DA x 3630

Where:
Target WQV = Target water quality volume (cubic feet)
Rv = Composite runoff coefficient in the drainage area = (% Impervious x 0.95) x (% Turf x 0.22)
DA = Drainage area (acres)
3630 = Conversion factor</td></tr>
<tr><td>Total Volume Provided By Retrofit Practice</td><td>Often retrofits cannot meet the full target water quality volume storage due to site constraints. This metric measures the actual storage volume potentially provided by the practice based on practice dimensions and storage layers, as measured in the field.

Total Volume = Surface Ponding + Soil Media Storage + Underdrain Gravel Storage

Assumptions:
Soil media porosity = 0.25
Gravel porosity = 0.40, as per VA Bioretention specification (No. 9)
Side slopes = 3:1

NOTE: The spreadsheet also calculates the “% of the Target WQ_V” stored in the practice, using the first two calculations</td></tr>
<tr><td>Drainage Area Pollutant Loads for TP, TN, TSS</td><td>These are the pollutant loads generated by the land covers in the drainage area <u>without any retrofit or existing practice.</u> Loading rates for TP, TN, and TSS were derived from 2009 Edge-Of-Stream rates from Phase 5.3.2 of the Chesapeake Bay Model for the Potomac River Basin.

Pollutant Load = (Urban Impervious x LR) + (Urban Pervious x LR)

LR = Loading Rate (lbs/acre per yr) from table below

<table>
<tr><td></td><td>TP</td><td>TN</td><td>TSS</td></tr>
<tr><td>Regulated Urban Impervious</td><td>1.62</td><td>16.86</td><td>1,171.32</td></tr>
<tr><td>Regulated Urban Pervious</td><td>0.41</td><td>10.07</td><td>175.8</td></tr>
</table></td></tr>
<tr><td>Runoff Depth Captured Per Impervious Acre</td><td>This value is the “X-axis” input to the Performance Curves in the Expert Panel report (see Appendix B of the Expert Panel report).

Retrofit Storage in acre-inches/Impervious acres in drainage area</td></tr>
<tr><td>Pollutant Removal for New Retrofits (lbs per year)</td><td>This computation replicates the performance curves in the Expert Panel report. The curves generate a % removal for TP, TN, and TSS and then applies the % removal to the pollutant load generated by the drainage area. There are curves for Runoff Reduction (RR) and Stormwater Treatment (ST) practices. RR practices treat stormwater through some treatment mechanism, such as filtering or settling, but also reduce the overall volume of runoff exiting the practice. ST practices accomplish just the former. Table 5 includes which practices are categorized as RR or ST, respectively.</td></tr>
</table>

<table>
<tr><td></td><td>An example of a performance curve equation is shown below for RR practice TP removal:

TP Removal % = $0.0304x^5+0.2619x^4+0.9161x^3-1.6837x^2+1.7072x-0.0091$

There was one stream restoration project at JMU (Arboretum, J35). Pollutant removals for this project were based on the interim rates in the Stream Restoration Expert Panel report (Schueler and Stack, 2013) and a restoration length of 700 linear feet. [1] The provisional rates in lbs/ft/year are: TP = 0.068; TN = 0.20; TSS = 310 (NOTE: for TSS, the actual rate is closer to 55 lbs/ft/year since a delivery factor of around 0.175 is applied). It is important to note that actual rates for the project will be based on one of the three protocols in the Expert Panel report, so may vary considerably from the interim projections.</td></tr>
<tr><td>Pollutant Removal for Conversions & Enhancements (lbs per year)</td><td>For Conversions & Enhancements, there is an extra step to calculate the “Credited Pollutant Removal.” This is the removal accomplished by the retrofit minus the removal assigned to the existing practice (with relevant performance discounts). Existing practice removal rates are derived from Table A-5 in the Retrofits Expert Panel report (approved CBP rates). It is important to note that, based on the Expert Panel report, post-retrofit rates for Conversions (e.g., converting a dry pond to a constructed wetland) DO use the performance curves, but post-retrofit rates for Enhancements still use Table A-5 rates.[2]

<u>Conversion</u> Credited Pollutant Removal =
Conversion Removal from Performance Curves – Existing Practice Removal from Table A-5

<u>Enhancement</u> Credited Pollutant Removal = Enhancement Removal from Table A-5 – Existing practice removal x Difference between pre- and post-retrofit performance discounts.

Table A-5 (undiscounted) rates are listed in the table below (lbs/acre per yr):

<table><tr><th></th><th>TP</th><th>TN</th><th>TSS</th></tr><tr><td>Dry Detention Pond</td><td>10</td><td>5</td><td>10</td></tr><tr><td>Dry ED Pond</td><td>20</td><td>20</td><td>60</td></tr></table></td></tr>
<tr><td>Retrofit Cost</td><td>These are planning-level cost for the retrofit type, using unit construction costs ($/per cubic foot treated) from available studies. With the caveat that cost data are notoriously variable, the project team used the most up-to-date cost data from the Bay Watershed and elsewhere. The unit costs were derived from a variety sources, including JRA (2013), King & Hagan (2011), CWP (2007), and, where available, actual construction bids for retrofit projects (see, for example, CWP, 2011). These represent reasonable planning-level costs, but these data can be modified using local cost data. Also, it is important to note that these costs are construction costs and NOT BMP life-cycle costs. This is because construction costs are easier to ascertain and have less “scatter,” so represent a more reliable metric to compare projects. Life-cycle costs include project planning and permitting, administration, long-term inspection and maintenance, and other costs. Information on life-cycle BMP costs is available from WVDEP (2012), King & Hagan (2011), and WERF (2009), among other sources.

Cost = Cubic Foot Treated x Unit Construction Cost from Table 5.</td></tr>
<tr><td>Cost-Effectiveness ($/lb of TP removed per year)</td><td>TP was used for this calculation since it is the keystone pollutant for the Virginia regulations.

Cost Effectiveness in $ = Retrofit Cost/lbs of TP Removed by Retrofit</td></tr>
</table>

[1] A proposal by Ecosystem Services, LLC (May 1, 2013) notes that there is approximately 1,400 linear feet of stream channel in this reach. A conservative estimate was made that the stream restoration protocols would apply to half of this reach length.
[2] This is because Enhancements, in theory, do not change the type of the existing practice, and so they are still considered an ED pond (even though the enhancement may add wetland cells, increase the flow path, etc.). Based on the Expert Panel report, dry and ED ponds should not use the performance curves. As such, with the method used in this project, the only net removal for Enhancements is assigning a performance discount to the existing practice and removing the discount, in part or in full, for the Enhancement retrofit.

Table 5. Unit Construction Costs and RR/ST Designation for Various Retrofit Practices

Retrofit Practice	RR or ST	Construction Cost/CF treated
Bioretention	RR	$24.46
Constructed Wetlands	ST	$12.37
Dry Swale	RR	$20.00
Filtering Practice	ST	$11.60
Green Roof	RR	$170.00
Infiltration	RR	$12.68
Permeable Pavers	RR	$63.15
Wet Ponds	ST	$12.37
Wet Swale	ST	$12.37
Rain Tank	RR	$15.00
Stormwater Planter	RR	$38.05
Regenerative Stormwater Conveyance	RR	$45.00
Filter Strip	RR	$6.00
Stream Restoration	--	$12.47
Conversion & Enhancements	--	$3.59

Step 3: Ranking the Projects

As a final step, the spreadsheet ranks the candidate retrofit projects within each jurisdiction from highest to lowest score, with the top-scoring project ranked #1. This ranking should not be taken at face value with regard to the final prioritizations of projects, as professional judgment is still required to identify which projects are most important for Harrisonburg to implement. For instance, projects that score high may have hidden "project killers" that reduce their feasibility. These may include overall cost, willingness of the landowner or manager, conflicts with other capital projects, community acceptance, loss of parking spaces, and other factors. Alternately, relatively low-ranking projects can be elevated by local stormwater managers because they can be implemented quickly, linked with other capital projects, and/or be implemented by an eager property manager or department director.

In order to vet the rankings produced by the spreadsheets, another meeting was held with the MS4 project representatives on July 3, 2013. At this meeting, the project team reviewed the mechanics of the scoring and ranking spreadsheets, presented the high-ranking projects, and requested that the MS4 representatives review and potentially amend the rankings.

<u>Practices with No Score or Rank:</u> It is important to note that some concepts developed during the field inventory were not given a score due to the nature of the practice. These include the following concept types:

- Bank Erosion Repair
- Impacted Buffer Repair
- Landscape Maintenance / Re-forestation
- Outfall Stabilization
- Pollution Prevention
- Filter Strip

These cannot be scored alongside the other practices because they do not create a storage volume and/or they represent changes in maintenance procedures or operations. However, these practices are listed in the overall retrofit inventory and should be equally considered for implementation.

As part of the broader MS4 program planning, some of these practices (e.g., buffer restoration, re-forestation) can be programmed in the VAST tool to compare pollutant removal benefits (see suggested scenarios in Section 5).

SECTION 4. STUDY RESULTS

4.1 Summary of Projects

Table 6 lists all of the 13 projects identified in Bridgewater, with the score and rank of each practice, as applicable. To see detailed parameters and values for each project, see **Appendix B**. For summaries and photos of each site, see **Appendix C**. One should be aware that the scores are provided for comparative purposes. For instance, a project with a score in the 40s or 30s may seem like a "throw-away," but can actually be a sensible and achievable project.

Table 6. All Projects Identified in Bridgewater

Site ID	Site Description	Proposed Practice	Total Score	Rank
B2-A	Oakdale Park	Conversion	85	1
B4-C	Harrison Park / Bridgewater Office	Bioretention	75	2
B6	Wildwood Park	Bioretention	75	3
B11-A	Sandy Bottom - Riverside Drive	Constructed Wetlands	72	4
B10	Wynant & Bank Street Park	Bioretention	59	5
B11-B	Sandy Bottom- Golf Course	Wet Swale	58	6
B8	Seven Bridges Park	Bioretention	46	7
B13	Cooks Creek Arboretum	Regenerative Stormwater Conveyance	44	8
B4-B	Bridgewater Office	Bioretention	36	9
B4-A	Bridgewater Office	Stormwater Planter	30	10
B1	Hollen Mill Court Pond	Landscape Maintenance	N/A	N/A
B2-B	Oakdale Park, Ditches	Landscape Maintenance	N/A	N/A
B13-ER	Cooks Creek Arboretum Stream Bank Erosion	Bank Erosion Repair	N/A	N/A

Based on a natural break in the retrofit scores, the six highest-scoring practices were considered as the "Top-Ranked" category. **Table 7** summarizes the top-ranked projects for Bridgewater**.**

Table 7. Summary of 6 Top-Ranked Retrofit Sites for Bridgewater

Site	DA (ac.)	%WQ_V[1]	TP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	Construction Cost	$/lb TP reduced per yr
B2-A: Oakdale Park	168	0.47	45.56	554.22	22,616	$351,823	$7,723
B6: Wildwood Park	5.60	0.46	2.87	35.08	1,855	$118,137	$41,209
B4-C: Harrison Park	5.41	0.27	1.82	28.54	714	$43,787	$24,100
B11-A: Sandy Bottom, Riverside Dr.	7.40	0.19	3.14	31.25	2,086	$98,962	$32,921
B10: Wynant & Bank	3.50	0.75	1.82	25.73	923	$93,324	$51,213
B11-B: Sandy Bottom G.C.	2.82	0.57	1.32	11.19	1,114	$39,817	$30,113
TOTALS	**192.73**		**56.53**	**686.01**	**29,308**	**$745,850**	**$13,194**[2]

[1] *This refers to the percent of the Target Water Quality Volume (WQ_V) captured by the practice, as described in* ***Table 4****. Since these are retrofit projects, they do not have a regulatory obligation to meet 100% of the WQ_V, but it is a good metric by which to compare projects.*

[2] *This value is not a Total, per se, but the total cost for the 10 projects divided by the total TP removal.*

4.2 Trends in the Three Communities

The following observations are general trends noted for all three jurisdictions.

What Are The Most Cost-Effective Practices?

Based on the scoring metric of cost per pound of Total Phosphorus reduced (cost-effectiveness), BMP conversions and enhancements are generally more cost-effective. **Table 8** shows the values for this metric for all three jurisdictions included in the project. Within each jurisdiction, conversions/enhancements are more cost-effective than new retrofits. For all three jurisdictions, the average cost-effectiveness for new retrofits is $56,279, compared to $23,647 for conversions/enhancements. For Bridgewater, the one conversion project (B2-A) was even more cost-effective, at just over $7,700 per pound. As **Table 8** also illustrates, there is a wide range of cost-effectiveness values for both new and conversion/enhancement projects, and project-specific factors (e.g., drainage area, type of project) will dictate this.

Of equal importance, conversions/enhancements, while more cost-effective on average, are limited in number because they rely on a pre-existing practice, while new retrofits can be located practically anywhere in the landscape. The three jurisdictions had a total of 64 candidate new retrofit projects on public land, but only 9 conversions/enhancements.

What this means in practical terms is that an MS4 should seek first to convert and/or enhance existing BMPs, but will likely need to blend this will the most cost-effective new retrofits in order to meet load reduction targets. These data also suggest that MS4s would be well-served to seek conversion/enhancement projects for existing practices on private land. While the administrative issues would be more difficult for public land projects (e.g., securing easements, working with landowners), the overall cost-effectiveness may be worth the effort.

What Are "Heroic" Retrofit Projects?

For each jurisdiction, there appears to be one or two "heroic" retrofit projects that have large drainage areas, are cost-effectiveness, and achieve disproportionately high load reductions. The influence of these heroic projects can be quite pronounced, as illustrated in **Table 9**. Compared to the load reductions achieved by ALL of the candidate retrofit projects for a given jurisdiction, the one or two heroic projects are generally responsible for half or more of the reductions, and this value can exceed 75% (in the case of Bridgewater). These projects are clearly the heavy-hitters, and of course are the top-ranked projects for each jurisdiction.

The conundrum for an MS4 is that these projects also tend to be the more expensive projects, with estimated price tags for construction being in the hundreds of thousands of dollars (compared in many cases to tens of thousands for lower ranked projects). However, viewed another way, the heroic projects are relative bargains, because they cost proportionately less per pound of pollutant reduced. With this in mind, an MS4 may want to prioritize the heroic projects, but also realize that implementation, including raising the necessary capital, may take several years to accomplish. Also, it will be critical to scrutinize these projects thoroughly, as there may be reasons to not elevate them so highly. Feasibility, construction issues, property rights, and political support must all be analyzed in a feasibility or concept design stage to truly analyze whether the projects can deliver what is promised.

Table 8. Cost-Effectiveness of New Retrofits vs. Conversions/Enhancements -- $/Pound of TP Removed

	Bridgewater	**Harrisonburg**	**JMU**
New Retrofits			
Number in Sample	9	31	24
Range of Values	$24,100 -- $120,046	$13,552 -- $210,949	$22,227 -- $105,657
Average	$51,511	$60,757	$56,568
Conversions/Enhancements			
Number in Sample	1	4	4
Range of Values	$7,723	$4,234 -- $94,553	$9,797 -- $14,164
Average	$7,723	$51,167	$12,052

Table 9. Percent of Load Reductions & Costs for "Heroic" Projects Compared to ALL Retrofits From This Study For Each Jurisdiction

	TP	**TN**	**TSS**	**Construction Cost ($)**
Bridgewater – Project B2-A, Oakdale Park	77%	78%	73%	40%
Harrisonburg – Projects H200-Alt (Heritage Oaks G.C. RSC) & H42 (Market St. Median)	54%	62%	36%	42%
JMU – Project J35, Arboretum Stream Restoration	50%	25%	57%	23%

SECTION 5. RECOMMENDATIONS

5.1 Further Considerations

For Bridgewater, implementation of the retrofits identified in this study must be done strategically and with full vetting of other available BMPs and strategies to achieve target pollutant load reductions. As Bridgewater embarks on its first MS4 Permit Cycle (including the TMDL Action Plan and load reduction requirements), it will be important to keep the following topics in mind.

Investigating the Full Range of Practices

Stormwater retrofits are only one of the BMP strategies available to MS4s to achieve pollutant load reductions. As of this report, the Chesapeake Bay Program Expert Panels have approved procedures and performance values for implementing new state performance standards, retrofits, stream restoration, and urban nutrient management (see: http://chesapeakestormwater.net/bay-stormwater/baywide-stormwater-policy/urban-stormwater-workgroup/). Several other Expert Panels are in progress or pending: illicit discharge detection and elimination (IDDE), street sweeping, enhanced erosion control, and floating wetlands. As these protocols become accepted by the Bay Program, it will be helpful for MS4s to analyze which practices will be most suitable and cost-effective for their jurisdiction.

Stormwater Design Considerations for Karst

Bridgewater and other Shenandoah Valley jurisdictions must address stormwater design issues associated with karst. Karst tends to be a very site-specific feature, and it is difficult to establish at the concept stage how it may affect a particular stormwater practice with regard to design details and associated costs. It is important to note that the pollutant removal performance values and costs presented in this report are based on Bay-wide data and procedures (and sometimes national data with regard to unit costs). As such, the performance values and unit costs do not anticipate the use of impermeable liners, more involved geotechnical work at the design stage, or other karst-specific issues. CWP does believe that karst is an important design consideration, but should not result in across-the-board or automatic BMP design modifications that increase cost.

The most recent Bay-wide guidance on stormwater design in karst is Technical Bulletin #1 from the Chesapeake Stormwater Network, and can be found here (CSN, 2009): http://chesapeakestormwater.net/2012/03/technical-bulletin-no-1-stormwater-design-guidelines-for-karst-terrain/. It should also be noted that the Virginia BMP Specifications on the Clearinghouse website (http://vwrrc.vt.edu/swc/NonProprietaryBMPs.html) contain short sections about design adaptations for karst.

Keeping in Touch With DEQ About MS4 Reporting

This study used the Bay Program-approved protocols, with some technical interpretations by CWP staff, to assign pollutant removal performance values to candidate retrofit (and some stream restoration) projects. A major caveat is that Virginia DEQ must still weigh in on how MS4s should report BMPs and their corresponding performance values. As of the writing of this report, DEQ has convened an MS4 Stakeholder Group to address issues with the TMDL Action Plan. Bridgewater staff may need to revisit the numbers presented in this section after DEQ issues its guidance.

5.2 Options for Achieving Required Load Reductions

The remainder of this section consists of several tables that present and analyze retrofit data for Bridgewater. The tables are as follows:

- **Table 10** presents assumed load reduction requirements for Bridgewater for Total Phosphorus (TP), Total Nitrogen (TN), and Total Suspended Solids (TSS). The numbers are relevant to the "TMDL Action Plan" required in the Virginia Small MS4 General Permit and Virginia's Phase II Watershed Implementation Plan (WIP).
- **Table 11** shows how potential load reductions from the candidate retrofit projects in this study compare to those needed in the MS4 Permit and WIP. The table breaks out total loads from all of the candidate retrofit projects, the 6 top-ranked projects, and the top-ranked Oakdale Park basin retrofit project only (see **Table 7**). The table also shows the percentage of the reduction achieved through retrofits for the 1st (current) permit cycle, as well as the 2nd cycle and the total required reductions through 3 cycles.

  It should be noted that the current MS4 General Permit only contains requirements to achieve 5% of the reductions, but also states that future permit cycles will be in accordance with the WIP.

  As such, the projections for future permits are based on the percent reductions noted in the WIP. As can be seen from this table, implementing the Oakdale Park project can fulfill permit obligations through the 2nd permit cycle for TN, very nearly for TP, but leaves a shortfall for TSS. The TSS "deficit" is 9,148 pounds per year, and this is a substantial issue for Bridgewater to consider. Even implementing all six top-ranked projects leaves a TSS deficit of 2,456 pounds per year through the 2nd cycle. Bridgewater will likely have to consider complementary practices, such as stream restoration or street sweeping, that are more conducive for TSS reductions. It is worth noting that the fledgling nutrient trading program in Virginia allows trading for TP and TN, but not for TSS.
- **Table 12** outlines several possible TMDL Action Plan scenarios for Bridgewater based on the retrofit data. These scenarios assume different retrofit implementation levels and timelines, and assume that retrofits will be implemented along with other MS4 strategies. Some of the scenarios envision limited purchase of nutrient credits through the Chesapeake Bay Nutrient Credit Exchange, although this program is still being fleshed out at the state level. It should be noted that these scenarios are hypothetical, and of course the actual strategy must be vetted through a local process. However, the proposed scenarios may help Bridgewater with understanding its choices as it continues to implement the MS4 program.

Table 10. Bridgewater MS4 Required Load Reductions			
	Required Load Reductions[1]		
	TP (lbs/yr)	**TN (lbs/yr)**	**TSS (lbs/yr)**
1st Permit Cycle (ending 2018) – Achieve 5% of total reduction[2]	6	63	4,538
2nd Permit Cycle (ending 2023) – Achieve additional 35% of total reduction	41	441	31,764
Total Reduction Required (in up to three permit cycles)	117	1,259	90,753

[1] Load reductions derived from DCR spreadsheet that is based on Phase 5.3.2 Watershed Model. The reductions are a % reduction from Edge-of-Stream baseline loads from July 1, 2009. Loads are calculated based on the acreage of "regulated urban impervious" and "regulated urban pervious" acres within the MS4, with specific loading rates for Potomac and Shenandoah River Basin, as documented in Phase 5.3.2 of the Chesapeake Bay Model. All load figures were rounded to the nearest whole number.

[2] The Virginia Small MS4 General Permit became effective on July 1, 2013. Section 1(C) – Special Conditions for the Chesapeake Bay TMDL – stipulates that MS4s achieve 5% of their required reductions in the 1st 5-year permit cycle, and also states that future permit cycle reductions will be in accordance with Virginia's Phase 1 and 2 Watershed Implementation Plans. The permit also requires MS4s to offset increased loads from some new development projects (initiated after July 1, 2009) as well as grandfathered projects (initiated after July 1, 2014). This table shows only numbers for reductions from existing sources. Reductions in the other two categories are expected to be low compared to values for existing sources.

Table 11. Bridgewater: Implementation of Retrofits Compared to Required Load Reductions				
	TP (lbs/yr)	**TN (lbs/yr)**	**TSS (lbs/yr)**	**Construction Cost**
Implement All Retrofits	**59**	**713**	**31,090**	**$880,221**
	% of Permit Cycle's Required Reduction			
All Retrofits % 1st Permit Cycle	1005%	1132%	685%	
All Retrofits % 2nd Permit Cycle (inclusive)[1]	126%	142%	86%	
All Retrofits % Total Reduction	50%	57%	34%	
Implement Only 6 Top-Ranked Retrofits	**57**	**686**	**29,308**	**$745,850**
	% of Permit Cycle's Required Reduction			
Top-Ranked % 1st Permit Cycle	963%	1089%	646%	
Top-Ranked % 2nd Permit Cycle (inclusive)	120%	136%	81%	
Top-Ranked % Total Reduction	48%	54%	34%	
Implement Only Oakdale Park Project (B2-A)	**46**	**554**	**22,616**	**$351,823**
	% of Permit Cycle's Required Reduction			
Oakdale Park % 1st Permit Cycle	776%	880%	498%	
Oakdale Park % 2nd Permit Cycle (inclusive)	97%	110%	62%	
Oakdale Park % Total Reduction	39%	44%	25%	

[1] "Inclusive" means the % reduction achieved compared to required reductions for the 1st plus 2nd permit cycles, based on the WIPs. This amounts to a total reduction of 40% (5% for the 1st permit cycle + an additional 35% for the 2nd).

Table 12. Overview of Possible MS4 Load Reduction Scenarios for Bridgewater

Permit Cycle Activities & Actions	Notes
Scenario 1: Implement Project B2-A (Oakdale Park) in two or more phases	
<u>1st Permit Cycle (2018):</u> Construct phase 1 of stormwater wetland at one of the inlets (probably on west side of basin). **<u>2nd Permit Cycle (2023):</u>** • Complete conversion of basin to constructed wetland over the course of permit cycle. • Use street sweeping, stream restoration, and/or additional retrofits to meet TSS deficit of 9,149 lbs. (or possibly partner with a neighboring MS4). **<u>Out-Year Permits:</u>** Re-evaluate other potential retrofits along with other Bay Program & Virginia credited practices: street sweeping, urban nutrient management, stream restoration, etc. to pick most cost-effective mix of practices.	• Design work will need to be conducted to figure out the phase 1 project and ensure that it will be adequate to meet load reductions for the 1st Permit Cycle. • Completion of the Oakdale Park project will meet 2nd Permit Cycle loads for TP and TN, but not TSS. The TSS deficit is projected to be just over 9,000 lbs/year. There are likely other BMPs that are more cost-effective for sediment, as it would take many retrofits to fill this gap. • For the 15-year implementation period, the Oakdale Park project alone will provide less than half of the total required. It makes sense to re-evaluate the implementation strategy mid-way through the 2nd Permit Cycle, since load allocations may change as well as the types and credits assigned to various BMPs.
Scenario 2: Trading + Project B2-A (Oakdale Park)	
<u>1st Permit Cycle (2018):</u> • Purchase certified nutrient credits for the modest TP and TN reductions. • Use another BMP (e.g., street sweeping, stream restoration) or partner with a neighboring MS4 for the 4,539 TSS reduction. • Use the time during this cycle to do design work and secure funding for the Oakdale Park project. **<u>2nd Permit Cycle (2023):</u>** • Construct the Oakdale Park project. • See Scenario 1 for TSS deficit issue. **<u>Out-Year Permits:</u>** See Scenario 1.	• Nutrient trading regulations are still in process at DEQ, so the rules of the game and cost are still uncertain. However, the MS4 General Permit does authorize the use of trading. • The big issue, as with Scenario 1, is filling the TSS gap. Stream restoration is probably a more promising BMP, but projects have to be identified, designed, and constructed.
Scenario 3: Smaller Retrofits, Trading, Other BMPs	
<u>1st Permit Cycle (2018):</u> • If capital costs for Oakdale Park are too high, it if feasible to meet load reductions with at least 2 smaller retrofits, likely some combination of B4-C, B6, B11-A, and/or B10. • There is also an option to use one smaller retrofit and trading to fulfill the 1st cycle. • As with other scenarios, there is still the TSS deficit to deal with. **<u>2nd Permit Cycle (2023):</u>** • By this cycle, some larger project would be needed. It could be Oakdale Park or possibly a stream restoration project. **<u>Out-Year Permits:</u>** Same as Scenarios 1 and 2.	• This option, while adequate for the 1st cycle, is not as good for future cycles, since capital funds still have to be expended, and the town may have to build the Oakdale Park project anyway. • While the absolute costs of the smaller retrofits are smaller *vis-à-vis* Oakdale Park, the cost/pound reduced for the smaller projects is higher. Therefore, this scenario is more expedient than cost-effective.

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APPENDIX A: FIELD FORMS

This appendix includes the field forms used during the stormwater retrofit study:

- Retrofit Reconnaissance Inventory form
- Hotspot Site Investigation form
- Severe Bank Erosion form
- Stormwater Outfall form
- Impacted Buffer form

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:**	
DATE:	**ASSESSED BY:**	**CAMERA ID:**	**PICTURES:**
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name:____
Address:____

Ownership: ☐ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:____________________

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:_______________

Proposed Retrofit Location:

Storage
☐ Existing Pond
☐ Below Outfall
☐ In Road ROW
☐ Above Roadway Culvert
☐ In Conveyance System
☐ Near Large Parking Lot
☐ Other:____________________________

On-Site
☐ Hotspot Operation
☐ Small Parking Lot
☐ Individual Street
☐ Underground
☐ Individual Rooftop
☐ Small Impervious Area
☐ Landscape / Hardscape
☐ Other:____________

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ ________________
Imperviousness ≈ ________________%
Impervious Area ≈ _______________

Notes:

Drainage Area Land Use:
☐ Residential
  ☐ SFH (< 1 ac lots)
  ☐ SFH (> 1 ac lots)
  ☐ Townhouses
  ☐ Multi-Family
☐ Commercial
☐ Institutional
☐ Industrial
☐ Transport-Related
☐ Park
☐ Undeveloped
☐ Other:____________

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☐ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):________

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:

☐ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☐ Demonstration / Education ☐ Repair ☐ Other:______________________

Retrofit Volume Computations - Target Storage:

Retrofit Volume Computations - Available Storage:

Proposed Treatment Option:

☐ Extended Detention ☐ Wet Pond ☐ Created Wetland ☐ Bioretention
☐ Filtering Practice ☐ Infiltration ☐ Swale ☐ Other:______________________

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Available Width: __________
Available Length: __________
Available Area: __________
Ponding Depth: __________
Soil Depth: __________

SITE CONSTRAINTS

Adjacent Land Use:

☐ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☐ Undeveloped ☐ Other:______________________

Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☐ No

If Yes, Describe:

Access:

☐ No Constraints

Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property

Ownership
☐ Other:______________________

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	☐	☐	☐	☐
Water:	☐	☐	☐	☐
Gas:	☐	☐	☐	☐
Electric to Streetlights:	☐	☐	☐	☐
Other:	☐	☐	☐	☐

____
____

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☐ Not Probable
Impacts to Wetlands	☐ Probable	☐ Not Probable
Impacts to a Stream	☐ Probable	☐ Not Probable
Floodplain Fill	☐ Probable	☐ Not Probable
Impacts to Forests	☐ Probable	☐ Not Probable
Impacts to Specimen Trees	☐ Probable	☐ Not Probable

How many?______________
Approx. DBH______________

Other factors:______________________________
____

Soils:

Soil auger test holes:	☐ Yes	☐ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

SKETCH

DESIGN OR DELIVERY NOTES

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other:______________________________

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

SITE CANDIDATE FOR FURTHER INVESTIGATION: ☐ YES ☐ NO ☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE
IF YES, TYPE(S):______________________________

Hotspot Site Investigation **HSI**

WATERSHED:	SUBWATERSHED:		UNIQUE SITE ID:	
DATE: ___/___/_____	ASSESSED BY:	CAMERA ID:		PIC#:
MAP GRID:	LAT ___°_____'_____" LONG ___°_____'____"			LMK #

A. SITE DATA AND BASIC CLASSIFICATION

Name and Address: ___________________

____

____

SIC code (if available): ___________

NPDES Status: ☐ Regulated ☐ Unregulated ☐ Unknown

Category: ☐ Commercial ☐ Industrial Miscellaneous ☐ Institutional ☐ Municipal ☐ Golf Course ☐ Transport-Related ☐ Marina ☐ Animal Facility

Basic Description of Operation:

____

	INDEX*
B. VEHICLE OPERATIONS ☐ **N/A** *(Skip to part C)*	**Observed Pollution Source?** ☐
B1. Types of vehicles: ☐ Fleet vehicles ☐ School buses ☐ Other: ____________	
B2. Approximate number of vehicles: _______	
B3. Vehicle activities *(circle all that apply)*: **Maintained Repaired Recycled Fueled Washed Stored**	○
B4. Are vehicles stored and/or repaired outside? ☐ Y ☐ N ☐ Can't Tell Are these vehicles lacking runoff diversion methods? ☐ Y ☐ N ☐ Can't Tell	○
B5. Is there evidence of spills/leakage from vehicles? ☐ Y ☐ N ☐ Can't Tell	○
B6. Are uncovered outdoor fueling areas present? ☐ Y ☐ N ☐ Can't Tell	○
B7. Are fueling areas directly connected to storm drains? ☐ Y ☐ N ☐ Can't Tell	○
B8. Are vehicles washed outdoors? ☐ Y ☐ N ☐ Can't Tell Does the area where vehicles are washed discharge to the storm drain? ☐ Y ☐ N ☐ Can't Tell	○
C. OUTDOOR MATERIALS ☐ **N/A** *(Skip to part D)*	**Observed Pollution Source?** ☐
C1. Are loading/unloading operations present? ☐ Y ☐ N ☐ Can't Tell If yes, are they uncovered *and* draining towards a storm drain inlet? ☐ Y ☐ N ☐ Can't Tell	○
C2. Are materials stored outside? ☐ Y ☐ N ☐ Can't Tell If yes, are they ☐ Liquid ☐ Solid Description: _______ Where are they stored? ☐ grass/dirt area ☐ concrete/asphalt ☐ bermed area	○
C3. Is the storage area directly or indirectly connected to storm drain (circle one)? ☐ Y ☐ N ☐ Can't Tell	○
C4. Is staining or discoloration around the area visible? ☐ Y ☐ N ☐ Can't Tell	○
C5. Does outdoor storage area lack a cover? ☐ Y ☐ N ☐ Can't Tell	○
C6. Are liquid materials stored *without* secondary containment? ☐ Y ☐ N ☐ Can't Tell	○
C7. Are storage containers missing labels or in poor condition (rusting)? ☐ Y ☐ N ☐ Can't Tell	○
D. WASTE MANAGEMENT ☐ **N/A** *(Skip to part E)*	**Observed Pollution Source?** ☐
D1. Type of waste *(check all that apply)*: ☐ Garbage ☐ Construction materials ☐ Hazardous materials **any of these**	○
D2. Dumpster condition (*check all that apply)*: ☐ No cover/Lid is open ☐ Damaged/poor condition ☐ Leaking or evidence of leakage (stains on ground) ☐ Overflowing **any of these**	○
D3. Is the dumpster located near a storm drain inlet? ☐ Y ☐ N ☐ Can't Tell If yes, are runoff diversion methods (berms, curbs) lacking? ☐ Y ☐ N ☐ Can't Tell **if both are yes**	○
E. PHYSICAL PLANT ☐ **N/A** *(Skip to part F)*	**Observed Pollution Source?** ☐
E1. Building: Approximate age: ________ yrs. Condition of surfaces: ☐ Clean ☐ Stained ☐ Dirty ☐ Damaged Evidence that maintenance results in discharge to storm drains (staining/discoloration)? ☐ Y ☐ N ☐ Don't know	○ ○

*Index: ○ denotes potential pollution source; ☐ denotes confirmed polluter (evidence was seen)

E2. Parking Lot: Approximate age _____ yrs. Condition: ☐ Clean ☐ Stained ☐ Dirty ☐ Breaking up Surface material ☐ Paved/Concrete ☐ Gravel ☐ Permeable ☐ Don't know	○
E3. Do downspouts discharge to impervious surface? ☐ Y ☐ N ☐ Don't know ☐ None visible Are downspouts directly connected to storm drains? ☐ Y ☐ N ☐ Don't know	○
E4. Evidence of poor cleaning practices for construction activities (stains leading to storm drain)? ☐ Y ☐ N ☐ Can't Tell	○
E5. Evidence of poor cleaning practices for washing activities (observed washwater dumping, stains leading to storm drain)? ☐ Y ☐ N ☐ Can't Tell	○
F. TURF/LANDSCAPING AREAS ☐ **N/A** *(skip to part G)* **Observed Pollution Source?**	☐
F1. % of site with: Forest canopy ____% Turf grass _____ % Landscaping ____% **Bare Soil 20 %**	○
F2. Rate the turf management status: ☐ High ☐ Medium ☐ Low **40% medium to high**	○
F3. Evidence of permanent irrigation or "non-target" irrigation ☐ Y ☐ N ☐ Can't Tell	○
F4. Do landscaped areas drain to the storm drain system? ☐ Y ☐ N ☐ Can't Tell	○
F5. Do landscape plants accumulate organic matter (leaves, grass clippings) on adjacent impervious surface? ☐ Y ☐ N ☐ Can't Tell	○
G. STORM WATER INFRASTRUCTURE ☐ **N/A** *(skip to part H)* **Observed Pollution Source?**	☐
G1. Are storm water treatment practices present? ☐ Y ☐ N ☐ Unknown If yes, please describe: __________________	○
G2. Are private storm drains located at the facility? ☐ Y ☐ N ☐ Unknown **> 25 %** Is trash, sediment and/or organic material present in gutters leading to storm drains? *(circle appropriate)*	○

H. INITIAL HOTSPOT STATUS - INDEX RESULTS

☐ Not a hotspot (fewer than 5 circles and no boxes checked) ☐ Potential hotspot (5 to 10 circles but no boxes checked)
☐ Confirmed hotspot (10 to 15 circles and/or 1 box checked) ☐ Severe hotspot (>15 circles and/or 2 or more boxes checked)

Follow-up Action:

Immediate (1 week)

☐ Refer for immediate enforcement
☐ Test for illicit discharge
☐ Check to see if hotspot is an NPDES non-filer

Mid-term (2-3 months)

☐ Schedule a review of storm water pollution prevention plan
☐ Suggest follow-up on-site inspection

Long-term (1 year)

☐ Onsite non-residential retrofit
☐ Suggest pollution prevention training for employees
☐ Other:____

Identified Opportunities:

General

☐ Include in future education effort (add specifics to Notes)
☐ Stencil or mark storm drain inlets
☐ Signage opportunities (buffer, wetland, bacteria, etc.)
☐ Other:____

Rooftop

☐ Evaluate feasibility of cistern or water reuse (roof area:____sf)
☐ Downspout disconnection (#: ____________)

Loading Areas

☐ Sweep loading areas
☐ Cover loading docks or redesign drainage (area: ________sf)

Fueling Islands

☐ Cover fueling islands (covered area: ___________sf)
☐ Install dry spill response kits (#: _____________)

Landscaping / turf

☐ Turf conversion to landscaping / Bayscaping (area: _______sf)
☐ Pervious area restoration (turf area: ____________sf)
☐ Tree planting (# or area: ______________)
☐ Reduce maintenance (mowing, herbicides, fertilizers)

Vehicle repairs

☐ Plumb indoor shop drains to sanitary
☐ Store fluids/batteries inside or under cover

Outdoor materials

☐ Provide cover or secondary containment (area: __________sf)
☐ Place materials on pallets

Dumpster management

☐ Cover or add/repair lids (#: ___________)
☐ Move dumpsters away from storm drains or streams

Parking lots

☐ Find and fix fluid leaks
☐ Trash and litter pick-up, sweeping
☐ Identify retrofit projects
☐ Reduce salt application

Stormwater Infrastructure

☐ Clean out storm drain inlets
☐ Perform maintenance inspection

Notes:

Severe Bank Erosion **ER**

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH: **TIME:**___:____AM/PM	**PHOTO ID** (CAMERA-PIC #): /#	
SITE ID: (*Condition-#*) **ER-**_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown

☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream)*

LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length *(if no GPS)* LT_______ft and/or RT_________ft Bottom width _______ft
Bank Ht LT_______ft and/or RT__________ft Top width __________ft
Bank Angle LT________° and/or RT________° Wetted Width _______ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

PERCENT OF BANK VEGETATED:
☐ <10% ☐ 10-25% ☐ 25-50%
☐ 50-75% ☐ >75%

BANK COMPOSITION:
☐ 100% sand ☐ Mix sand, gravel, cobble
☐ 100% clay ☐ Other:_______________

DESCRIPTION OF BANK TOE:
☐ Loose/unstable
☐ Mixed (some rocks/veg., loose)
☐ Appears stable (rocks/veg.)

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY(*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5 4	3 2	1
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5 4	3 2	1

NOTES/CROSS SECTION SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**
SURVEY REACH ID: / **TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID (*Condition-#*): **OT-**_____ / **LAT** ___° _____' _____" **LONG** ___° _____' _____" **LMK**_____	**GPS:** (*Unit ID*)	

BANK: ☐ LT ☐ RT ☐ Head

FLOW: ☐ None ☐ Trickle ☐ Moderate ☐ Substantial ☐ Other:

TYPE:	**MATERIAL:**	**SHAPE:** ☐ Single	**DIMENSIONS:**	**SUBMERGED:**
☐ Closed pipe	☐ Concrete ☐ Metal ☐ PVC/Plastic ☐ Brick ☐ Other:	☐ Circular ☐ Double ☐ Elliptical ☐ Triple ☐ Other:	Diameter:_____(in)	☐ No ☐ Partially ☐ Fully
☐ Open channel	☐ Concrete ☐ Earthen ☐ Other:	☐ Trapezoid ☐ Parabolic ☐ Other:	Depth: _____(in) Width (Top):_____(in) " (Bottom):_____(in)	*NOT APPLICABLE*

CONDITION:	**ODOR:** ☐ NO	**DEPOSITS/STAINS:**	**VEGGIE DENSITY:**	**PIPE BENTHIC GROWTH:** ☐ None
☐ None	☐ Gas	☐ None	☐ None	☐ Brown ☐ Orange ☐ Green
☐ Chip/Cracked	☐ Sewage	☐ Oily	☐ Normal	☐ Other:
☐ Peeling Paint	☐ Rancid/Sour	☐ Flow Line	☐ Inhibited	**POOL QUALITY:** ☐ No pool
☐ Corrosion	☐ Sulfide	☐ Paint	☐ Excessive	☐ Good ☐ Odors ☐ Colors ☐ Oils
☐ Other:	☐ Other:	☐ Other:	☐ Other:	☐ Suds ☐ Algae ☐ Floatables
				☐ Other:

FOR FLOWING ONLY		
	COLOR:	☐ Clear ☐ Brown ☐ Grey ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:
	TURBIDITY:	☐ None ☐ Slight Cloudiness ☐ Cloudy ☐ Opaque
	FLOATABLES:	☐ None ☐ Sewage (toilet paper, etc.) ☐ Petroleum (oil sheen) ☐ Other:
OTHER CONCERNS:	☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation	
	☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other:	

POTENTIAL RESTORATION CANDIDATE ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization
☐ no ☐ Storm water retrofit ☐ Other:

If yes for daylighting:
Length of vegetative cover from outfall: ___________ft Type of existing vegetation:______________________ Slope: ___________°

If yes for stormwater:
Is stormwater currently controlled? Land Use description:_________________________________
☐ Yes ☐ No ☐ Not investigated Area available:

OUTFALL SEVERITY: (*circle #*)	Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream.	Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized.	Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems.
	5 4	3 2	1

SKETCH/NOTES:

REPORTED TO AUTHORITIES: ☐ YES ☐ NO

Impacted Buffer **IB**

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	

SITE ID: (*Condition-#*)	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** ______	**GPS:** (*Unit ID*)
IB-______	*END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** ______	

IMPACTED BANK: ☐ LT ☐ RT ☐ Both

REASON INADEQUATE: ☐ Lack of vegetation ☐ Too narrow ☐ Widespread invasive plants ☐ Recently planted ☐ Other:

LAND USE: *(Facing downstream)*	Private	Institutional	Golf Course	Park	Other Public
LT Bank	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐:

DOMINANT LAND COVER:	Paved	Bare ground	Turf/lawn	Tall grass	Shrub/scrub	Trees	Other
LT Bank	☐	☐	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐	☐	☐:

INVASIVE PLANTS: ☐ None ☐ Rare ☐ Partial coverage ☐ Extensive coverage ☐ unknown

STREAM SHADE PROVIDED? ☐ None ☐ Partial ☐ Full

WETLANDS PRESENT? ☐ No ☐ Yes ☐ Unknown

POTENTIAL RESTORATION CANDIDATE ☐Active reforestation ☐Greenway design ☐ Natural regeneration ☐ Invasives removal ☐ no ☐ Other:

RESTORABLE AREA

	LT	BANK	RT
Length (ft):	_________		_________
Width (ft):	_________		_________

REFORESTATION POTENTIAL: (*Circle #*)

Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting	Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate	Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting
5 4	3 2	1

POTENTIAL CONFLICTS WITH REFORESTATION ☐ Widespread invasive plants ☐ Potential contamination ☐ Lack of sun ☐ Poor/unsafe access to site ☐ Existing impervious cover ☐ Severe animal impacts (deer, beaver) ☐ Other:

NOTES:

APPENDIX B: BRIDGEWATER RETROFIT CONCEPTS RANKING TABLE

Site ID	Site Description	Proposed Practice	Drainage Area (acre)	Impervious Cover (acre)	Target WQv (cf)	Available Practice Width (ft)	Available Practice Length (ft)	% Water Quality Volume[1]	TP Removal (lb/yr)	TN Removal (lb/yr)	TSS Removal (lb/yr)	Cost $	Cost Effectiveness ($/lb TP removed)	Scoring							Rank
														Cost Effectiveness	Phosphorus Removal	Maintenance Burden	Potential Utility or Site Constraints	Aesthetics / Safety	Total Score		
B2-A	Oakdale Park	Conversion	168	28.56	209,845.94	-	-	47	45.56	554.22	22,616.03	$351,823	$7,723	35	35	7.5	5	2.5	85		1
B4-C	Harrison Park / Bridgewater Office	Bioretention	5.41	0.90	6,705.34	35	35	27	1.82	28.54	713.69	$43,787	$24,100	35	20	7.5	10	2.5	75		2
B6	Wildwood Park	Bioretention	5.60	2.25	10,434.44	50	75	46	2.87	35.08	1,855.19	$118,137	$41,209	20	32	7.5	10	5	75		3
B11-A	Sandy Bottom - Riverside Drive	Constructed Wetlands	7.40	2.22	11,792.42	-	-	68	3.14	31.25	2,086.22	$98,962	$31,565	27	35	0	5	5	72		4
B10	Wynant & Bank Street Park	Bioretention	3.50	0.88	5,113.76	30	70	75	1.82	25.73	923.23	$93,324	$51,213	16	20	7.5	10	5	59		5
B11-B	Sandy Bottom- Golf Course	Wet Swale	2.82	1.40	5,961.91	13.5	309	54	1.32	11.19	1,113.61	$39,817	$30,113	28	15	7.5	5	2.5	58		6
B8	Seven Bridges Park	Bioretention	1.40	0.80	3,237.96	30	40	41	0.76	8.30	571.98	$32,389	$42,402	20	9	7.5	5	5	46		7
B4-B	Bridgewater Office	Bioretention	0.61	0.53	1,891.59	35	35	100	0.62	5.80	532.59	$46,359	$74,716	11	7	7.5	5	5	36		8
B4-A	Bridgewater Office	Stormwater Planter	0.03	0.03	103.46	2	30	103	0.03	0.30	30.09	$4,053	$120,046	7	0	7.5	10	5	30		9
B1	Wet pond adjacent to Hollen Mill Court	Landscaping maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
B13-ER	Cooks Creek Arboretum	Streambank stabilization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
B13-OT	Cooks Creek Arboretum	Outfall stabilization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
B2-B	Oakdale Park	Landscaping maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-

[1] This refers to the percent of the Water Quality Volume (WQV) captured by the practice. For this application, the WQV is defined as the runoff generated by 1" of rainfall in the drainage area, which is the Virginia standard in the Runoff Reduction Method (see **Section 3** for the associated computation). Since these are retrofit projects, they do not have a regulatory obligation to meet 100% of the WQV, but it is a good metric by which to compare projects.

APPENDIX C: RETROFIT MAPS, SUMMARIES, AND FIELD FORMS

This appendix includes the maps, summaries, and field forms for the retrofit concepts.

B1: Wet Pond Adjacent to Hollen Mill Court


B1
B1: Wet Pond Adjacent to Hollen Mill Court
Retrofit IDs
Drainage Areas
N
Feet
0
100
200
Center for Watershed Protection
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B1: Hollen Mill Court Pond

Score: N/A

Rank: N/A

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Sediment forebay*

Figure 2: *Side slopes are mowed short*

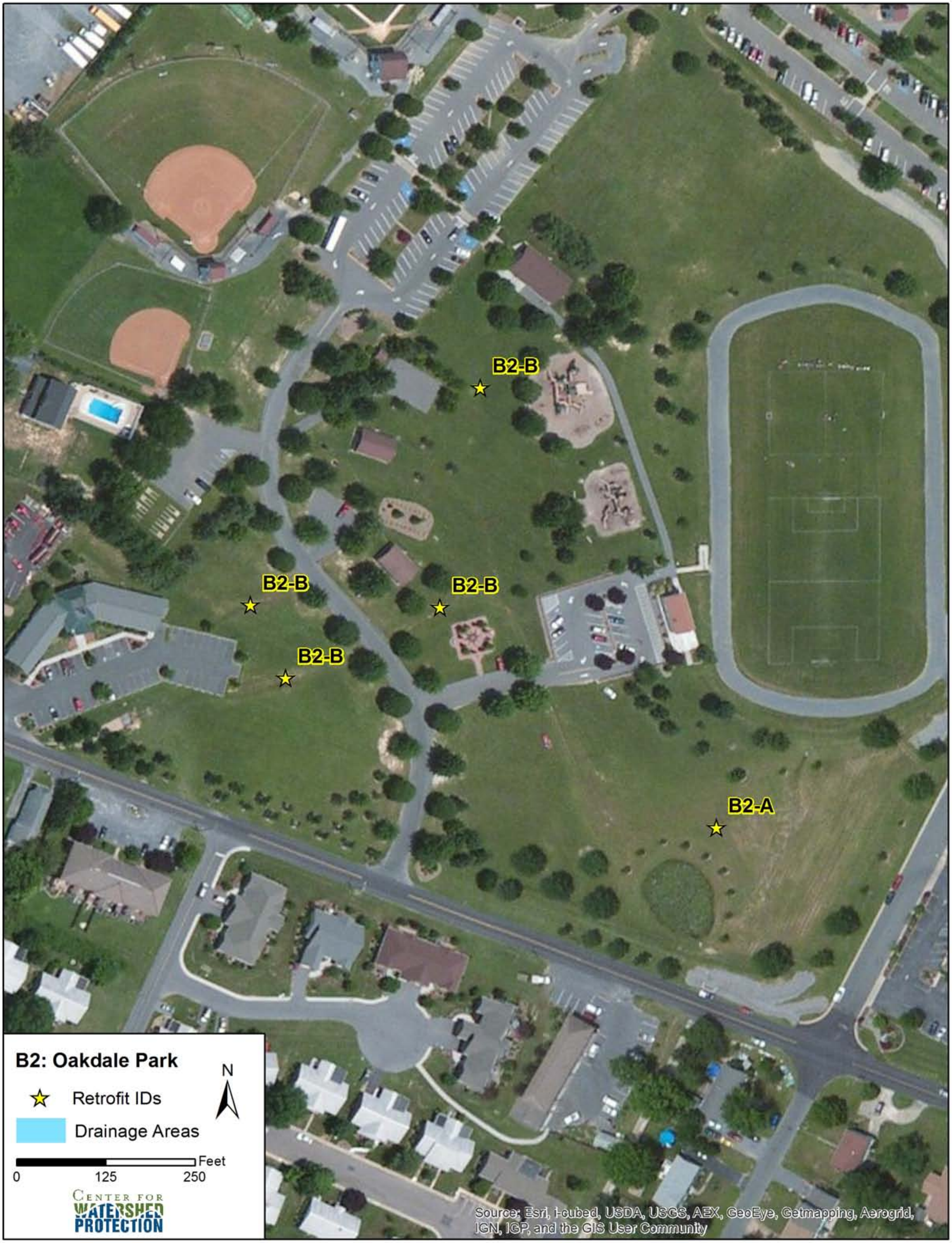
Description: A new wet retention pond with a sediment forebay (Figure 1) has been built to control runoff from a subdivision under development at Hollen Mill Court. Runoff enters the pond through a pipe inlet and by over-land flow down into the north side of the forebay. The slopes of the wet pond are steep and have turf grass that has not become fully established, but is mowed quite short (Figure 2).

The drainage area is approximately 40 acres and is expected to have an impervious area of about 6 acres when the subdivision is fully built out.

Proposed Solution: In order to reduce erosion on the steep slopes, a number of landscape maintenance changes can be made. The grass can be allowed to grow taller in between mowing the slopes to allow roots to become better established and deeper (to hold soil together). Soil compaction from frequent use of heavy mowers can make it harder for grass to grow, so consider using weed-eaters or light mowers.

Where runoff enters the forebay on the north side, grass could be kept especially tall so as to slow down the runoff and filter out more pollution. If owners are concerned about aesthetics, keep a smooth mowed edge to show purposeful delineation of the high-grass area.

B2: Oakdale Park


B2-B
B2-B
B2-B
B2-B
B2-A
B2: Oakdale Park
Retrofit IDs
Drainage Areas
N
Feet
0
125
250
CENTER FOR WATERSHED PROTECTION
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B2-A: Oakdale Park, Constructed Wetland

Score: 85

Rank: 1

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Small pond in SE corner of Park*

Figure 2: *Looking East from pond at earthen berm*

Figure 3: *Outlet pipe of pond, starting to rust out*

Figure 4: *Approximate area of proposed retrofit*

Description: The SE corner of Oakdale Park, at the corner of Mt. Crawford Avenue and Parkside Drive, has a broad grass area surrounded by an earthen berm (Figure 2 & 4). This 2.2-acre grass area serves as a flood control detention pond, capturing runoff from a 168-acre drainage area –primarily from above the park in several residential neighborhoods. At the lowest part of the detention pond is a small wet pond (Figure 1) with a corrugated metal pipe that serves as the only outlet pipe for the whole detention pond. Figure 3 shows that the bottom of the outlet pipe is starting to rust out and there is some erosion around it.

Proposed Retrofit: Given that the flat detention pond appears to stay fairly soggy, this may be a great area to convert to a constructed stormwater wetland. This type of practice would not only improve the pollution reduction capability of the stormwater practice, but could also serve as an attractive landscape and provide habitat to birds, butterflies, and other pollinators. The tall grasses may also deter geese, who prefer ponds surrounded by mowed grass. This retrofit would require (1) excavating variable ponding depths, (2) installing a variety of wetland plants, (3) and installing a new concrete outlet pipe (which would be more durable than corrugated metal).

B2-B: Oakdale Park, Ditches

Score: N/A

Rank: N/A

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Ditch from library parking lot*

Figure 2: *Pipe outfall and ditch on N. side of park*

Figure 3: *Some ditches hold water for longer*

Description: There are ditches/swales throughout Oakdale Park that currently are mowed (Figures 1 to 3). Since nearly all the park's runoff gets conveyed through these ditches, there could be an opportunity to use these to reduce pollution from stormwater runoff (especially nutrients).

Proposed Retrofit: Because short grass does not do much to filter stormwater, we propose that landscape crews allow grasses and other plants to grow taller in these ditches. Instead of mowing regularly, landscapers could mow or bushhog once or twice a year. This will allow roots to grow deeper which will also increase how much water the plants absorb and the nutrient-uptake of those plants. This is a fairly straightforward shift in landscape maintenance, but will require clear instructions (and perhaps signage) for the landscape crews and public who uses the park. Making this shift in conjunction with the constructed wetland retrofit, would continue the natural landscaping theme throughout the park. Because Oakdale Park is used by so many people in Bridgewater, if these retrofits are done well, they can serve as models for landscaping and good stormwater management to others in the community.

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:** B2-A

DATE: 3/20/13	**ASSESSED BY:** LW	**CAMERA ID:** C-ville	**PICTURES:** 3182-3186
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: Oakdale Park
Address:

Ownership: ☑ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☑ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☑ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☑ Existing Pond
- ☐ Above Roadway Culvert
- ☐ Below Outfall
- ☐ In Conveyance System
- ☐ In Road ROW
- ☐ Near Large Parking Lot
- ☐ Other:

On-Site
- ☐ Hotspot Operation
- ☐ Individual Rooftop
- ☐ Small Parking Lot
- ☐ Small Impervious Area
- ☐ Individual Street
- ☐ Landscape / Hardscape
- ☐ Underground
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 168 acres
Imperviousness ≈ 17% %
Impervious Area ≈ 28.56 acres

Notes: According to Bridgewater staff

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☑ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☑ Yes ☐ No ☐ Possible
If Yes, Describe:

$\boxed{\text{5180 s.f.}}$ → Wet pond (shallow) with CMP outlet through berm
- Very soggy in grass area surrounding pond (detention area)
- CMP pipe starting to corrode

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):

- This corner of park used as a stormwater detention area [total detention area ≈ 98,000 s.f.]
- berm surrounds detention basin area

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [ ] Recharge
- [ ] Channel Protection
- [ ] Flood Control
- [ ] Demonstration / Education
- [ ] Repair
- [ ] Other:

Retrofit Volume Computations - Target Storage:

Retrofit Volume Computations - Available Storage:

Proposed Retrofit Practice: (Runoff Reduction)
- [ ] Disconnection
- [ ] Bioretention
- [ ] Bio Swale
- [ ] Expanded Tree Pit
- [ ] Infiltration
- [ ] Green Roof
- [ ] Permeable Pavement
- [ ] Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
- [x] Constructed Wetland
- [ ] Wet Swale
- [ ] Wet Pond
- [ ] Filtering Practice
- [ ] Proprietary:
- [ ] Other:

Retrofit Category (as defined by Chesapeake Bay Program):
- [ ] New BMP
- [ ] BMP Enhancement
- [ ] BMP Restoration
- [x] BMP Conversion
- [ ] Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Convert stormwater detention area to a constructed wetland
- include multiple pools of variable depth – high marsh + low marsh
- meandering flow path between inlets and outlet
- diversity of plants

Improve outlet structure:
– Replace CMP with riser or concrete horizontal pipe w/ headwall

Available Width:	
Available Length:	
Available Area:	98,000 s.f.
Ponding Depth:	
Soil Depth:	

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [x] Park
- [ ] Undeveloped
- [ ] Other:

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [x] No

If Yes, Describe:

Access:
- [x] No Constraints

Constrained due to
- [ ] Slope
- [ ] Space
- [ ] Utilities
- [ ] Tree Impacts
- [ ] Structures
- [ ] Property Ownership
- [ ] Other:

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	[ ]	[ ]	[ ]	[x]
Water:	[ ]	[ ]	[ ]	[x]
Gas:	[ ]	[ ]	[ ]	[x]
Electric to Streetlights:	[ ]	[ ]	[x]	[ ]
Other:	[ ]	[ ]	[ ]	[ ]

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[ ] Probable	[x] Not Probable
Impacts to a Stream	[ ] Probable	[x] Not Probable
Floodplain Fill	[ ] Probable	[x] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[ ] Probable	[x] Not Probable

How many?

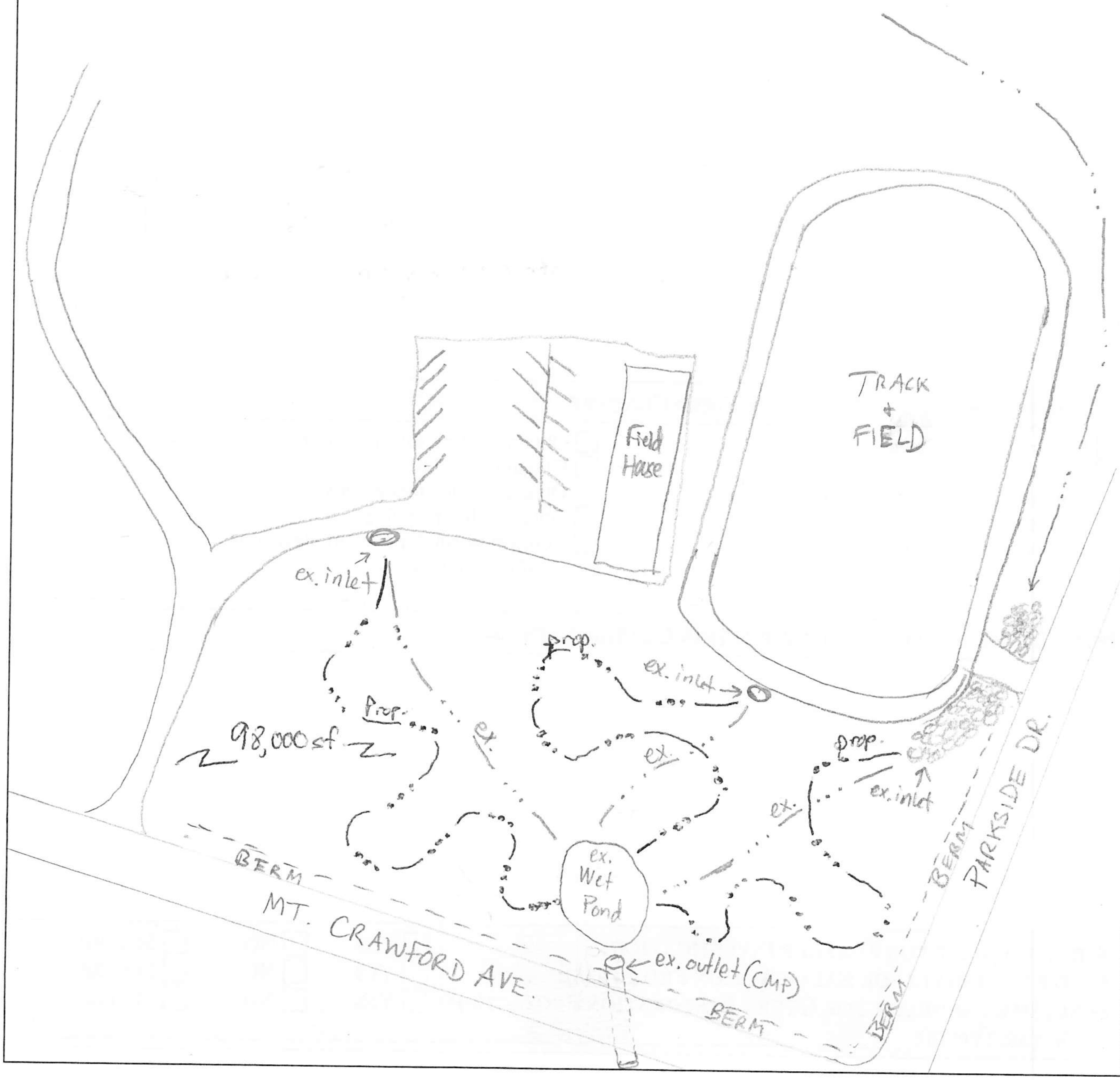
Approx. DBH

Other factors:

Soils:

Soil auger test holes:	[ ] Yes	[x] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[ ] No
Evidence of shallow bedrock:	[ ] Yes	[ ] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[ ] No

SKETCH


TRACK + FIELD
Field House
ex. inlet
prop.
ex. inlet
Prop.
ex.
98,000 sf
ex.
prop.
ex. inlet
ex.
ex. Wet Pond
BERM
MT. CRAWFORD AVE.
ex. outlet (CMP)
BERM
BERM
BERM
PARKSIDE DR.

Design or Delivery Notes

- Consider keeping existing trees and incorporating into wetland design
- assess hydrologic regime: Is site only soggy during certain times of year? Dry in summer?

Follow-up Needed to Complete Field Concept

- [ ] Confirm property ownership
- [ ] Confirm drainage area
- [ ] Confirm drainage area impervious cover
- [ ] Confirm volume computations
- [ ] Complete concept sketch
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [x] Obtain utility mapping
- [ ] Confirm storm drain invert elevations
- [x] Confirm soil types
- [ ] Other:

Initial Feasibility and Construction Considerations

- Check location of utilities

Site Candidate for Further Investigation: ☐ Yes ☐ No ☐ Maybe
Is Site Candidate for Early Action Project(s): ☐ Yes ☐ No ☐ Maybe
If No, Site Candidate for Other Restoration Project(s): ☐ Yes ☐ No ☐ Maybe
If yes, type(s):

Retrofit Reconnaissance Investigation
Updated: 3/13/2013

RRI

WATERSHED:	**SUBWATERSHED:**		**UNIQUE SITE ID:** B2-B
DATE:	**ASSESSED BY:** LW	**CAMERA ID:** Cville	**PICTURES:** 3187-3197
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: Oakdale Park - ditches
Address:

Ownership: ☐ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
☐ Existing Pond ☐ Above Roadway Culvert
☐ Below Outfall ☐ In Conveyance System
☐ In Road ROW ☐ Near Large Parking Lot
☐ Other:

On-Site
☐ Hotspot Operation ☐ Individual Rooftop
☐ Small Parking Lot ☐ Small Impervious Area
☐ Individual Street ☐ Landscape / Hardscape
☐ Underground ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈
Imperviousness ≈ %
Impervious Area ≈

Notes: See GIS

Drainage Area Land Use:
☐ Residential
☐ SFH (< 1 ac lots)
☐ SFH (> 1 ac lots)
☐ Townhouses
☐ Multi-Family
☐ Commercial
☐ Institutional
☐ Industrial
☐ Transport-Related
☐ Park
☐ Undeveloped
☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☐ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):

Open grass drainage ditches throughout Park

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:
☐ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☐ Demonstration / Education ☐ Repair ☐ Other:____________________

Retrofit Volume Computations - Target Storage:	**Retrofit Volume Computations - Available Storage:**

Proposed Retrofit Practice: (Runoff Reduction)
☐ Disconnection ☐ Bioretention ☐ Bio Swale
☐ Expanded Tree Pit ☐ Infiltration ☐ Green Roof
☐ Permeable Pavement ☐ Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
☐ Constructed Wetland ☑ Wet Swale ☐ Wet Pond
☐ Filtering Practice ☐ Proprietary:____________
☐ Other: ____________

Retrofit Category (as defined by Chesapeake Bay Program):
☐ New BMP ☐ BMP Enhancement ☐ BMP Restoration ☐ BMP Conversion ☐ Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Convert ditches throughout park to unmowed wet swales

Available Width:	
Available Length:	
Available Area:	
Ponding Depth:	
Soil Depth:	

SITE CONSTRAINTS

Adjacent Land Use:
☐ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☐ Undeveloped ☐ Other:____________
Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☐ No
If Yes, Describe:

Access:
☐ No Constraints
Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property
Ownership
☐ Other:____________

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	☐	☐	☐	☐
Water:	☐	☐	☐	☐
Gas:	☐	☐	☐	☐
Electric to Streetlights:	☐	☐	☐	☐
Other:	☐	☐	☐	☐

____

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☐ Not Probable
Impacts to Wetlands	☐ Probable	☐ Not Probable
Impacts to a Stream	☐ Probable	☐ Not Probable
Floodplain Fill	☐ Probable	☐ Not Probable
Impacts to Forests	☐ Probable	☐ Not Probable
Impacts to Specimen Trees	☐ Probable	☐ Not Probable

How many?__________
Approx. DBH__________

Other factors:____________________
____

Soils:

Soil auger test holes:	☐ Yes	☐ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

SKETCH

DESIGN OR DELIVERY NOTES

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

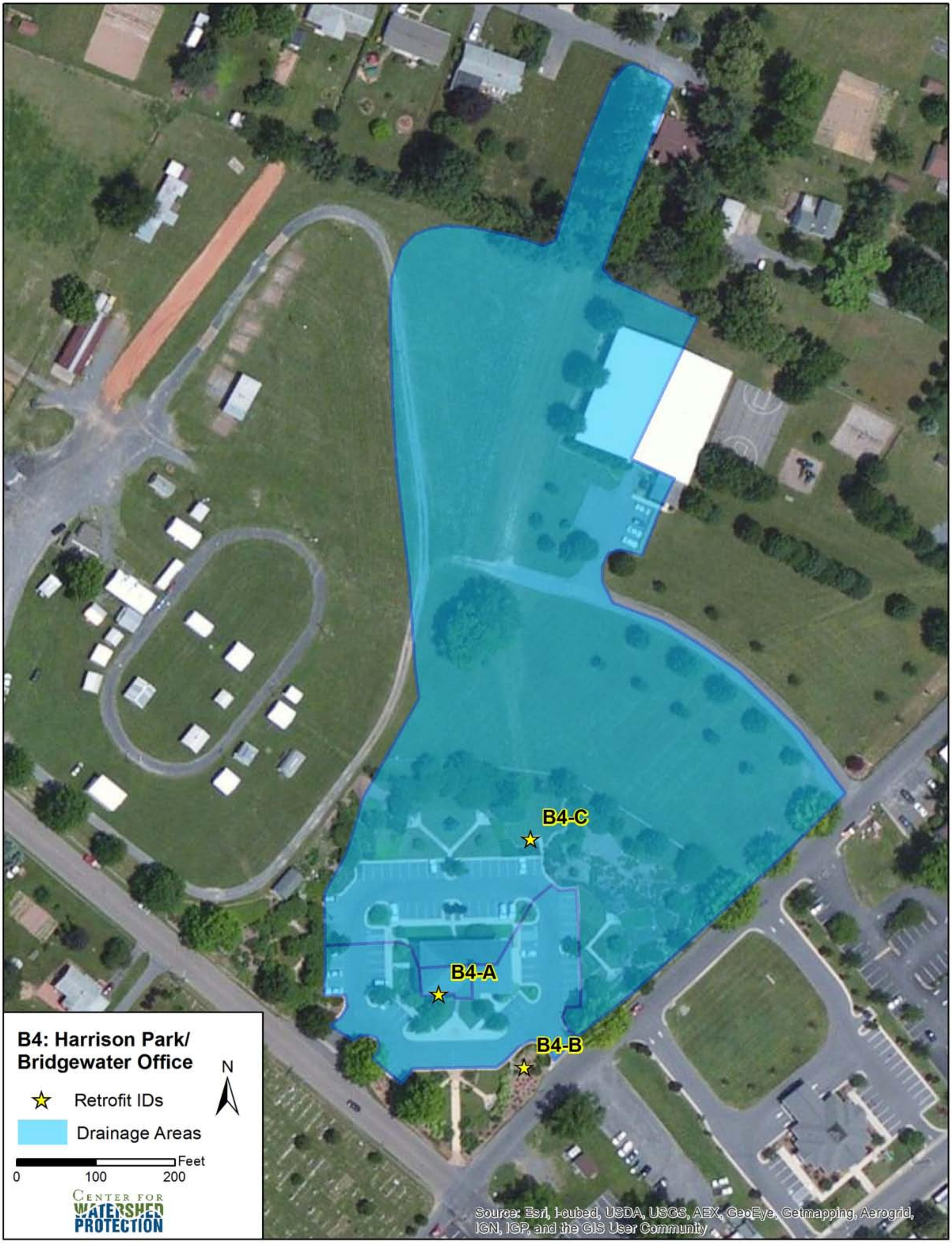
- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other:______________________________

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☐ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):______________________________

B4: Harrison Park/Bridgewater Office


B4-C
B4-A
B4-B
B4: Harrison Park/
Bridgewater Office
N
Retrofit IDs
Drainage Areas
Feet
0
100
200
Center for
Watershed
Protection
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B4-A: Bridgewater Office

Score: 30

Rank: 10

Investigators: David Nichols, John Ware, Lisa Fraley-McNeal

Figure 1: *Roof drains on southern side of office*

Description: Two roof drains located on the southern side of the Bridgewater office building drain a 0.03 acre portion of the rooftop (Figure 1). The roof drains are connected to the storm drain system.

Proposed Retrofit: This retrofit concept directs the two existing roof drains into a 3.5' by 30' stormwater planter located along the southern side of the building. Although the volume of runoff treated is minimal compared to the other proposed retrofits in the Town, the stormwater planter would provide a good demonstration project, as well as aesthetic value.

B4-B: Bridgewater Office

Score: 36

Rank: 9

Investigators: David Nichols, John Ware, Lisa Fraley-McNeal

Figure 1: *Inlet at landscaped area*

Figure 2: *Convert landscaped area to bioretention*

Figure 3: *Concrete flume and inlet draining N. Grove St.*

Description: An inlet at edge of the Bridgewater office parking lot and next to a landscaped area along N. Grove St. receives approximately 0.6 acres of parking lot and adjacent grass area runoff (Figure 1). The landscape area could be converted to bioretention (Figure 2).

Proposed Retrofit: This retrofit involves the conversion of the existing landscaped area between the parking lot and N. Grove St. to a 35' by 60' bioretention. The main constraint is whether there is a willingness to remove the existing landscaping. The parking lot drainage inlet would be blocked and the runoff directed into the practice. The underdrain can be tied into the existing inlet. Potential constraints include a utility pole and guy-wire, and relocation of one tree. In addition, there is a concrete flume draining N. Grove St. leading to an inlet within the landscaped area (Figure 3). However, where this inlet drains to could not be verified during the field assessment and should be further investigated. This proposed retrofit location is highly visible along a public street at the Bridgewater office and would provide a good demonstration project.

B4-C: Harrison Park / Bridgewater Office

Score: 75

Rank: 2

Investigators: David Nichols, John Ware, Lisa Fraley-McNeal

Figure 1: *Proposed bioretention location at existing inlet*

Description: Runoff from the northern parking lot at the Bridgewater office drains down a concrete channel and into an inlet in a depressional area next to the lot (Figure 1). This inlet also receives runoff from the adjacent grass area within the park, for a total drainage area of approximately 5.4 acres.

Proposed Retrofit: A 35' by 35' bioretention practice is proposed at the existing inlet adjacent to the parking lot. The concrete channel draining the parking lot could be converted into a step pool system. The existing inlet would be raised and serve as an emergency overflow. The underdrain would also be tied into this inlet. Although not as visible as the other proposed retrofits at the Bridgewater office, this retrofit has the potential to treat a larger drainage area.

RRI

WATERSHED:	SUBWATERSHED:	UNIQUE SITE ID: B4-A,B,C	
DATE: 3-19-13	ASSESSED BY:	CAMERA ID:	PICTURES: C=15-18
GPS ID:	LMK ID:	LAT:	LONG:

B=19-2
A=24-2

SITE DESCRIPTION

Name: HARRISON PARK / Bridgewater Office
Address: 201 GREEN STREET

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☒ Small Parking Lot
- ☒ Individual Street
- ☐ Underground
- ☒ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ (a) 0.03 (b) 0.61 (c) 5.41 ac
Imperviousness ≈ (a) 100% (b) 87% (c) 17%
Impervious Area ≈ (a) 0.03 (b) 0.53 (c) 0.90 ac

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☒ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☒ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):

A - EXISTING ROOF DRAINS x2; GRASS SLOPE, IRRIGATION INSTALLED; FLOOD LIGHTS
B - EXISTING DI AT PARKING LOT AND AT EDGE OF ROAD; EXISTING LANDSCAPED AREA; UTILITY POLE AND GUY-WIRE; ONE TREE; PUBLIC STREET. IRRIGATION SYSTEM
C - PAVED FLUME; DI; EDGE OF PARKING LOT; LANDSCAPED AREA, GRASS AREA; IRRIGATION SYSTEM

Existing Head Available:
A - 3 1/6' Planter box
B - 8.5' measured from manhole rim to invert
C - 4' measured from grate to invert.

Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [x] Demonstration / Education
- [ ] Recharge
- [ ] Repair
- [ ] Channel Protection
- [ ] Other:
- [ ] Flood Control

Retrofit Volume Computations - Target Storage:	**Retrofit Volume Computations - Available Storage:**
A) 103 ft³	A) 107 ft³
B) 1892 ft³	B) 1895 ft³
C) 6705 ft³	C) 1790 ft³

Proposed Retrofit Practice: (Runoff Reduction)
- [ ] Disconnection
- [x] Bioretention
- [ ] Bio Swale
- [ ] Expanded Tree Pit
- [ ] Infiltration
- [ ] Green Roof
- [ ] Permeable Pavement
- [x] Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
- [ ] Constructed Wetland
- [ ] Wet Swale
- [ ] Wet Pond
- [ ] Filtering Practice
- [ ] Proprietary:
- [ ] Other:

Retrofit Category (as defined by Chesapeake Bay Program):
- [x] New BMP
- [ ] BMP Enhancement
- [ ] BMP Restoration
- [ ] BMP Conversion
- [ ] Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

A - Direct 2 existing roof drains into a stormwater planter
B. Create bioretention in existing landscaped area
C. Create bioretention at existing inlet located in depressional area adjacent to corner of parking lot

	BMP - A	BMP - B	BMP - C
Available Width:	3.5'	35'	35'
Available Length:	30'	60'	35'
Available Area:	105 ft²	2100 ft²	1225 ft²
Ponding Depth:	1'	1'	1'
Soil Depth:	18"	30"	24"

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [x] Transport-Related
- [x] Park
- [ ] Undeveloped
- [ ] Other:

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [x] No
If Yes, Describe:

Access:
- [x] No Constraints

Constrained due to
- [ ] Slope
- [ ] Space
- [ ] Utilities
- [ ] Tree Impacts
- [ ] Structures
- [ ] Property

Ownership
- [ ] Other:

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	[ ]	[ ]	[x]	[ ]
Water:	[ ]	[x]	[ ]	[ ]
Gas:	[ ]	[ ]	[x]	[ ]
Electric to Streetlights:	[ ]	[ ]	[x]	[ ]
Other:	[ ]	[ ]	[ ]	[ ]

Potential Permitting Factors:

	Probable	Not Probable
Dam Safety Permits Necessary	[ ]	[x]
Impacts to Wetlands	[ ]	[x]
Impacts to a Stream	[ ]	[x]
Floodplain Fill	[ ]	[x]
Impacts to Forests	[ ]	[x]
Impacts to Specimen Trees	[ ]	[x]

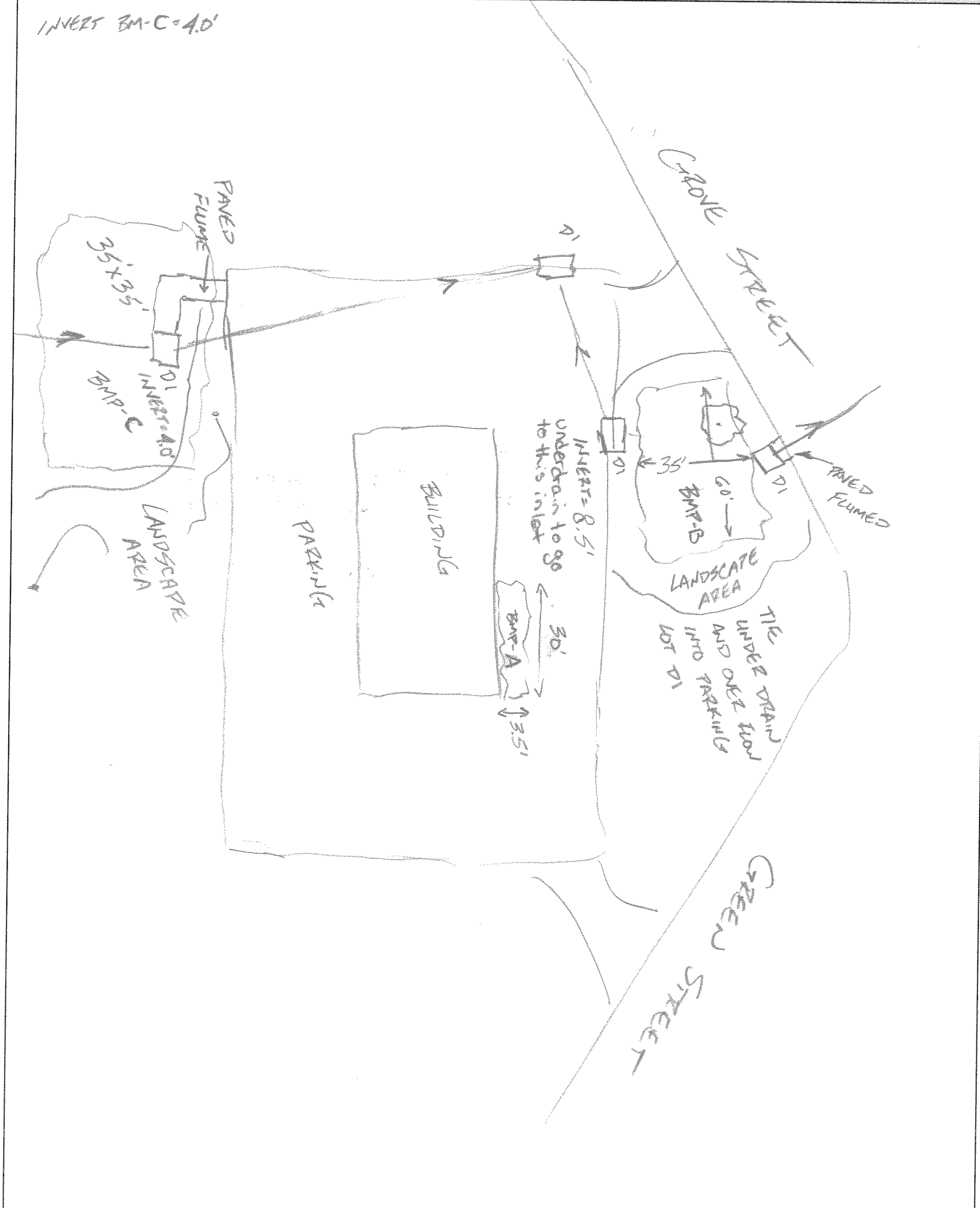
How many?
Approx. DBH

Other factors:

Soils:

	Yes	No
Soil auger test holes:	[ ]	[x]
Evidence of poor infiltration (clays, fines):	[ ]	[x]
Evidence of shallow bedrock:	[ ]	[x]
Evidence of high water table (gleying, saturation):	[ ]	[x]

SKETCH



Unique Site ID: B4-A,B,C

DESIGN OR DELIVERY NOTES

B4-A - 3½' above ground planter

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☒ Confirm drainage area impervious cover
- ☒ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other:

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

B - VERIFY FUNCTION OF DI AT EDGE OF ROAD; UTILITY POLE AND GUY-WIRE, EXISTING LANDSCAPED AREA, WHICH WILL BE REMOVED

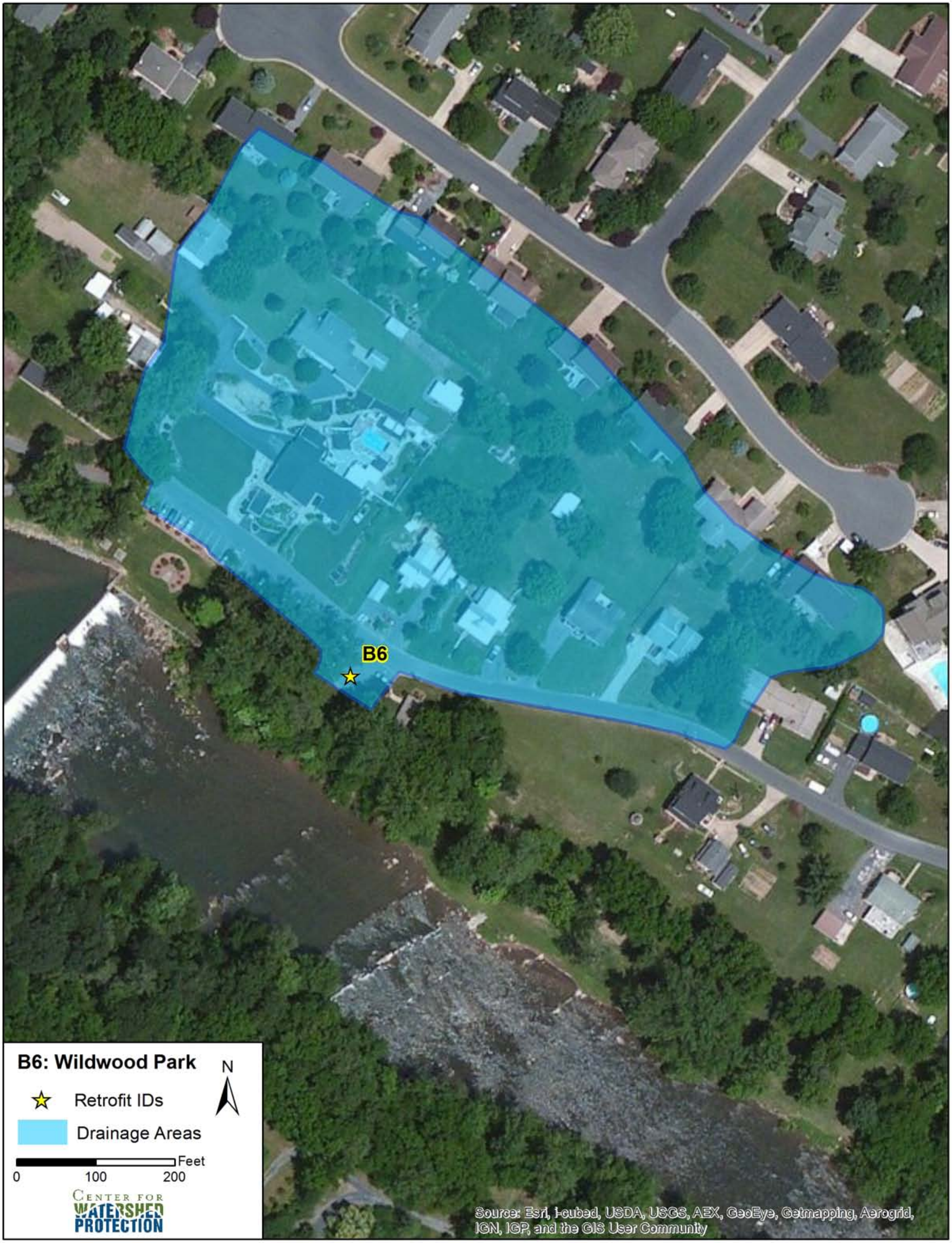
C - TAKE OUT PAVED FLUME AND INCORPORATE STEP POOL SYSTEM

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☐ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):

Unique Site ID: B4-A, B, C

B6: Wildwood Park


B6
B6: Wildwood Park
N
Retrofit IDs
Drainage Areas
Feet
0
100
200
Center for Watershed Protection
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B6: Wildwood Park

Score: 75

Rank: 3

Investigators: David Nichols, John Ware, Lisa Fraley-McNeal

Figure 1: *Convert this parking area to bioretention*

Figure 2: *Concrete channel to North River*

Description: Approximately 5.6 acres of residential and park parking lot runoff drains to corner of the eastern-most parking area in Wildwood Park near the pavilion (Figure 1). Runoff currently drains down a concrete channel and to the North River (Figure 2). This is a high-traffic area due to park visitors.

Proposed Retrofit: This retrofit concept converts the existing eastern-most parking area with 10 parking spaces and a small island into a 50' by 75' bioretention. The main constraint would be the removal of parking spaces. The traffic flow should be investigated to determine how heavily utilized this parking area is and if the removal of the 10 parking spaces is feasible. About 20 parking spaces would remain, which may be sufficient. In addition, relocation of a handicap parking space in the proposed area would be needed. The existing concrete channel can be utilized as an overflow structure, or could be redesigned to a grass swale or step pool channel down to the North River. This retrofit would be a good candidate for a demonstration project due to high visibility within the park. Ponding depth would be limited to 6" for safety considerations in this high-traffic area.

Retrofit Reconnaissance Investigation
Updated: 3/13/2013

RRI

WATERSHED: North River	**SUBWATERSHED:**		**UNIQUE SITE ID:** B6
DATE: 3/19/13	**ASSESSED BY:** LFM David, John	**CAMERA ID:** Red Olympus	**PICTURES:** 1-5
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: Wildwood Park
Address:

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☒ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☒ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 5.6 ac
Imperviousness ≈ 40% %
Impervious Area ≈ 2.25 ac

Notes:

Drainage Area Land Use:
- ☒ Residential
  - ☒ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):

Parking lot and roadway drainage to corner of parking lot, down concrete culvert and to N. River.

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [x] Demonstration / Education
- [ ] Recharge
- [ ] Repair
- [ ] Channel Protection
- [ ] Other: ______
- [ ] Flood Control

Retrofit Volume Computations - Target Storage:
10,434 ft^3

Retrofit Volume Computations - Available Storage:
4829 ft^3

Proposed Retrofit Practice: (Runoff Reduction)
- [ ] Disconnection
- [x] Bioretention
- [ ] Bio Swale
- [ ] Expanded Tree Pit
- [ ] Infiltration
- [ ] Green Roof
- [ ] Permeable Pavement
- [ ] Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
- [ ] Constructed Wetland
- [ ] Wet Swale
- [ ] Wet Pond
- [ ] Filtering Practice
- [ ] Proprietary: ______
- [ ] Other: ______

Retrofit Category (as defined by Chesapeake Bay Program):
- [x] New BMP
- [ ] BMP Enhancement
- [ ] BMP Restoration
- [ ] BMP Conversion
- [ ] Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:
Create bioretention in existing eastern-most parking area. The bioretention will need to be placed where there are currently 10 parking spaces and a small island.

Available Width:	50'
Available Length:	75'
Available Area:	3750 ft^2
Ponding Depth:	6"
Soil Depth:	24"

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [x] Park
- [ ] Undeveloped
- [ ] Other: ______

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [x] No
If Yes, Describe:

Access:
- [x] No Constraints

Constrained due to
- [ ] Slope
- [ ] Space
- [ ] Utilities
- [ ] Tree Impacts
- [ ] Structures
- [ ] Property

Ownership
- [ ] Other: ______

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	[ ]	[ ]	[x]	[ ]
Water:	[ ]	[ ]	[x]	[ ]
Gas:	[ ]	[ ]	[x]	[ ]
Electric to Streetlights:	[ ]	[ ]	[x]	[ ]
Other:	[ ]	[ ]	[ ]	[ ]

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[ ] Probable	[x] Not Probable
Impacts to a Stream	[ ] Probable	[x] Not Probable
Floodplain Fill	[ ] Probable	[x] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[ ] Probable	[x] Not Probable

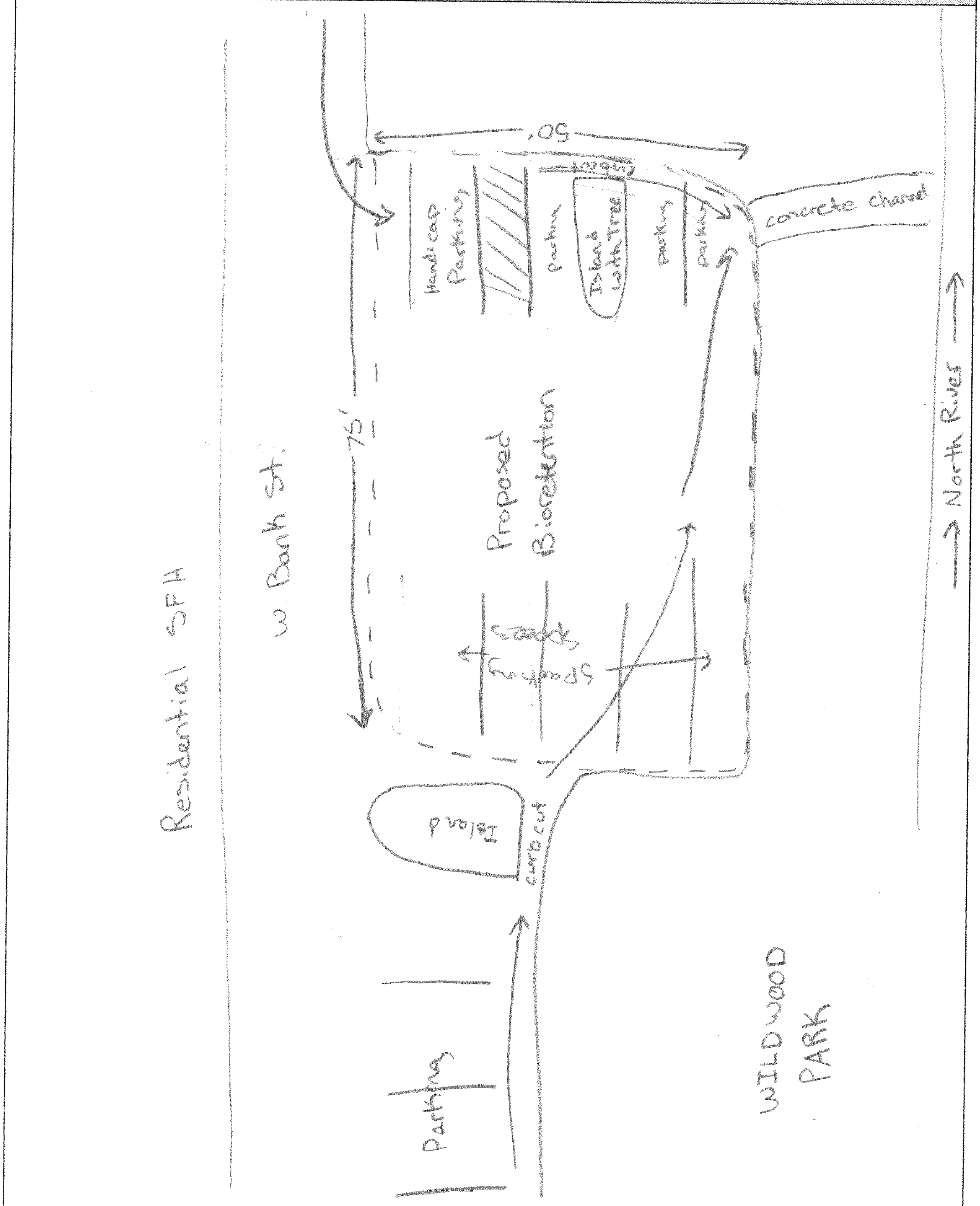
How many? ______
Approx. DBH ______

Other factors: ______

Soils:

Soil auger test holes:	[ ] Yes	[x] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[x] No
Evidence of shallow bedrock:	[ ] Yes	[x] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[x] No

SKETCH



Unique Site ID: B6

DESIGN OR DELIVERY NOTES

Examine traffic flows to see how heavily utilized the parking area is. Need to determine if the removal of 10 parking spaces is feasible. Relocation of a handicap parking space would also be needed.
Utilize the existing concrete channel as the overflow or potentially redesign to a grass swale or step pool channel down to North River.

*Need to measure head to determine the depth of the bioretention possible and where the underdrain would be located. Assumed a 4' head measurement for preliminary calculations.

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- [ ] Confirm property ownership
- [x] Confirm drainage area
- [x] Confirm drainage area impervious cover
- [ ] Confirm volume computations
- [ ] Complete concept sketch
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [x] Obtain utility mapping
- [ ] Confirm storm drain invert elevations
- [ ] Confirm soil types
- [ ] Other: ______

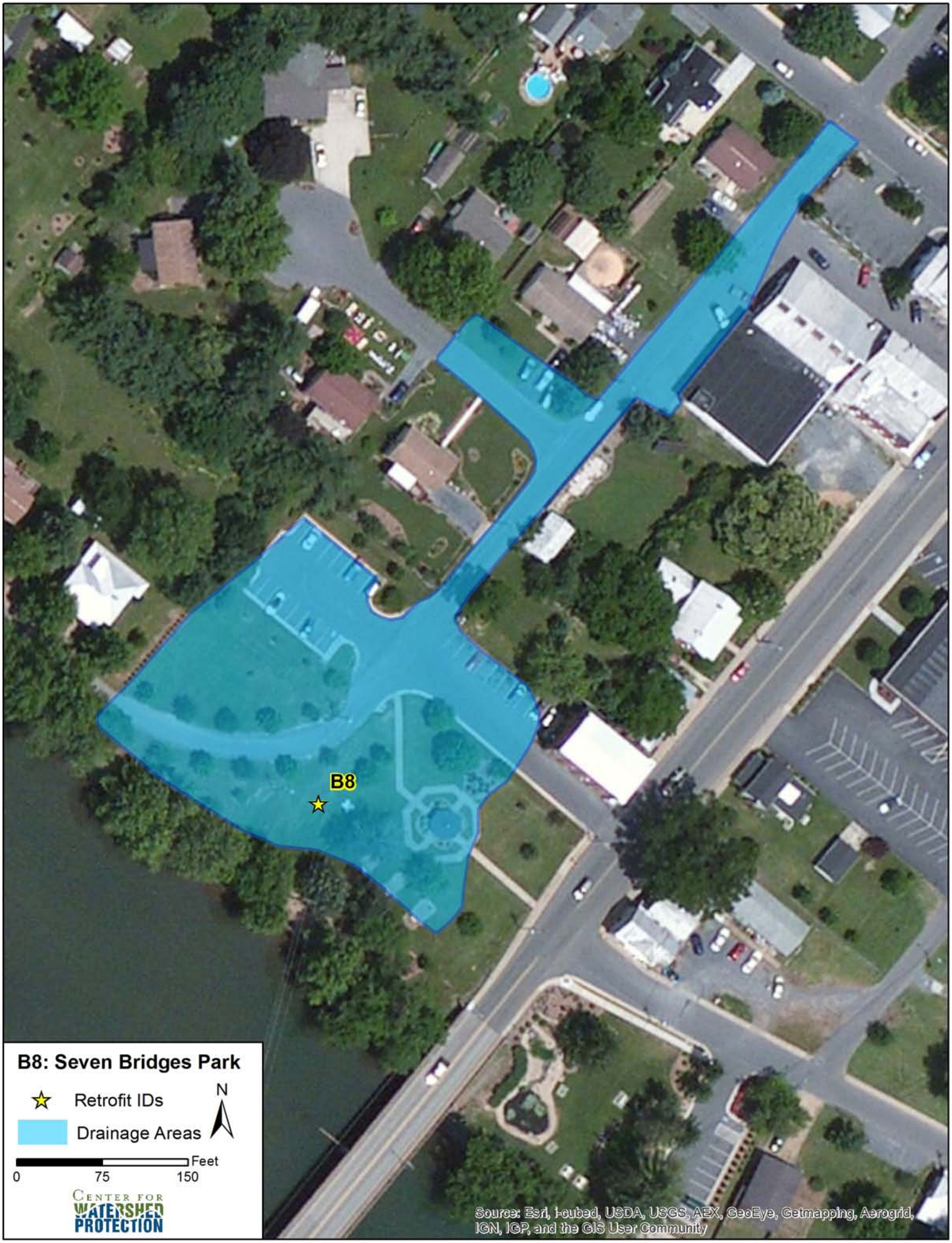
INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

Good candidate for demonstration project
Main constraint will be the removal of parking spaces.

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☐ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S): ______

B8: Seven Bridges Park


B8
B8: Seven Bridges Park
Retrofit IDs
Drainage Areas
N
Feet
0
75
150
CENTER FOR WATERSHED PROTECTION
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B8: Seven Bridges Park

Score: 46

Rank: 7

Investigators: David Nichols, John Ware, Lisa Fraley-McNeal

Figure 1: *Convert this area into bioretention*

Description: Approximately 1.5 acres of street and parking lot runoff drains to Seven Bridges Park near the North River. This is a high-traffic area that is utilized frequently to launch canoes into the river (Figure 1).

Proposed Retrofit: This retrofit concept converts the grass area between S. Grove St. and the gazebo into a 30' by 40' bioretention. The inlet on the corner of S. Grove St. and W. Riverside Dr. would need to be blocked and runoff directed into the practice. Potential utility conflicts include overhead electric lines, including a pole and guy-wire. This retrofit would be a good demonstration project and could include a bridge over the bioretention so that foot traffic for canoe launching is not hindered. In addition, the ponding depth would be limited to 6" for safety consideration due to the heavy use of the park.

RRI

WATERSHED: North River	**SUBWATERSHED:**		**UNIQUE SITE ID:** B8
DATE: 3-19-13	**ASSESSED BY:** PEN	**CAMERA ID:**	**PICTURES:** 6-14
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: SEVEN BRIDGES PARK
Address: 201 WEST RIVERSIDE DRIVE

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☒ Other: GRASS PARK LAND

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 1.4 ac
Imperviousness ≈ 57% %
Impervious Area ≈ 0.8 ac

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☒ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☒ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☒ Transport-Related
- ☒ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable): PARKING LOT; PAVED STREETS; UNDERGROUND STORM SYSTEM; PARK LAND; DRAINING TO NORTH RIVER; EXISTING UTILITIES (OVERHEAD LINES WITH POLE AND GUY-WIRES) MAY BE IN THE WAY; THIS AREA IS THE UNOFFICIAL CANOE LAUCHING SITE;

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:
☒ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☒ Demonstration / Education ☐ Repair ☐ Other:

Retrofit Volume Computations - Target Storage:
3238 ft^3

Retrofit Volume Computations - Available Storage:
1324 ft^3

Proposed Retrofit Practice: (Runoff Reduction)
☐ Disconnection ☒ Bioretention ☐ Bio Swale
☐ Expanded Tree Pit ☐ Infiltration ☐ Green Roof
☐ Permeable Pavement ☐ Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
☐ Constructed Wetland ☐ Wet Swale ☐ Wet Pond
☐ Filtering Practice ☐ Proprietary:
☐ Other:

Retrofit Category (as defined by Chesapeake Bay Program):
☒ New BMP ☐ BMP Enhancement ☐ BMP Restoration ☐ BMP Conversion ☐ Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:
BIO-RETENTION; DIRECT EXISTING STORM PIPE INTO BMP

Available Width:	30'
Available Length:	40'
Available Area:	1200 ft^2
Ponding Depth:	6"
Soil Depth:	18"

← safety depth since practice would be located in Park

SITE CONSTRAINTS

Adjacent Land Use:
☒ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☒ Transport-Related ☒ Park
☐ Undeveloped ☐ Other:

Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☒ No
If Yes, Describe:

Access:
☒ No Constraints
Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property
Ownership
☐ Other:

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	☐	☐	☒	☐
Water:	☐	☐	☒	☐
Gas:	☐	☐	☒	☐
Electric to Streetlights:	☐	☒	☐	☐
Other:	☐	☐	☐	☐

POLE AND GUY-WIRE

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☒ Not Probable
Impacts to Wetlands	☐ Probable	☒ Not Probable
Impacts to a Stream	☐ Probable	☒ Not Probable
Floodplain Fill	☐ Probable	☒ Not Probable
Impacts to Forests	☐ Probable	☒ Not Probable
Impacts to Specimen Trees	☐ Probable	☒ Not Probable

How many?
Approx. DBH

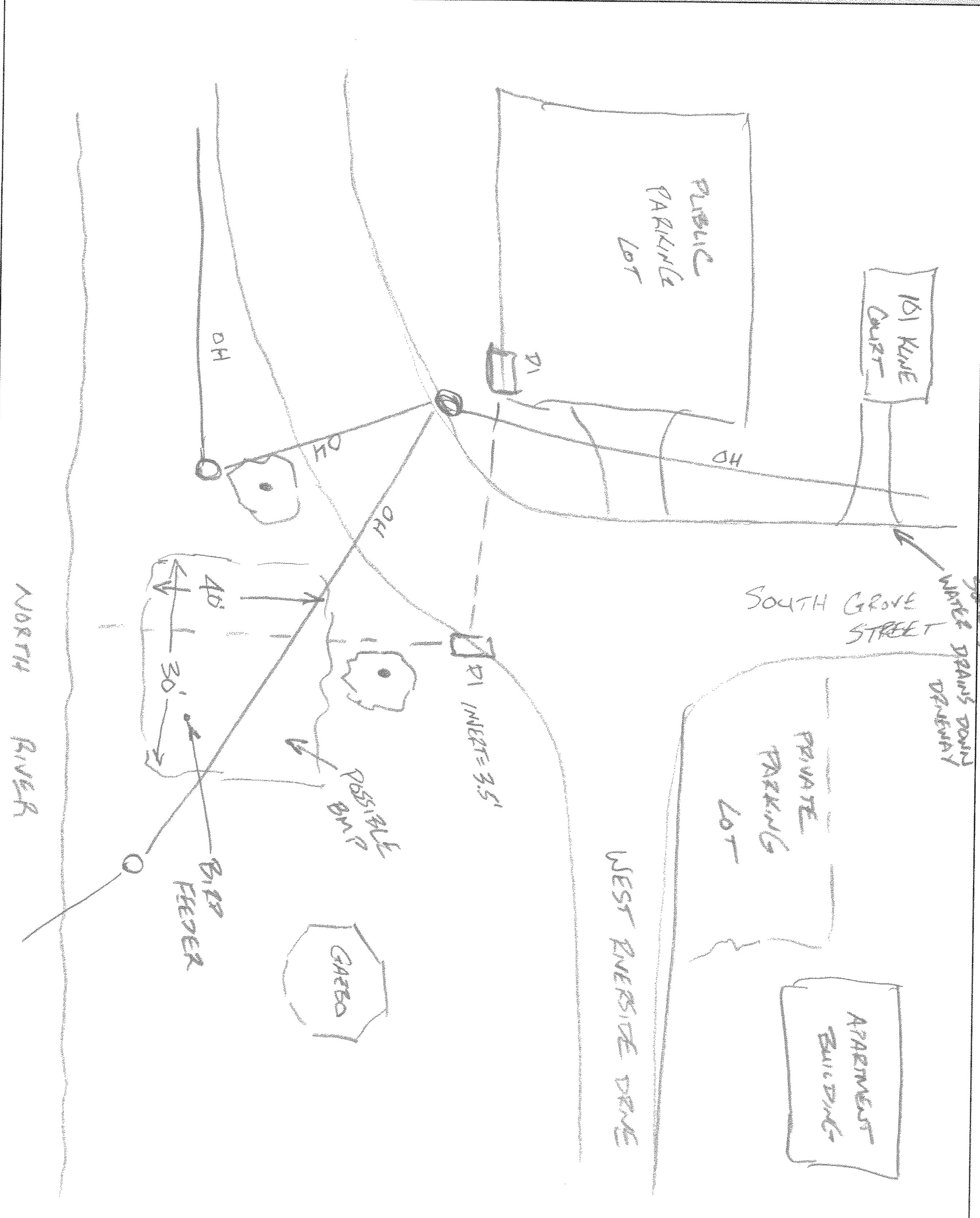
Other factors:

Soils:

Soil auger test holes:	☐ Yes	☒ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☒ No
Evidence of shallow bedrock:	☐ Yes	☒ No
Evidence of high water table (gleying, saturation):	☐ Yes	☒ No

 Unique Site ID: B8

SKETCH


PUBLIC PARKING LOT
101 KLINE COURT
DI
OH
OH
OH
OH
SOUTH GROVE STREET
SOME STORM WATER DRAINS DOWN DRIVEWAY
PRIVATE PARKING LOT
WEST RIVERSIDE DRIVE
APARTMENT BUILDING
NORTH RIVER
40'
30'
DI INVERT= 3.5'
POSSIBLE BMP
BIRD FEEDER
GAZEBO

DESIGN OR DELIVERY NOTES

Need to measure available head. For preliminary calculations, assumed 4' of head available

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☒ Confirm drainage area impervious cover
- ☒ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other:

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

GOOD DEMONSTRATION PROJECT BECAUSE OF VISABILITY; POSSIBLE BRIDGE OVER BMP FOR FOOT TRAFFIC

SITE CANDIDATE FOR FURTHER INVESTIGATION: ☐ YES ☐ NO ☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE
IF YES, TYPE(S):

B10: Wynant & Bank Street Park


B10
B10: Wynant & Bank Street Park
Retrofit IDs
Drainage Areas
N
Feet
0
100
200
Center for Watershed Protection
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B10: Wynant and Bank Street Park

Score: 59

Rank: 5

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Install bioretention in low grass area*

Figure 2: *Overflow grate inlet in front of culvert*

Description: This small public park is located in a residential neighborhood of single-family homes and contains a playground and a small, mowed open space with trees of various sizes. A 6-foot deep storm drain catch basin with a grate inlet is located at the southwest end of the park.

Proposed Retrofit: The recommended retrofit is to install a bioretention practice approximately 70’ long and 30’ wide adjacent and just to the north of the grate inlet. Since there is plenty of elevation difference between the grass surface and the bottom of the catch basin, the bioretention profile can be deep: allow for 12” of ponding depth, 24” of bioretention soil mix, and 24” of gravel in which to set a perforated underdrain pipe. The underdrain can be tied directly into the existing catch basin to allow water that has filtered down through the bioretention profile to escape. The existing grate inlet can serve as the emergency overflow for excess water from larger storm events.

Caution should be taken to keep the bioretention footprint out of drip-line of nearby trees so as not to stress tree roots during excavation. The existing soil consists of compacted and rocky clay loam, so on-site soils should definitely not be used in the bioretention soil mix.

WATERSHED:	**SUBWATERSHED:**		**UNIQUE SITE ID:** R10
DATE: 3/20/13	**ASSESSED BY:** LW	**CAMERA ID:** C-ville	**PICTURES:** 3162-3166
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: Wynant + Bank St. Park
Address:

Ownership: ☑ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☑ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☑ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
☐ Existing Pond ☐ Above Roadway Culvert
☐ Below Outfall ☐ In Conveyance System
☐ In Road ROW ☐ Near Large Parking Lot
☐ Other:

On-Site
☐ Hotspot Operation ☐ Individual Rooftop
☐ Small Parking Lot ☐ Small Impervious Area
☐ Individual Street ☑ Landscape / Hardscape
☐ Underground ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 3.5 acres
Imperviousness ≈ 25 %
Impervious Area ≈ 0.89

Notes:

Drainage Area Land Use:
☑ Residential
☐ SFH (< 1 ac lots)
☐ SFH (> 1 ac lots)
☐ Townhouses
☐ Multi-Family
☐ Commercial
☐ Institutional
☐ Industrial
☐ Transport-Related
☑ Park
☐ Undeveloped
☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☑ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable): N/A

- Swale through park eventually drains into a grate inlet at southern end of park
- Drainage area comprised of sheetflow from several adjacent homes and streets

Existing Head Available:

6 feet

Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)

From top of grate to invert of conveyance pipe

PROPOSED RETROFIT

Purpose of Retrofit:
- [x] Water Quality
- [x] Demonstration / Education
- [ ] Recharge
- [ ] Repair
- [ ] Channel Protection
- [ ] Other:
- [ ] Flood Control

Retrofit Volume Computations - Target Storage:

Retrofit Volume Computations - Available Storage:

Proposed Retrofit Practice: (Runoff Reduction)
- [ ] Disconnection
- [x] Bioretention
- [ ] Bio Swale
- [ ] Expanded Tree Pit
- [ ] Infiltration
- [ ] Green Roof
- [ ] Permeable Pavement
- [ ] Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
- [ ] Constructed Wetland
- [ ] Wet Swale
- [ ] Wet Pond
- [ ] Filtering Practice
- [ ] Proprietary:
- [ ] Other:

Retrofit Category (as defined by Chesapeake Bay Program):
- [x] New BMP
- [ ] BMP Enhancement
- [ ] BMP Restoration
- [ ] BMP Conversion
- [ ] Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

- Construct bioretention at southern end of park around grate inlet
- Very visible location to neighborhood residents
- Include underdrain + connect to grate inlet

Available Width:	~30'
Available Length:	~70'
Available Area:	
Ponding Depth:	0.5'-1'
Soil Depth:	2'-3'

SITE CONSTRAINTS

Adjacent Land Use:
- [x] Residential
- [ ] Commercial
- [ ] Institutional
- [ ] Industrial
- [ ] Transport-Related
- [ ] Park
- [ ] Undeveloped
- [ ] Other:

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [ ] No

If Yes, Describe:

Access:
- [x] No Constraints

Constrained due to
- [ ] Slope
- [ ] Space
- [ ] Utilities
- [ ] Tree Impacts
- [ ] Structures
- [ ] Property

Ownership
- [ ] Other:

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	[ ]	[ ]	[x]	[ ]
Water:	[ ]	[ ]	[x]	[ ]
Gas:	[ ]	[ ]	[x]	[ ]
Electric to Streetlights:	[ ]	[ ]	[x]	[ ]
Other:	[ ]	[ ]	[ ]	[ ]

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[ ] Probable	[x] Not Probable
Impacts to a Stream	[ ] Probable	[x] Not Probable
Floodplain Fill	[ ] Probable	[x] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[ ] Probable	[x] Not Probable

How many?

Approx. DBH

Other factors:

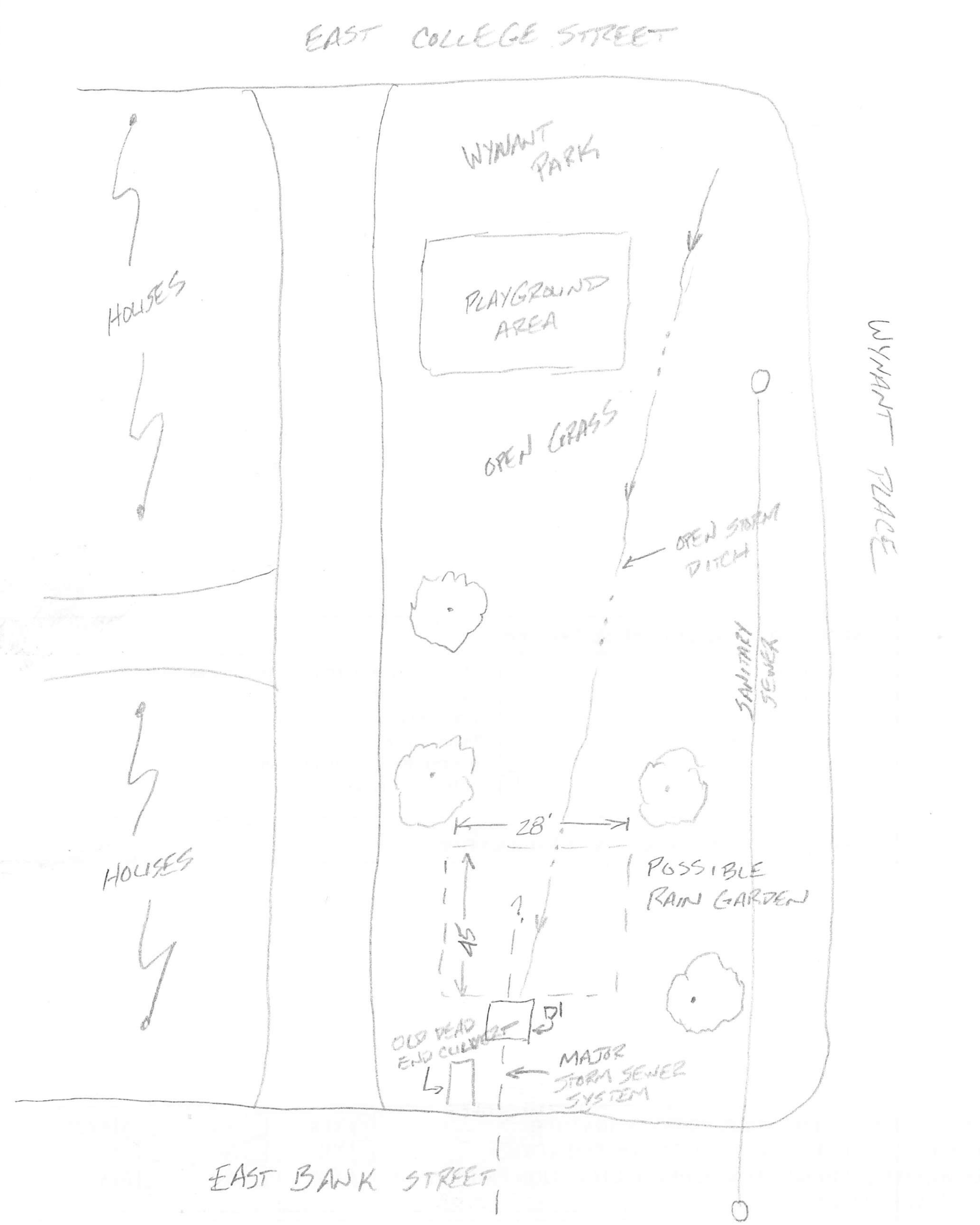
Soils:

Soil auger test holes:	[x] Yes	[ ] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[x] No
Evidence of shallow bedrock:	[ ] Yes	[x] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[x] No

- Clay loam, with lots of rock
- couldn't get auger more than 4" down

Unique Site ID: B10

SKETCH


EAST COLLEGE STREET
WYNANT PARK
PLAYGROUND AREA
HOUSES
OPEN GRASS
WYNANT PLACE
OPEN STORM DITCH
SANITARY SEWER
28'
45
?
POSSIBLE RAIN GARDEN
HOUSES
3'
OLD DEAD END CULVERT
MAJOR STORM SEWER SYSTEM
EAST BANK STREET

DESIGN OR DELIVERY NOTES

- Aesthetics important since the retrofit would be quite visible
- Stay away from tree roots as best as possible

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

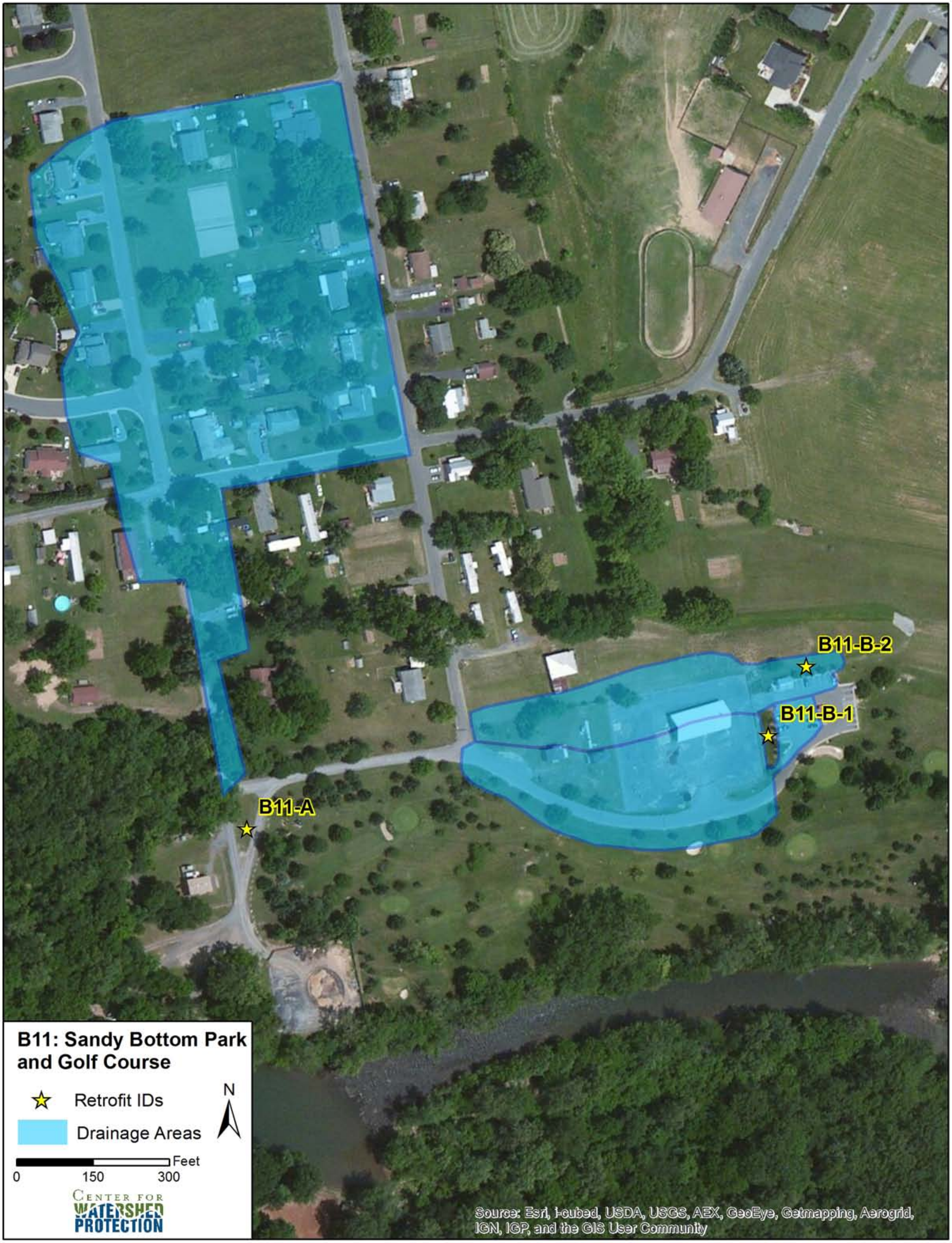
- [ ] Confirm property ownership
- [x] Confirm drainage area
- [ ] Confirm drainage area impervious cover
- [x] Confirm volume computations
- [ ] Complete concept sketch
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [ ] Obtain utility mapping
- [ ] Confirm storm drain invert elevations
- [ ] Confirm soil types
- [ ] Other:

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

SITE CANDIDATE FOR FURTHER INVESTIGATION:	[x] YES	[ ] NO	[ ] MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	[ ] YES	[ ] NO	[x] MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	[ ] YES	[ ] NO	[ ] MAYBE

IF YES, TYPE(S):

B11: Sandy Bottom Park and Golf Course


B11-B-2
B11-B-1
B11-A
B11: Sandy Bottom Park and Golf Course
Retrofit IDs
Drainage Areas
N
Feet
0
150
300
Center for Watershed Protection
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B11-A: Sandy Bottom – Riverside Drive

Score: 72

Rank: 4

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Ponded area in front of pump station*

Figure 2: *Convert this area into wetland*

Description: Approximately 7 acres of street and residential lot runoff drains to the lower end of E. Riverside Drive near the North River. This retrofit would be located across the road from the water pump station owned by the City of Harrisonburg. Runoff currently drains to and ponds in a triangular grass median in front of the pump station (Figure 1).

Proposed Retrofit: This retrofit concept converts the grass median, the diagonal gravel access road (which can be spared), and some of the grass border area just to the east into a constructed wetland with a sediment forebay at the head (Figure 2). This area would need to be dug down to allow for deeper storage of runoff (about 12" deep) and a culvert should be installed to convey stormwater collected in the open ditches along Riverside Drive into the forebay. No storm drain pipes exist in the area, so a long overflow pipe may need to be installed to carry excess water from the practice down to the river to avoid flooding the road.

B11-B: Sandy Bottom – Golf Course

Score: 58

Rank: 6

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Grass swale on west side of parking lot*

Figure 2: *Grass swale behind restroom building*

Figure 3: *View of maintenance building area from behind restroom*

Description: Runoff from the golf course parking lot as well as runoff from the nearby maintenance building and gravel lot (Figure 3) collects in two mowed grass swales (Figures 1 and 2) that are connected to each other with a culvert. This runoff eventually drains through a mowed area and then enters the North River. Water seems to stay ponded in the swale on the western side of the parking lot.

Proposed Retrofit: Since the groundwater table is likely high here and the soils stay fairly wet (due to its close proximity to the river), this may be a suitable area for converting the two mowed grass swales to "wet swales" with wetland vegetation. In the western swale, this retrofit would just entail planting water-loving plants and reduce the frequency of mowing. Behind the restrooms, some excavation could be done to create a wider, flatter swale where water can pond up for longer. Wetland plants should be planted here. The saturated soil and wetland vegetation of wet swales provide an ideal environment for settling out dirt, breaking down oils, and taking up excess nutrients.

Retrofit Reconnaissance Investigation **RRI**
Updated: 3/13/2013

WATERSHED:	SUBWATERSHED:	UNIQUE SITE ID: B11-A

DATE: 3/20/13	ASSESSED BY: LW	CAMERA ID: C-ville	PICTURES: 3167-3170
GPS ID:	LMK ID:	LAT:	LONG:

SITE DESCRIPTION

Name: Sandy Bottom - Riverside Dr.
Address:

Ownership: ☑ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☑ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☑ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☑ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 7.4
Imperviousness ≈ 30 %
Impervious Area ≈ 2.2

Notes: See large map for DA outline

Drainage Area Land Use:
- ☑ Residential
  - ☑ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☑ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):

- Riverside Dr. drains down to Sandy Bottom via ditches
- Located in floodplain of North River

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:
[x] Water Quality [ ] Recharge [ ] Channel Protection [ ] Flood Control
[ ] Demonstration / Education [ ] Repair [x] Other: Management

Retrofit Volume Computations - Target Storage:

Retrofit Volume Computations - Available Storage:

Proposed Retrofit Practice: (Runoff Reduction)
[ ] Disconnection [ ] Bioretention [ ] Bio Swale
[ ] Expanded Tree Pit [ ] Infiltration [ ] Green Roof
[ ] Permeable Pavement [ ] Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
[x] Constructed Wetland [ ] Wet Swale [ ] Wet Pond
[ ] Filtering Practice [ ] Proprietary:
[ ] Other:

Retrofit Category (as defined by Chesapeake Bay Program):
[x] New BMP [ ] BMP Enhancement [ ] BMP Restoration [ ] BMP Conversion [ ] Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:
- Install constructed wetland to collect runoff from Riverside Dr
- install some kind of overflow system → pipe to river or overflow ditch to river

Available Width:	
Available Length:	
Available Area:	
Ponding Depth:	0.5-1'
Soil Depth:	

See drawing + GIS

SITE CONSTRAINTS

Adjacent Land Use:
[x] Residential [ ] Commercial [ ] Institutional
[ ] Industrial [ ] Transport-Related [ ] Park
[ ] Undeveloped [x] Other: Pump Station (H-burg)

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [ ] No
If Yes, Describe:

Access:
[ ] No Constraints
Constrained due to
[ ] Slope [ ] Space
[ ] Utilities [ ] Tree Impacts
[ ] Structures [ ] Property
Ownership
[ ] Other:

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	[ ]	[ ]	[x]	[ ]
Water:	[ ]	[x]	[ ]	[ ]
Gas:	[ ]	[ ]	[ ]	[x]
Electric to Streetlights:	[ ]	[ ]	[ ]	[x]
Other:	[ ]	[ ]	[ ]	[ ]

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[x] Not Probable
Impacts to Wetlands	[ ] Probable	[x] Not Probable
Impacts to a Stream	[ ] Probable	[x] Not Probable
Floodplain Fill ?	[ ] Probable	[ ] Not Probable
Impacts to Forests	[ ] Probable	[x] Not Probable
Impacts to Specimen Trees	[ ] Probable	[x] Not Probable

How many?
Approx. DBH

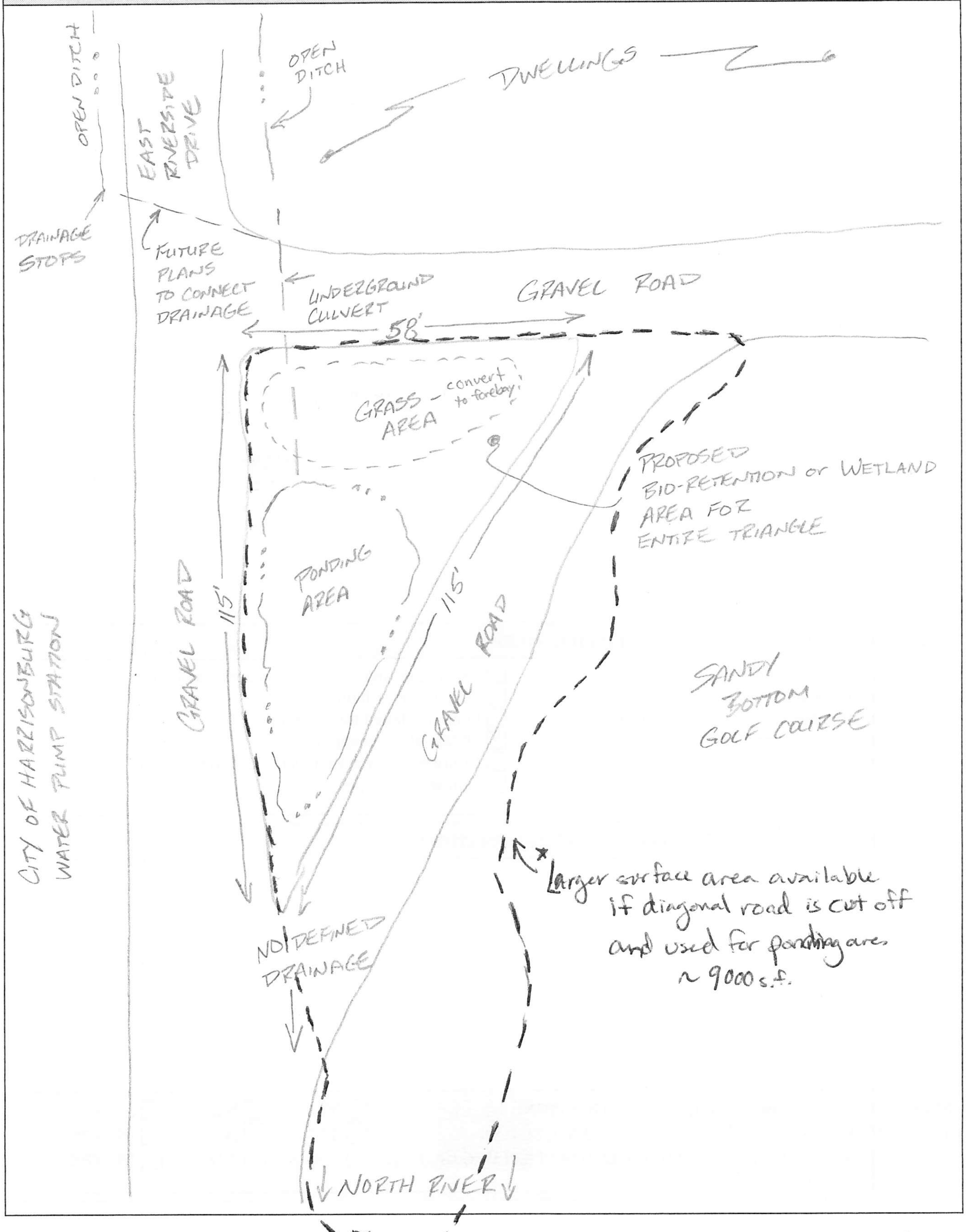
Other factors:

Soils:

Soil auger test holes:	[x] Yes	[ ] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[x] No
Evidence of shallow bedrock:	[ ] Yes	[x] No
Evidence of high water table (gleying, saturation):	[x] Yes Maybe	[ ] No

Sandy + some clay
- May be compacted or just saturated

SKETCH


OPEN DITCH
EAST RIVERSIDE DRIVE
OPEN DITCH
DWELLINGS
DRAINAGE STOPS
FUTURE PLANS TO CONNECT DRAINAGE
UNDERGROUND CULVERT
GRAVEL ROAD
58'
GRASS AREA - convert to forebay
PROPOSED BIO-RETENTION or WETLAND AREA FOR ENTIRE TRIANGLE
PONDING AREA
115'
115'
GRAVEL ROAD
GRAVEL ROAD
CITY OF HARRISONBURG WATER PUMP STATION
SANDY BOTTOM GOLF COURSE
*Larger surface area available if diagonal road is cut off and used for ponding area ~9000 s.f.
NO DEFINED DRAINAGE
NORTH RIVER

DESIGN OR DELIVERY NOTES

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- [ ] Confirm property ownership
- [ ] Confirm drainage area
- [ ] Confirm drainage area impervious cover
- [ ] Confirm volume computations
- [ ] Complete concept sketch
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [x] Obtain utility mapping
- [ ] Confirm storm drain invert elevations
- [ ] Confirm soil types
- [ ] Other:____________________

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☐ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE

IF YES, TYPE(S):____________________

RRI

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:** B11-B	
DATE: 3/20/13	**ASSESSED BY:** LW	**CAMERA ID:** c-ville	**PICTURES:** 3171-3174 = #1
GPS ID:	**LMK ID:**	**LAT:**	**LONG:** 3175 - 3177 = #2

SITE DESCRIPTION

Name: Sandy Bottom - Golf Carse parking lot
Address:

Ownership: ☑ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☑ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☑ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☐ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☑ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☐ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 2.82 acres (both DAs)
Imperviousness ≈ 50 %
Impervious Area ≈ 1.4 acres

Notes:

Drainage Area Land Use:
- ☐ Residential
  - ☐ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☑ Park
- ☐ Undeveloped
- ☑ Other: materials storage

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☑ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):

- Gravel parking lot around maintenance building and asphalt golf carse lot drain to ditches (grass)
- Located in floodplain of North River

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:
☑ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☑ Demonstration / Education ☐ Repair ☐ Other:______

Retrofit Volume Computations - Target Storage:	**Retrofit Volume Computations - Available Storage:**

Proposed Retrofit Practice: (Runoff Reduction)
☐ Disconnection ☐ Bioretention ☐ Bio Swale
☐ Expanded Tree Pit ☐ Infiltration ☐ Green Roof
☐ Permeable Pavement ☐ Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
☐ Constructed Wetland ☑ Wet Swale ☐ Wet Pond
☐ Filtering Practice ☐ Proprietary:______
☐ Other:______

Retrofit Category (as defined by Chesapeake Bay Program):
☑ New BMP ☐ BMP Enhancement ☐ BMP Restoration ☐ BMP Conversion ☐ Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

- Convert grass channels to vegetated wet swales (2)
- Swale #1 already holding back water
- No underdrain since no ex. pipes

btwn golf lot + gravel lot

	①	②
Available Width:	10'	15'
Available Length:	94'	215'
Available Area:		
Ponding Depth:		
Soil Depth:		

SITE CONSTRAINTS

Adjacent Land Use:
☐ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☐ Undeveloped ☐ Other:______
Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☑ No
If Yes, Describe:

Access:
☐ No Constraints
Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property
Ownership
☐ Other:______

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	☐	☑	☐	☐
Water:	☐	☑	☐	☐
Gas:	☐	☐	☑	☐
Electric to Streetlights:	☐	☑	☐	☐
Other:	☐	☐	☐	☐

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☑ Not Probable
Impacts to Wetlands	☐ Probable	☑ Not Probable
Impacts to a Stream	☐ Probable	☑ Not Probable
Floodplain Fill	☐ Probable	☑ Not Probable
Impacts to Forests	☐ Probable	☑ Not Probable
Impacts to Specimen Trees	☐ Probable	☑ Not Probable

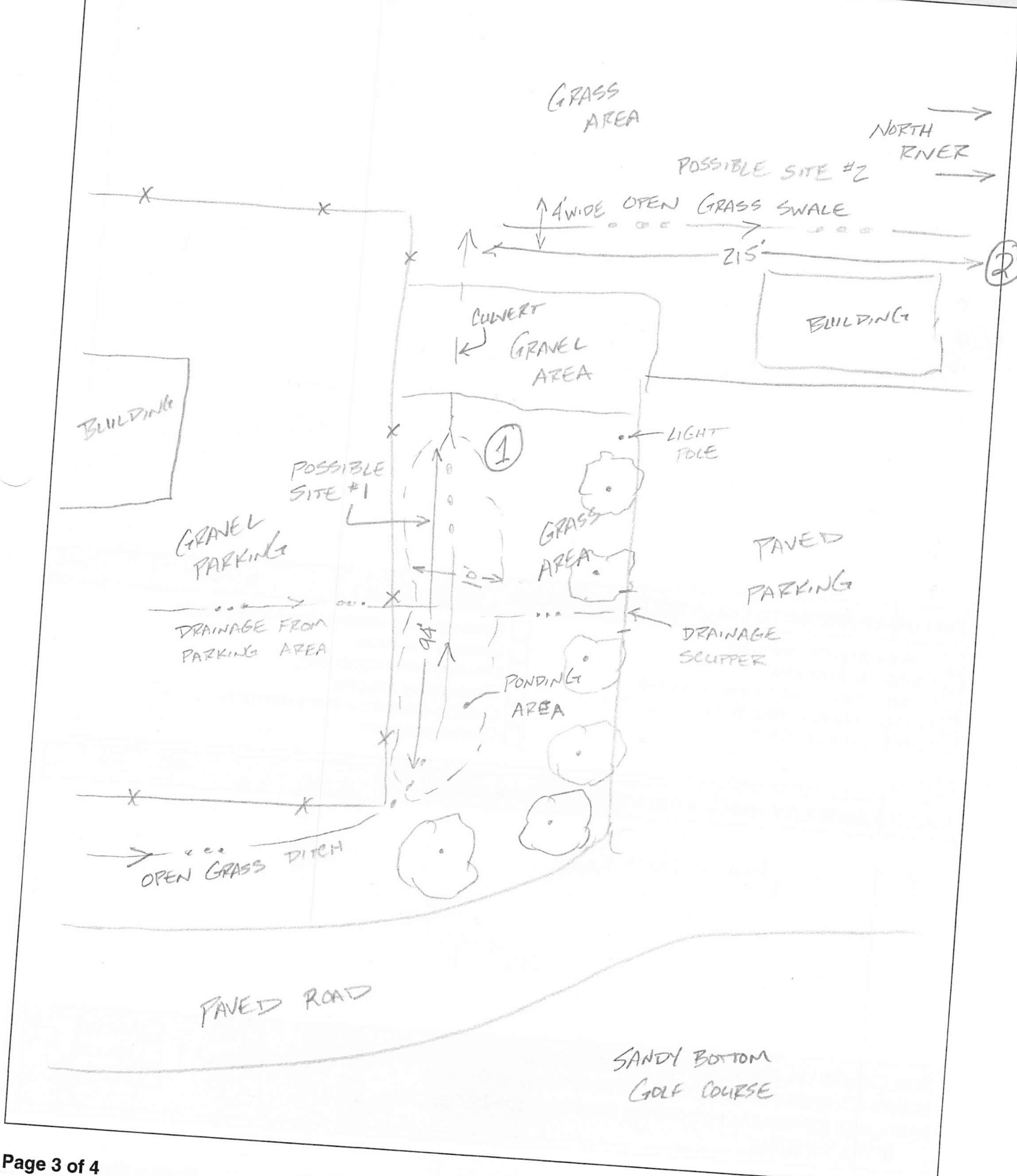
How many?______
Approx. DBH______

Other factors:______

Soils:

Soil auger test holes:	☐ Yes	☐ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

SKETCH



Unique Site ID: B11-B

Design or Delivery Notes

Follow-up Needed to Complete Field Concept

- [ ] Confirm property ownership
- [ ] Confirm drainage area
- [ ] Confirm drainage area impervious cover
- [ ] Confirm volume computations
- [ ] Complete concept sketch
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [ ] Obtain utility mapping
- [ ] Confirm storm drain invert elevations
- [ ] Confirm soil types
- [ ] Other:______

Initial Feasibility and Construction Considerations

☆ In floodplain of North River

Site Candidate for Further Investigation:	[x] Yes	[ ] No	[ ] Maybe
Is Site Candidate for Early Action Project(s):	[ ] Yes	[x] No	[ ] Maybe
If no, site candidate for Other Restoration Project(s):	[ ] Yes	[ ] No	[ ] Maybe

If yes, type(s):______

B13: Cooks Creek Arboretum


B13-ER
B13
B13: Cooks Creek Arboretum
Retrofit IDs
Drainage Areas
N
Feet
0
250
500
CENTER FOR
WATERSHED
PROTECTION
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

B13: Cooks Creek Arboretum

Score: 48

Rank: 8

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Erosion below outfall*

Figure 2: *Channel enters culvert*

Figure 3: *Channel exits culvert and flows to creek*

Description: The pipe opening shown in Figure 1 is the outfall for runoff from a 21-acre drainage area. This drains a large portion of the residential neighborhood just uphill of the Cooks Creek Arboretum. As seen in the photo, the channel right below the outfall is eroding and getting deeper. It appears that water from an underground spring also comes out of this pipe, since there was a significant amount of water flowing out at the time of this visit, but no recent rainfall.

Proposed Solutions: Install a regenerative stormwater conveyance (RSC) system in the outfall channel, above and below the road culver. The RSC system is basically a boulder and riffle step-pool channel with an underlying sand and wood chip bed. The system is designed to both convey stormwater and provide water quality treatment. The rip-rap stones present in the channel can be re-used to build the RSC system. An interim or alternative solution would be to stabilize the erosion at the outfall, and this would prevent erosion but not qualify for as many pollution reduction credits as the RSC system.

B13-ER: Cooks Creek Arboretum Stream Bank Erosion

Score: N/A

Rank: N/A

Investigators: David Nichols, John Ware, Laurel Woodworth

Figure 1: *Bank erosion is just upstream of rip-rap*

Figure 2: *Close-up of stream bank erosion*

Description: Several sections of the stream bank of Cooks Creek near the Arboretum are actively eroding. This erosion could worsen and gradually eat away at the hillside, which could present a safety issue. The dirt that is loosened by this erosion also contributes to harmful sediment accumulation downstream.

Proposed Solutions: An immediate solution is to stop mowing right up to the water and allow vegetation to grow taller so that roots can hold on to the stream bank soil. If erosion worsens, the next step would be to take a more formal stream bank restoration approach that involves excavating the stream bank back to give it a more gradual slope and allow the stream more room to expand out into a floodplain when the flow is high.

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:** B13	
DATE: 3/20/13	**ASSESSED BY:** LW	**CAMERA ID:**	**PICTURES:** 3198-3205, 3208
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: Cooks Creek Arboretum
Address:

Ownership: ☑ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☑ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☑ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
- ☐ Existing Pond
- ☑ Below Outfall
- ☐ In Road ROW
- ☐ Other:
- ☐ Above Roadway Culvert
- ☐ In Conveyance System
- ☐ Near Large Parking Lot

On-Site
- ☐ Hotspot Operation
- ☐ Small Parking Lot
- ☐ Individual Street
- ☐ Underground
- ☐ Individual Rooftop
- ☐ Small Impervious Area
- ☑ Landscape / Hardscape
- ☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 21.3 acres
Imperviousness ≈ ~35 % ← visual estimate
Impervious Area ≈ 7.46 acres

Notes:

Drainage Area Land Use:
- ☑ Residential
  - ☑ SFH (< 1 ac lots)
  - ☐ SFH (> 1 ac lots)
  - ☐ Townhouses
  - ☐ Multi-Family
- ☐ Commercial
- ☐ Institutional
- ☐ Industrial
- ☐ Transport-Related
- ☐ Park
- ☐ Undeveloped
- ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☑ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):

- Subdivision has curb + gutter and drains to outlet pipe above Cooks Creek
- constant flow coming through pipe (appears to be spring fed)
  - ↳ watercress growing below
  - ↳ erosion along outfall channel

Existing Head Available:	**Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)**

PROPOSED RETROFIT

Purpose of Retrofit:
☑ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☐ Demonstration / Education ☐ Repair ☐ Other:

Retrofit Volume Computations - Target Storage:	**Retrofit Volume Computations - Available Storage:**

Proposed Retrofit Practice: (Runoff Reduction) ☐ RSC
☐ Disconnection ☐ Bioretention ☐ Bio Swale
☐ Expanded Tree Pit ☐ Infiltration ☐ Green Roof
☐ Permeable Pavement ☐ Rainwater Harvesting

Proposed Retrofit Practice: (Stormwater Treatment)
☐ Constructed Wetland ☐ Wet Swale ☐ Wet Pond
☐ Filtering Practice ☐ Proprietary:
☐ Other:

Retrofit Category (as defined by Chesapeake Bay Program):
☑ New BMP ☐ BMP Enhancement ☐ BMP Restoration ☐ BMP Conversion ☐ Not CBP-approved

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:
- To deal w/ outfall erosion and provide treatment, install Regenerative Stormwate Conveyance (RSC) between outfall and creek
- Install RSC step pools above and below road culvert

Available Width:	
Available Length:	66' + 64'
Available Area:	
Ponding Depth:	
Soil Depth:	

SITE CONSTRAINTS

Adjacent Land Use:
☑ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☑ Park
☐ Undeveloped ☐ Other:
Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☐ No
If Yes, Describe:

Access:
☑ No Constraints
Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property
Ownership
☐ Other:

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	☐	☐	☐	☑
Water:	☐	☐	☐	☑
Gas:	☐	☐	☑	☐
Electric to Streetlights:	☐	☐	☐	☑
Other:	☐	☐	☐	☐

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☑ Not Probable
Impacts to Wetlands	☐ Probable	☑ Not Probable
Impacts to a Stream	☐ Probable	☑ Not Probable
Floodplain Fill ?	☐ Probable	☐ Not Probable
Impacts to Forests	☐ Probable	☑ Not Probable
Impacts to Specimen Trees	☐ Probable	☐ Not Probable

How many?
Approx. DBH

Other factors:

Soils:

Soil auger test holes:	☐ Yes	☑ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

SKETCH


UNDERGROUND STORM PIPE
UNDERGROUND SPRING
COOKS CREEK ARBORETUM
BANKS OF DITCH ERODING
DITCH
Convert to Regenerative Stormwater Conveyance Channel (66-feet long)
GRAVEL PARKING
CULVERT
PAVED DRIVE
DWELLINGS
OPEN DITCH
(64 ft)
COOKS CREEK

DESIGN OR DELIVERY NOTES

- constant flow of water from spring: consider design implications (if any)

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☑ Obtain utility mapping
- ☑ Confirm ~~storm drain~~ invert elevations
- ☐ Confirm soil types
- ☐ Other: ____

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

- Measure elevations of:
  - outfall
  - Upper + lower end of culvert
  - Creek

SITE CANDIDATE FOR FURTHER INVESTIGATION: ☐ YES ☐ NO ☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE
IF YES, TYPE(S): ____

Severe Bank Erosion **ER**

Cooks Creek Arboretum

WATERSHED/SUBSHED:	**DATE:** 3 /20 /13	**ASSESSED BY:** B13-ER
SURVEY REACH: **TIME:**___:___AM/PM	**PHOTO ID** (CAMERA-PIC #): 3206 /# 3207	
SITE ID: (*Condition-#*) **ER-**____	*START* **LAT** ___° ___' ___" **LONG** ___° ___' ___" **LMK** ____ / *END* **LAT** ___° ___' ___" **LONG** ___° ___' ___" **LMK** ____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown

☐ Downcutting ☐ Bed scour
☐ Widening ☑ Bank failure
☐ Headcutting ☑ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream)*
LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*) LT____ft and/or RT 50 ft Bottom width ____ft
Bank Ht LT____ft and/or RT 4 ft Top width ____ft
Bank Angle LT____° and/or RT____° Wetted Width ____ft

LAND OWNERSHIP: ☐ Private ☑ Public ☐ Unknown **LAND COVER:** ☐ Forest ☐ Field/Ag ☑ Developed: lawn

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☑ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5 4	3	2 1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair access**: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5 4	3	2 1

NOTES/CROSS SECTION SKETCH:

Cooks Creek Streambank

REPORTED TO AUTHORITIES ☐ YES ☐ NO