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Final Back River / Lake Shores Watershed Plan

PREPARED FOR:
CITY OF HAMPTON

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125 YEARS

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1. Introduction

1.1.Purpose

This watershed action plan is a strategy for the restoration of the Back River/Lake Shore watershed (sub-watershed 7) in the City of Hampton, VA. This plan assesses the watershed's existing stormwater management, identifies deficiencies within the existing system, and presents recommendations to decrease flooding. In addition, this plan analyzes the watershed for potential water quality treatment opportunities and presents recommendations to improve the water quality of the discharges into the Chesapeake Bay.

1.2.Background

The approximately 1,290 acre Back River/Lake Shores watershed is located southwest of Interstate 64 between Hampton Roads Center Parkway and Interstate 664. West Mercury Boulevard bisects the watershed in half, as seen in Figure 1-1. There are two open channel systems that convey approximately 1,050 acres of the watershed to Newmarket Creek to the Back River and ultimately the Chesapeake Bay. The last 240 acres of the watershed discharge directly into Newmarket Creek at ten different locations along the southern boundary of the watershed.

The establishment of a comprehensive "pollution diet" for the Chesapeake Bay at the end of 2010 has been the driving force behind many changes in the way stormwater management is regulated and implemented in the Commonwealth of Virginia. The Chesapeake Bay Total Maximum Daily Load (TMDL) is required under the federal Clean Water Act (CWA) and is full of meticulous accountability measures to initiate actions to restore clean water in the Chesapeake Bay as well as regional streams, creeks, lakes, and rivers.

The City of Hampton's Public Works Department initiated the Back River/Lake Shores watershed study to aid in the compliance of their Final Chesapeake Bay TMDL Local Phase II Watershed Implementation Plan (WIP), dated January 30, 2012. This watershed plan will also be a useful tool in the development of the City's Phase III WIP in 2017.

The Virginia Department of Environmental Quality (DEQ) is currently creating a bacterial TMDL for Back River. The final public meeting for this effort took place on July 30, 2013. Newmarket Creek is impaired for low dissolved oxygen and will have a TMDL by 2018.

FIGURE 1-1: LAKE SHORE - BACK RIVER WATERSHED

Hampton, Virginia

1.3.Requirements and Regulations

This watershed plan was developed to satisfy various permits, plans and regulations while also meeting citizen safety needs from flood events. The following were considered during the development of this report:

- City of Hampton Chesapeake Bay TMDL Local Phase II WIP
- Hampton Comprehensive Waterways Management Plan
- City of Hampton Municipal Separate Storm Sewer System (MS4) Permit

1.3.1. Chesapeake Bay TMDL Local Phase II WIP

The Environmental Protection Agency (EPA) developed a TMDL for the Chesapeake Bay that established waste load allocations (WLAs) for nitrogen (N), phosphorus (P) and total suspended solids (TSS) using a watershed model developed by The Chesapeake Bay Program (CBP). In response to the EPA's TMDL, the City of Hampton released a local Phase II WIP on January 30, 2012 which outlines the City's plan to reach ultimate pollutant reduction goals by 2025. The Phase II WIP provides local area targets for implementation on a smaller scale. In 2017, the City will be required to submit a Phase III WIP that ensures all practices will be in place by 2025. Watershed action plans, such as this one, are key components in determining the City's ability to reach pollutant reduction goals outlined in the Phase II and Phase III WIP.

1.3.2. Hampton Comprehensive Waterways Management Plan

The City of Hampton Comprehensive Waterways Management Plan Steering Committee finalized a plan to address flooding, stormwater management, shoreline protection and waterways management and maintenance on March 27, 2012. This plan discusses the City's approach to meeting their stormwater management goals. The City's stormwater management goals are as follows:

1. Make annual progress toward meeting the 2017 mandate of having 60% of the actions and strategies in place to meet the ultimate goals for 2025 regarding reductions in phosphorous, nitrogen and sediment.
2. Make a 10% annual reduction in citizen drainage complaint calls taken by 311.
3. Increase stormwater program funding and revenue to meet new state and federal stormwater compliance requirements.
4. Utilize city surveys to establish a baseline and then measure the annual increase in public awareness and engagement in prevention of stormwater pollution and revitalization of wetlands and natural habitats.

All four of these goals are addressed for the Back River/Lake Shores watershed with this plan.

1.3.3. MS4 Permit

The City of Hampton is a Phase I MS4 permit holder. As part of this permit, the City is required to have a stormwater management program to reduce the contamination of stormwater runoff and eliminate illicit discharges. The MS4 contains six minimum control measures that the City must implement to achieve pollutant load reductions. The six minimum control measures required are:

1. Public Education and Outreach
2. Public Participation and Involvement
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post-Construction Runoff Control
6. Pollution Prevention and Good Housekeeping

All six of these minimum control measures are addressed for the Back River/Lake Shores watershed with this plan.

1.3.4. Regulations

Proposed stormwater management improvements shall comply with the state of Virginia regulations. Effective July 1, 2013 the following regulations were transferred to the State Water Control Board under the Virginia Department of Environmental Quality (VDEQ):

- 4 VAC 50-30 Erosion and Sediment Control Regulations
- 4 VAC 50-60 Stormwater Management Regulations
- 4 VAC 50-90 Chesapeake Bay Preservation Area Designation and Management Regulations

Other standards and manuals that shall be used to design and implementation of the proposed stormwater improvements in Section 5 of this plan are as follows:

- City of Hampton Design and Construction Standards
- Virginia Department of Transportation (VDOT) Road and Bridge Standards
- VDOT Drainage Manual

1.4.Report Organization

This report is organized into the following five major sections:

Section 1 explains the purpose of this report including background, requirements, regulations and report organization.

Section 2 provides key watershed characteristics.

Section 3 describes the analyses processes used to develop the proposed improvements.

Section 4 discusses the types of watershed restoration practices recommended for Back River/Lake Shores watershed.

Section 5 discusses the specific proposed improvements recommended for Back River/Lake Shores watershed. This section also provides prioritization, estimated pollutant removal, flood reduction volumes, and preliminary cost estimates for these proposed improvements.

2. Watershed Overview

2.1. Topography, Soils and Land Use

The watershed has a very flat topography with 0-3% slopes. Soils found within the watershed mostly consist of hydrologic Group D soil with some pockets of Group B.

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

Land use is mainly residential, with an average lot size of 0.243 acres. There are also several areas of commercial and dense housing. A summary of these key watershed characteristics can be found in Table 2-1 and Figure 2-1 is a map of the watershed's existing land use.

WATERSHED CHARACTERICSTICS		
	Acres	% of Watershed
Total Area	1290	100.0%
Sub-Watershed 1	890	69.0%
Sub-Watershed 2	290	22.5%
Sub-Watershed 3	110	8.5%
IMPERVIOUS AREA		
Water	70.17	5.8%
Buildings	129.24	10.6%
Pavement	243.52	20.0%
Total % Impervious		36.4%
PERVIOUS AREA		
Open Space/Lawns		63.6%
SOILS		
Dragston	79.39	6.5%
Munden	205.70	16.9%
Nimmo	326.78	26.9%
Tomotley	286.91	23.6%
Other	254.87	21.0%
EXISTING LAND USE		
Other	62.14	5.1%
Commercial/Industrial	176.37	14.5%
High Density Residential	40.33	3.3%
Low Density Residential	515.57	42.4%
Public	115.25	9.5%
Undeveloped	134.92	11.1%

Table 2-1: Lake Shore/Back River Key Watershed Characteristics

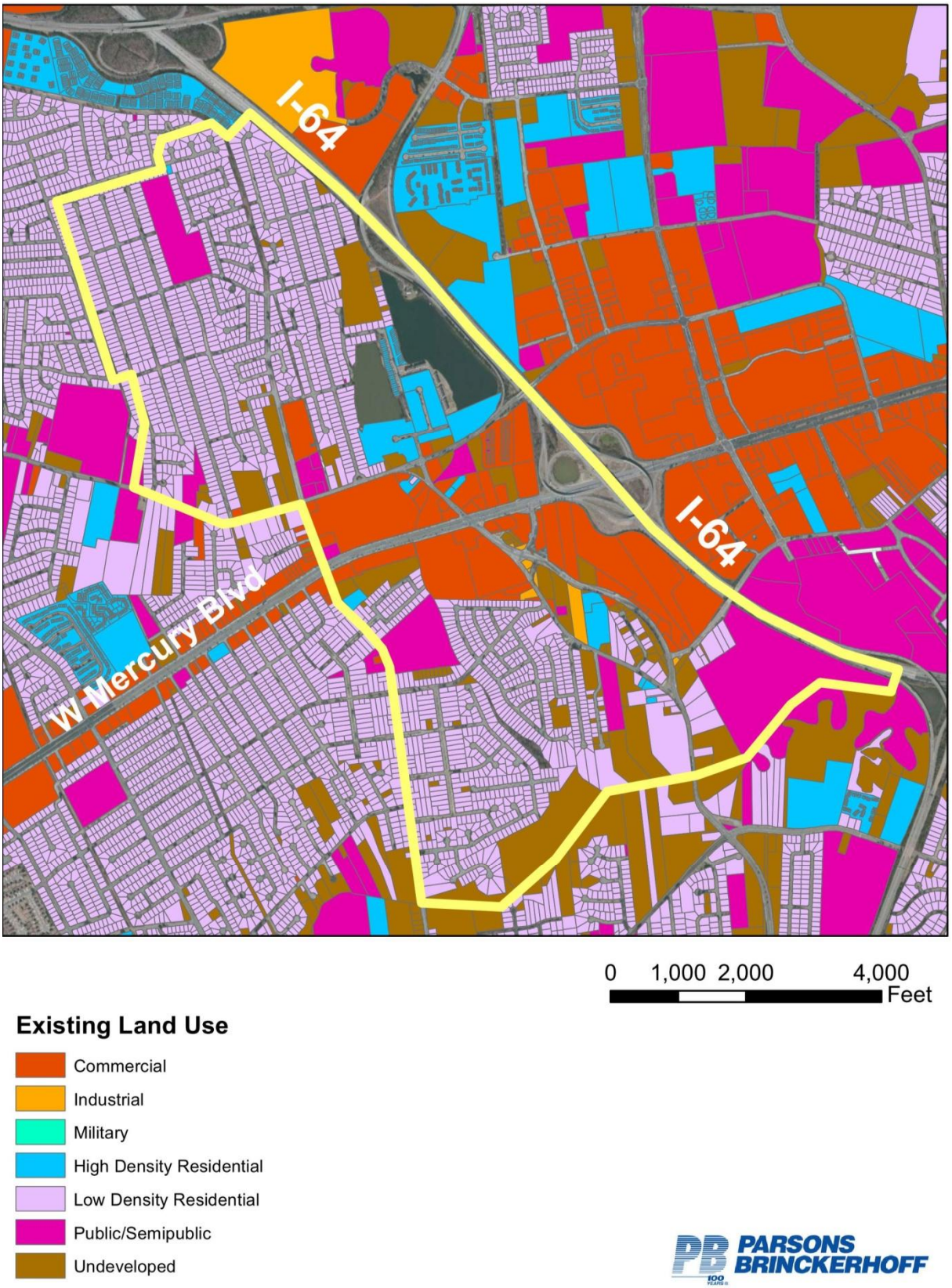


Figure 2-1: Back River/Lake Shores Land Use Classification

2.2.Drainage and Stormwater Management

The existing drainage collection system consists of ditches, culverts, and storm sewer pipes and inlets. There are two main sub-watersheds within the Back River/Lake Shores watershed. The first sub-watershed drains to a main open channel which begins at Burton Road and discharges at the southern end of the watershed into Newmarket Creek. The second sub-watershed drains to a main open channel which begins at Bromsgrove Drive and discharges into Newmarket Creek near the southwest corner of the I-64 and I-664 interchange. Figure 2-2 shows the existing main drainage channel in sub-watershed 1.

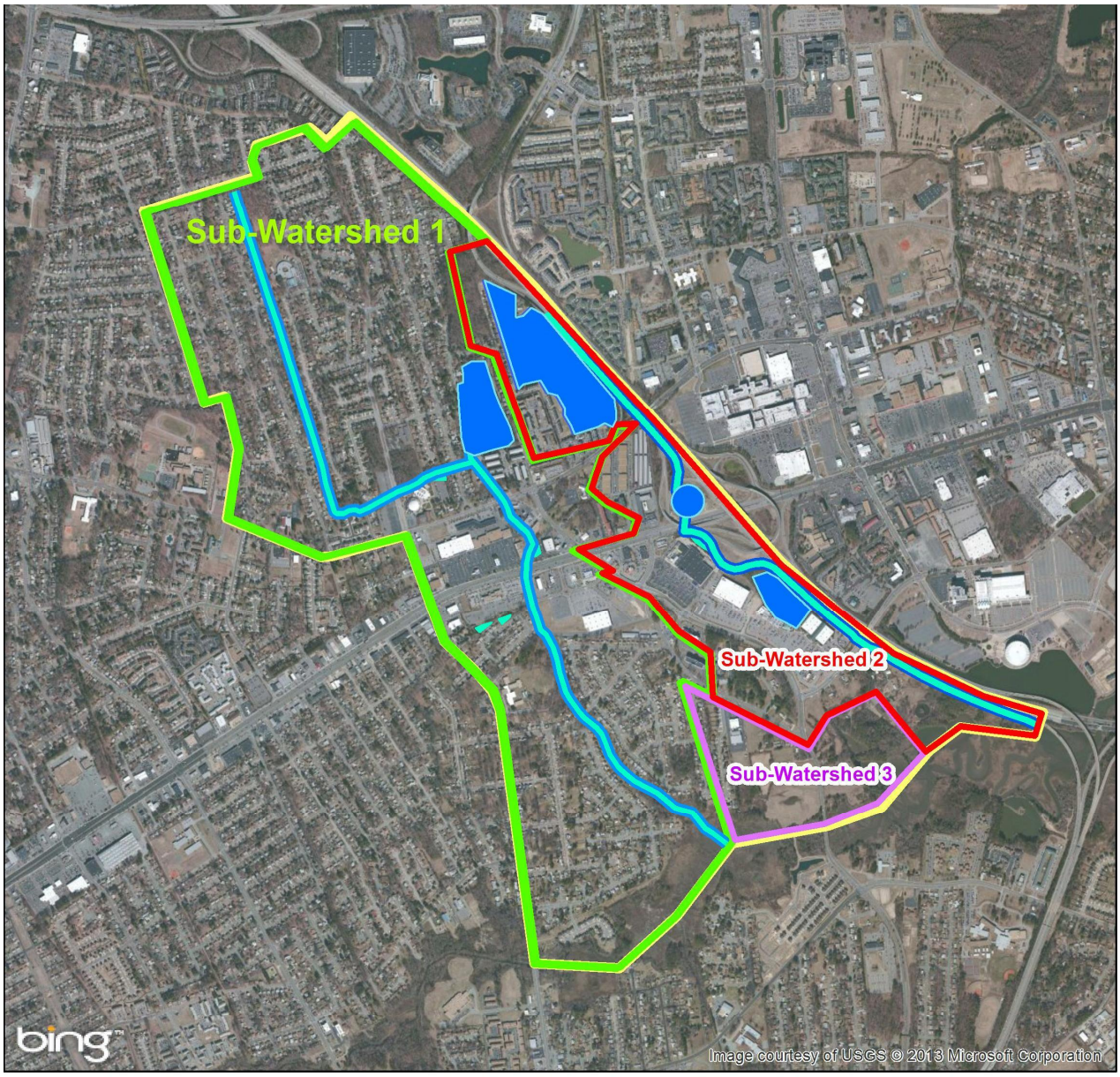
Figure 2-2: Sub-watershed 1 Main Channel Downstream of Berkshire Terrace

The channel is well defined and in fair condition. One major issue with the channel is its very low slope and in some areas negative slope. The existing culverts along the channel also have extremely low to no slope causing water to bottleneck and cause erosion upstream of the culverts. As seen in Figure 2-2, the west bank of the channel experiences heavy vegetative growth.

There is one publicly owned stormwater management facility located within the watershed. VDOT recently constructed a pond in the northwest cloverleaf of the Interstate 64 and Mercury Blvd. interchange. The construction plans for this pond suggest that it was designed to be an extended detention pond; however, it seems to be functioning as a retention pond since there is constantly water retained in the BMP. Figure 2-3 shows the existing stormwater management facility in the interchange.

Figure 2-3: Existing SWM Pond in I-64/Mercury Blvd Interchange

Several privately owned stormwater management facilities are located within the watershed. Two privately owned lakes within the watershed receive public drainage system discharges. Lake One Association owns the 16.4 acre lot on Lake One Drive where Lynnhaven Lake is located. Gibbs Lake LLC owns the 33.47 acre lot that Lake Gibbs is located on in the northwest corner of the I-64 and Cunningham Drive interchange. The rest of the privately owned stormwater management facilities are much smaller. These facilities treat stormwater runoff from commercial developments before releasing into one of the main open channels. All existing stormwater management facility locations and sub-watershed drainage divides can be found in Figure 2-4.



0 1,000 2,000 4,000 Feet

Watershed Characteristics

- Sub-watershed #1
- Sub-watershed #2
- Sub-watershed #3
- Main Drainage Channel
- Lake/BMP

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Figure 2-4: Lake Shore/Back River Existing Drainage Divides and Stormwater Management Facilities

3. Watershed Analyses

3.1.Data Collection

3.1.1. Existing City Data

The City of Hampton provided a geodatabase file containing existing watershed data on February 18, 2013. High precision shapefiles with a tolerance of $8.98x10^{-9}$ included:

- Two foot topographic contours (2006)
- Utility lines and structures
- Stormwater structures, pipes, culverts, ditches and swales (pipe sizes and limited inverts were included)
- Planametric features including buildings and pavement
- Zoning
- Existing and proposed land use
- Soils
- Watershed boundary
- Waters

During analysis of the watershed it was determined that two small areas outside of the provided watershed boundary also drain to the main drainage channel located in sub-watershed 1. The adjusted boundary and delineation of sub-watershed 1 and 2 can be found in Figure 2-4.

3.1.2. Citizens Complaints

The City provided a map of the Lake Shore/Back River watershed with highlighted existing drainage issues to aid with the development of this study. The map contains flood problem areas observed by both City employees and citizens. This map can be found in Appendix B.

3.1.3. Field Investigations

Parsons Brinckerhoff performed multiple field investigations to get a clear understanding of the watershed's key drainage characteristics and issues. Investigations took place during dry and wet weather events. The map discussed in section 3.1.2 was used in the field to verify problem areas and existing storm sewer structures, ditches and culverts. Some of the stormwater structures in the City's geographical information system (GIS) could not be verified in the field. These differences are called out on the proposed watershed improvement maps in Appendix C. Parsons Brinckerhoff also reviewed the Federal Emergency Management Agency (FEMA) flood data for Back River/Lake Shores watershed. Flood Insurance Rate Maps (FIRMs) and flood profiles from the August 16, 2011 City of Hampton Flood Insurance Study (FIS) for Newmarket Creek are located in Appendix A.

3.1.4. Survey

The City of Hampton's survey department provided survey data for the main channel in sub-watershed 1 including cross sections, structure inverts and pipe outlets. The information was provided as hand drawn PDFs without a scale. This creates room for error on accuracy of cross section location however; it doesn't have much effect on the accuracy of the modeling. Survey information is located in Appendix B.

3.1.5. Turbidity Samples

Turbidity is a measure of water clarity how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO).

Turbidity samples were taken at several locations along the main channel in sub-watershed 1 and Lynnhaven Lake on March 22, 2013. A summary of the turbidity results can be found in Table 3-1.

Location	Turbidly (NTU)
Main Channel	
Upstream of Concord Dr.	4.5
Downstream of Concord Dr.	13.6
Upstream of Berkshire Terrace	4.0
Downstream of Berkshire Terrace	6.12
Lynnhaven Lake	
Outfall	12.4

Table 3-1: Back River/Lake Shores Turbidity Results

3.2.Model Development

The purpose of this modeling effort was to evaluate the existing and proposed conditions in order to identify problem areas and determine potential flood reduction benefits of proposed stormwater improvements.The Back River/Lake Shores watershed models were developed using GIS data provided by the City of Hampton, site plan documents from City records, information gathered from multiple site visits as well as survey data. Development within the watershed is ongoing, therefore some of the information obtained through GIS and City documents may be outdated, but for the purpose of this study it provides the best basis from which to build the models.

The Stormwater and Wastewater Management Model XPSWMM, Version 2012 was used to model the performance of the drainage conveyance system within the Back River/Lake Shores watershed. XPSWMM utilizes link-node and spatially distributed modeling for the analysis, design and simulation of storm systems. A link-node system was developed to represent the main channel in the watershed. Pipes discharging into the main channel with diameters greater than 24" were also included.

The SCS Type II rainfall distribution was selected, using a constant time interval of 0.1 hours. The 2, 10, 25, 50 and 100 year design storm rainfall depths were obtained from NOAA Atlas 14 Point Precipitation Frequency Estimates for the City of Hampton. An initial abstraction was represented as a fraction (0.2) of the total amount of precipitation. Drainage areas and their characteristics were estimated based on field investigations, GIS and survey. Drainage area characteristics include percent impervious, slope and area.

Lakes and BMP's were modeled as storage nodes. Stage-storage curves were estimated based on GIS and survey data. Open channels, ditches, swales, pipes and culverts were represented as links within the model. Characteristics of each link were obtained from survey, GIS and site visits and include Manning's "n", longitudinal slope, upstream and downstream inverts, diameter (or base-width, depth, and side slopes) and length. When slopes where unknown, 0.2% was assumed.

3.3. Modeling Scenarios

Three scenarios were investigated for the modeling efforts. These scenarios included the (1) existing conditions, (2) future land cover per latest Comprehensive plan, and (3) future land cover with future drainage improvements in place.

3.3.1. Existing Conditions

Existing conditions were determined by field investigations, information provided by the City of Hampton and online resources.

Pipe locations, inverts, cross sections, water depths and slope were found using GIS data provided by the City, site plan documents from City records, information gathered from multiple site visits by Parsons Brinckerhoff and survey data provided by the City Surveyor.

A custom soil resource report was generated using the Web Soil Survey resource available on the Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture (USDA) website.

An existing base flow of 5 cubic feet per second (cfs) was included in the model of the channel. The base flow was assumed based on observed water in the channel during dry weather, survey information showing water depths, and a visual inspection of the flow entering the main channel at the upstream end.

Several issues were identified along the main drainage channel during site visits. Other problem areas were identified from records of citizen complaints and published reports provided by the City. The main areas of concern were located along the main channel.

The accuracy of the Existing Conditions Model was determined by verifying that the results were consistent with the observed flooding and drainage issues identified.

3.3.2. Future Land Cover

The Back River/Lake Shores watershed is already highly developed. State stormwater regulations require new development and redevelopment to incorporate the Runoff Reduction Method (RRM) and decrease impervious area, therefore reducing the impact of future development.

After studying the City's latest Comprehensive plan and investigating the existing conditions, it was determined that any future land development will have little effect on the existing drainage system and therefore was not modeled separately.

3.3.3. Future Land Cover with Drainage Improvements

The Existing Conditions Model was modified to include areas with proposed stormwater treatment. Parsons Brinckerhoff focused on treating and capturing runoff north of Todds Lane, upstream of Lynnhaven Lake, to alleviate major flooding and erosion issues observed south of Todds Lane, with slight modifications to the southern part of the main channel.

3.4. Pollutant Loading and Reduction Analysis

The Virginia RRM spreadsheets were used to determine potential N and P pollutant loading, load reductions, and runoff reductions for the proposed stormwater improvements described in section 5 of this plan. Neither the Virginia BMP Clearinghouse nor the City of Hampton Comprehensive Waterways Management Plan provides TSS loading rates or removal efficiencies for non-propriety BMPs. Table 3-1 contains loading rates based on the CBP's watershed model from July 2011. Table 3-2 provides BMP TSS removal efficiencies used in this plan. RRM spreadsheets for the proposed improvements can be found in Appendix D.

Table 3-1 Loading Rates

Land Cover	Sediment Per Acre
Impervious Urban	675.86
Pervious Urban	92.26
Cropland	664.57
Pasture	118.85
Livestock	2452
Forest and Wetlands	31.05

Table 3-2 BMP Removal Efficiencies

SWM Facility Type	TSS Removal Efficiency (%)
Dry Pond	10%
Wet Pond	60%
Wetland	60%
Infiltration	95%
Filtration	80%
Extended Detention	60%
Hydrodynamic Separator	85%
Grassed Swale	50%

4. Restoration Strategies

4.1. Introduction

This section presents an overview of the restoration strategies and associated pollutant load reductions proposed for restoring the Back River/Lake Shores watershed. Section 4.3 discusses the pollutant removal calculations for proposed BMPs to ensure that the City of Hampton Chesapeake Bay TMDL Phase II WIP requirements are met in this watershed.

4.2. Watershed-Wide Strategies

4.2.1. Urban Nutrient Management

The state of Virginia passed a house bill that restricts the sale and usage of fertilizer containing phosphorus that will go into effect December 31, 2013. Raising awareness among citizens about some of the common activities around their homes and how those activities can negatively affect water quality is

an important watershed-wide tool to implement. Residential yards are a major source of pollutant runoff. Fertilizer, pesticides, landscaping and waste disposal are activities that can impact water quality. Here are the details of the law:

- HB 1831 passed in 2011 prohibits the sale, distribution and use of lawn maintenance fertilizer containing phosphorus beginning December 31, 2013.
- The prohibition does not apply to starter fertilizer, manipulated manure, yard waste compost, products derived from sewage sledge, soils containing fertilizer and fertilizer products intended for gardening, tree, shrub and indoor planting application, including nurseries, or reclaimed water.
- Beginning on December 31, 2013, it will be unlawful to offer for sale any deicing agent containing urea, nitrogen, or phosphorus intended for application or parking lots roadways, and sidewalks, or other paved surfaces.
- Retailers are allowed to sell their existing inventory of lawn maintenance fertilizer and deicing agents.
- On December 31, 2013 a label will be required on bags of lawn fertilizer that states that the product should not be applied near storm drains or drainage ditches or when heavy rain is expected.
- The bill prohibits localities from further regulating contractor-applicators who are in compliance with the fertilizer laws, golf courses that have approved nutrient management plans, and agricultural operations with a resources management plan or a nutrient management plan.
- If localities find it necessary to adopt more stringent storm water ordinances they will have to report this fact to the Virginia Department of Environmental Quality.

Neighborhoods should be provided with educational materials that emphasize responsible fertilizing techniques such as proper application amounts, proper time of year, and keeping fertilizers away from impervious surfaces. Informational brochures/mailings, community newsletters, or community meetings are a few good ways to deliver this information. The Curb Appeal flyer the City of Hampton has already developed is a perfect example.

4.2.2. Green Street Implementation

A Green Street is a natural stormwater management approach that uses plants and soil to slow, filter, and cleanse stormwater runoff from streets before it outfalls to natural streams. Traditional stormwater management directs runoff into pipes but a green street manages stormwater right at the source within the City right of way. Proper Green Street design reduces peak runoff flows and frees capacity in the receiving storm sewer system. This helps to eliminate the need to install or replace expensive underground conveyance systems while also improving the aesthetic appearance of residential streets.

Initial evaluation of the Lake Shore/Back River watershed identified multiple residential streets in the Northampton neighborhood that would be ideal for Green Street pilot projects. The streets in this area are wide and runoff is mainly conveyed by long runs of gutter. There are multiple design options for Green Streets. Figure 4-1 shows a design option that incorporates parking areas and curb extensions along a residential street. Figure 4-2 shows a design option that runs the entire length of the street.

Retrofitting Green Street designs into existing streets in the City of Hampton will cause the streets to be narrower, reducing impervious cover.

Figure 4-1: Photo of Green Street in Portland, Oregon from ASLA website

Figure 4-2: Photo of Green Street in Portland, Oregon from ASLA website

A portion of Patrician Drive between Berkshire Terrace and James Terrace still has roadside ditches to convey drainage while the rest of Patrician Drive has been improved with curb and gutter and underground storm sewer system. This portion of Patrician Drive is an ideal area to implement a pilot Green Street project.

Many highly developed urban areas like New York, Boston, and Portland are incorporating Green Street designs throughout their cities to aid with pollutant load reduction and flood reduction. The success of most green design concepts is infiltration. Infiltration is dependent on the water table depth. In areas

like the City of Hampton, where there is not always enough depth between the BMP and the water table, an underdrain must be incorporated.

4.2.3. Reduce Impervious Cover

4.2.3.1. Convert Concrete Ditches

Converting concrete ditches to grass swales is beneficial in two ways. First, it reduces the impervious cover within the watershed. Second, is allows for pollutant load reductions. Figure 4-5 shows all the concrete ditches within the Back River/Lake Shores watershed. It may not be feasible to convert all the concrete ditches due to the amount of disruption to resident's yard and fences or adversely effecting hydraulic performance of the ditch.

4.2.3.2. Convert Impervious Pavement to Pervious Pavement

Potential areas for this conversion would be City owned properties. For example, Kraft Elementary has an asphalt path that runs the length of the property along the main drainage channel. Replacing this path with pervious pavers or pervious asphalt would reduce pollutant loading. Figure 4-4 shows the existing asphalt path at Kraft Elementary. Table 4-1 provides nutrient pollutant removal efficiencies for pervious pavement.

Figure 4-4: Impervious Path on Kraft Elementary Lot

Pollutant	Removal Efficiency
TN	25%
TP	25%
TSS	80%

Table 4-1: Pervious Pavement Removal Efficiencies

Figure 4-5: Concrete Ditch Locations

4.2.4. Pet Waste Management

Pet waste is a major contributor of bacterial pollutants into waterways. VDEQ reports there are approximately 7,000 registered dogs in the City of Hampton. Municipalities can do a variety of things to encourage pet owners to properly dispose of their animal's waste. They can distribute materials that explain how pet waste harms water quality and how citizens can help reduce water pollution. Additionally, municipalities can enact an ordinance that provides a legal basis to fine pet owners for improper waste disposal. Public awareness is definitely the first step in a pet waste management program. Sign postings are the most common outreach strategies.

4.2.5. Maintenance

4.2.5.1. Street Sweeping

Street sweeping removes trash, sediment and organic matter from the curb and gutter system, preventing them from entering storm drains and nearby streams. This reduces sedimentation and pollutants in the receiving waters. Adding a neighborhood to the sweeping route or increasing frequency of sweeping would address build-up of pollutants. Table 4-3 provides pollutant removal efficiencies for street sweeping from the EPA.

Pollutant	Removal Efficiency
TN	3%
TP	3%
TSS	9%

Table 4-3: Street Sweeping Pollutant Removal Efficiencies

4.2.5.2. Ditch Cleaning

The City of Hampton currently has a ditch maintenance plan and schedule in place. Multiple areas of the Back River/Lakes Shores watershed should be added to this plan and schedule. Large amounts of sediment were observed in roadside ditches and in the main channel of sub-watershed 1 as seen in Figure 4-6. The sub-watershed 1 main channel also has heavy vegetative growth along the banks that should be maintained annually. This will help with flooding issues throughout the main channel.

Figure 4-6: Approximately 12"-18" of Sediment and Debris in Upper Portion of Main Channel

4.2.5.3. Structure Cleaning

During field investigations, multiple storm sewer structures were observed to be full of trash and debris. Figure 4-7 shows an inlet on Todds Lane near Hunt Club Blvd that's undersized and full of trash and debris. Annual vacuuming off storm sewer structures can drastically reduce downstream pollutants.

Figure 4-7: Todd Lane Storm Structure

4.2.6. Monitoring

4.2.6.1. Illicit Discharge Detection

The City of Hampton has developed an illicit discharge detection and elimination program to find and remove contamination harmful to aquatic life and water quality. During a field investigation, a leaking sanitary sewer pipe was located along the main channel in sub-watershed 1 between Willowtree Road and the Bethel Church parking lot. This illicit discharge was reported to the City by Parsons Brinckerhoff immediately. The illicit discharge was not observed during a return field investigation. While these instances are not yet quantifiable, finding these illicit discharges and containing them improves the water quality conditions throughout the watershed and City.

4.2.6.2. Bacteria Source Tracking

Bacteria or Microbial Source Tracking (MST) is the process of locating the bacteria source and eliminating it at the source. MST always begins with the simplest techniques and moves to the more sophisticated. The first step is always a detailed sanitary survey involving review of GIS data and a stream walk to look for evidence of an anomaly. This part of the MST study was done and included in this report under section 4.2.6.1 and 5.2.2. The field inspection is typically followed by testing for fecal indicator bacteria during dry weather and wet weather events. Smoke testing or video inspection could be an included step. The final step could include bacteria speciation to determine if the bacteria were truly enteric or whether it was from re-growth in the sediments or environment. DNA testing of host specific marker can identify and quantify whether there is a human component. There are other host specific markers for dogs, gulls, geese, pigs and others.

4.2.7. Storm Drain Marking

Labeling storm drain inlet with plaques, tiles, or paint helps to keep citizens aware not to dump pollutants into the drain. Storm drain markers were not observed throughout the Back River/Lake Shores watershed.

4.2.8. Installation of Tide Valves or Gates

Residential areas along Newmarket Creek were identified for tidal event flooding in the Flood Areas Map provided by the City, located in Appendix B. The placement of tide valves or gates on the end of these storm sewer systems would substantially reduce reverse flow from high tide events. Industry opinion of tide valves and gates is mixed. They have the potential to get stuck open and require regular maintenance, especially tide gates. The time and cost of maintenance for these structures should be considered by the City prior to installation. Tide valves and gates also change the hydraulic performance of the storm sewer system. The existing storm systems will need to be analyzed prior to installation.

4.2.9. Public BMP Education

When placing stormwater treatment systems in residential areas it's important the residents understand how these treatment systems function and why maintenance of these systems is so critical. Mailings should be sent to each resident explain the project and the goals the City is trying to achieve through the project. Signs or placards could be used as reminders to the public of the benefits of these systems

and why they should be protected. Figure 4-8 shows use of an education sign along a Green Street in Portland, Oregon.

Figure 4-8: BMP Education Sign in Portland, Oregon

4.3.Stormwater Management Strategies

4.3.1. Stormwater BMP Conversions

Stormwater BMP conversions are retrofits of existing stormwater ponds to employ more effective treatment mechanisms. Detention ponds are typically designed to address flood reduction only and in turn provide almost no pollutant removal. This makes detention ponds good opportunities for conversion to a type of stormwater management facility that provides water quality benefits in addition to flood control.

4.3.2. New Stormwater Retrofits

New stormwater retrofits are projects that create storage to reduce nutrients from existing developed land that is not currently receiving any stormwater treatment. Based on initial evaluations, several sites with sufficient open space for stormwater retrofits to treat runoff from impervious surfaces were identified. These sites are located in the upper half of the watershed in neighborhoods, institutions, private properties and forested areas. The following BMP retrofits are proposed for the Back River/Lake Shores watershed:

- Extended Detention (ED) Constructed Wetlands
- Amended Grass Swales
- Wet Swales
- Urban Bioretention
- Rooftop Disconnection
- Hydrodynamic Separators

4.3.3. Stormwater Enhancements

Stormwater enhancements are retrofits that utilize the existing treatment mechanism in an existing BMP but improve removal by increasing storage volume or hydraulic residence time.

4.3.4. Urban Stream Restoration

Stream restoration practices are used to enhance the appearance, stability and aquatic function of urban stream corridors. Initial evaluation of the Lake Shore/Back River watershed showed opportunities for stream repair, stream cleanup, and buffer restoration along the sub-watershed 1 main channel. A revised report released by the Center for Watershed Protection (CWP) June 2013 titled "Cost-Effectiveness of Urban Stormwater BMPs in the James River Basin" puts urban stream restoration in the top three high cost-effectiveness BMPs for nitrogen, phosphorus and sediment removal.

Pollutant	Removal Efficiency
TN	0.2 lbs/ft
TP	0.068 lbs/ft
TSS	52.5 lbs/ft

Table 4-4: Urban Stream Restoration Efficiency from CWP Report

As of January 2012, CBP has approved the removal efficiencies for urban stream restoration found in Table 4-4.

5. Proposed Watershed Improvements

5.1. Introduction

This section describes specific proposed improvements that will improve pollutant removal and reduce flooding throughout the Back River/Lake Shores watershed as well as downstream waterways. Included in each improvement's description are the potential pollutant removals as well as flood reduction. This section also prioritizes the implementation of the proposed improvements in terms of need and potential. Some of the proposed improvements won't provide nutrient load reduction opportunities but they will enhance the efficiency of the existing drainage conveyance system and help alleviate existing flooding problems in the watershed.

In Appendix C, the proposed improvements are shown on maps that break the watershed into nine zones A-I. The following descriptions use these nine zones as reference. In Appendix D are calculations for TSS removal and summaries for the best management practices (BMPs) proposed in this section. Estimated sizing in the summaries is based on Virginia's BMP Clearinghouse minimum design standards and assumed ground water elevations.

All proposed improvements that involve land disturbance will require wetland delineation to make sure no wetlands are impacted during construction. A preliminary summary and description of anticipated permitting requirements have been provided for each proposed improvement map zone in Appendix E.

5.2.Prioritization of Improvements

5.2.1. Lynnhaven Lake Outlet Structure

Lynnhaven Lake has a contributing drainage area of approximately 133 acres comprised of residential, apartments, and forest land use. Currently the lake does not have a control structure so water flows constantly out into the main channel causing excessive erosion and flooding downstream. There is evidence that there used to be some sort of outfall structure at one time. Figure 5-1 shows the current outlet of the lake where large pieces of broken concrete are lying in the water. Figure 5-1 and Figure 5-2 show the existing condition of the lake's outfall.

Figure 5-1: Lynnhaven Lake Outfall

Figure 5-2: Channel at Lynnhaven Lake Outfall

Most of the pipe inverts coming into Lynnhaven Lake are well above the normal water surface elevation and the FIRM for the area shows that Lynnhaven Lake is in an AE floodplain zone with an elevation of 7.5'. The FIRM map can be found in Appendix A. City GIS data and survey information was used to create an approximate existing model of the lake in Bentley's Pondpack. FEMA information, results from the existing model and field observations are not conclusive enough to determine if the lake has room for additional storage.

The existing model was then run with a weir control structure added to the lake with an elevation of 6.0'. Estimated existing and proposed discharge rates and proposed water surface elevations can be found in Table 5-1.

Storm Event	Existing Outflow (cfs)	Proposed Outflow (cfs)	Proposed Water Surface Elev. (ft)
2-year	60.69	0	5.33
10-year	89.99	0	5.68
25-year	112.47	0	5.95
50-year	127.16	2.26	6.09
100-year	140.61	5.68	6.24

Table 5-1: Approximate Output for Lynnhaven Lake

5.2.1.1. Improvement Benefit

Placing an outlet control structure on Lynnhaven Lake will drastically reduce flooding and erosion issues in sub-watershed 1's main channel. A thorough survey and analysis should be done on Lynnhaven Lake to determine accurate existing conditions and the best outlet to fix flooding downstream. Improved retention time allows for sediment and nutrients to drop out. Potential pollutant reductions from Lynnhaven Lake are located in Table 5-2. This proposed improvement can be seen on map Zone F.

Pollutant	Load Reduction (lbs/yr)
TP	95.32
TN	360.35
TSS	27562

Table 5-2: Lynnhaven Lake Pollutant Load Reductions

5.2.2. Berkshire Terrace Culvert Replacement and Conflict Removal

In the main channel in sub-watershed 1, there is an existing 60" reinforced concrete pipe (RCP) that has a conflict sanitary sewer pipe running through it. There is evidence in the channel downstream of this culvert that the sanitary sewer pipe is most likely leaking and spreading bacteria into the watershed. During field investigations large amounts of algae growth was observed in the channel and a noticeable sewage odor was detected. Figure 5-2 shows algae growth in a downstream section of the channel between Benjamin Terrace and Willowtree Road.

Figure 5-2: Algae Plumes in Main Channel Downstream of Conflict Culvert

The existing 60" RCP should be replaced with two smaller equivalent diameter pipes to avoid the sanitary line. The sanitary sewer will also need to be partially replaced or reinforced to eliminate future leaking. A minimum double 36" culvert will be required to adequately convey the 10-year storm.

5.2.2.1. Improvement Benefit

This improvement will remove an illicit discharge and reduce bacterial pollutant loading. However, this reduction cannot be quantified. Complete survey of the area is needed to determine specific size of replacement pipes and if the sanitary sewer line can be completely avoided.

5.2.3. Willowtree Road Culvert Replacement

In the main channel in subwatershed 1 there is an existing double 42" culvert under Willowtree Road. The culvert is currently sitting up above the bottom of the channel as shown in Figure 5-3. The invert out of the 60" culvert immediately upstream of the Willowtree Road culvert is elevation 6.0'. The invert in of the double 42" culvert is 7.9' making the culvert the high point of the channel by almost two feet and creating a bottleneck effect in the channel. Frequent flooding has been observed in area by residents and channel erosion can be seen in Figure 5-4. The existing SWMM model reinforces the field observations and citizen's complaints. The proposed improvements can be seen on map Zone E.

Figure 5-3: Upstream Entrance of Double 42" Culvert under Willowtree Road

Figure 5-4: Main Channel Sub-watershed 1 Erosion

The double culvert should be replaced with the same size pipes but placed lower in the channel. The channel needs to be widened, regraded and stabilized from the upstream 60" pipe to the double 48" culvert under the Bethel Church parking lot at the intersection of Hunts Club Blvd and Todds Lane. Adjacent to this portion of the channel is an empty privately owned property that is labeled as area of interest (AOI) #1 on map Zone E. This land could be used to expand the channel or provide urban stream restoration.

5.2.3.1. Improvement Benefit

This improvement will help to alleviate some of the flooding issues in the area by improving hydraulic efficiency within the channel and allowing flow to pass through more smoothly. This improvement could also provide more storage that will keep larger storms events contained within the channel. If urban stream restoration was incorporated through this area, pollutant load reductions found in Table 5-3 could be applied.

Pollutant	Load Reduction (lbs/yr)
TP	80
TN	27.2
TSS	21000

Table 5-3: Urban Stream Restoration Potential Pollutant Removal

5.2.4. Inlet Replacement, New Inlets, New Curb & Gutter

There are a few areas within the watershed where inadequate curb inlet sizes are causing large spreads in the roadway. These curb inlets need to be replaced with new curb inlets with longer throats. Proposed improvement maps zones B, C, and E show inlet replacement locations. Figure 5-5 shows a few of the undersized and damaged inlets on Todds Lane, Lowden Hunt Drive and Concord Drive.

Figure 5-5: Undersized and Damaged Inlets in Flood Areas

There are also a couple locations on Concord Drive where additional inlets will help alleviate roadway flooding. One of the proposed inlets is shown in City GIS but an existing inlet could not be located during field investigations.

The existing curb and gutter along Benjamin Terrace between Winchester Drive and Springdale Way is not adequately conveying roadway drainage to the existing inlets. The low points of the gutter are not at the inlets; instead the low points are off to the sides of the inlets causing water to pond on the road.

Figure 5-6: Benjamin Terrace Existing Conditions

5.2.4.1. Improvement Benefits

This improvement will help alleviate flooding on five residential streets in the Northampton neighborhood as well as on Todds Lane. The inlets to be replaced can be seen on proposed improvement maps Zone B, C, and E. The two new inlet locations can be seen on map Zone C and the new curb and gutter can be seen on Zone E.

5.2.5. Kraft Elementary School Extended Detention Wetland Retrofit

Kraft Elementary school located in the Northampton neighborhood on Concord Drive has adequate space for a new stormwater retrofit. Approximately 34 acres of residential area currently drains through the school site in three storm sewer systems. Two of the systems are located along the school's back property line and third system is located between the school's athletic fields. All three storm sewer systems discharge into the main channel in sub-watershed 1. Figure 5-8 shows the existing storm sewer systems running through the Kraft school site.

Figure 5-8: Existing Storm Sewer Systems on Kraft School Site

This proposed improvement diverts the existing storm sewer systems to the new ED wetland with new storm sewer pipes as well as redirecting an existing grass swale and converting it to an amended swale. The proposed area for the constructed wetland is currently forested land and is just north of the school's athletic fields.

5.2.5.1. Improvement Benefits

Flood reduction and nutrient load reduction can be provided with this improvement. This improvement could provide a runoff reduction of 800 cubic feet (CF) and approximately 46,000 CF of additional storage. Table 5-4 provides the potential pollutant load reduction for the Kraft Elementary school retrofit. The layout for this improvement can be seen on map Zone A.

Pollutant	Load Reduction (lbs/yr)
TP	20.72
TN	62.54
TSS	6595

Table 5-4: Potential Kraft Elementary Pollutant Removal

5.2.6. Aberdeen School Neighborhood Park ED Wetland Retrofit

Aberdeen School Neighborhood Park located in the Aberdeen Gardens neighborhood has adequate space for a new stormwater retrofit. Approximately 31 acres of roadway, residential and school area drains through storm sewer system and a large swale into the main channel in sub-watershed 1. Figure 5-9 shows the existing condition at the proposed site. In this proposed improvement, runoff is diverted into a new ED constructed wetland in the southeast corner of the school property.

Figure 5-9: Aberdeen School Existing Conditions

5.2.6.1. Improvement Benefit

This proposed improvement provides both pollutant load reduction and flood reduction for the watershed. This improvement could provide approximately 42,000 CF of additional storage. Table 5-5 provides the pollutant load reduction for the Aberdeen School Neighborhood Park retrofit. The layout for this improvement can be seen on proposed improvement map Zone H.

Pollutant	Load Reduction (lbs/yr)
TP	19.30
TN	55.22
TSS	6794

Table 5-5: Potential Aberdeen Wetland Load Reduction

5.2.7. Bonwood Road City-Owned Property Retrofit

An existing 290 foot swale is located on the City owned property at the end of Bonwood Road (PIN 4002206) is experiencing flooding issues. As shown in Figure 5-10, the wet swale is in between two 42" RCP storm sewer systems immediately upstream of Lynnhaven Lake. The City-owned property is 0.12 acres which is not large enough for a BMP that will provide nutrient or flood reduction for the entire 89 acre contributing drainage area. The option of enclosing the swale in storm sewer was contemplated; however, preliminary calculations show that the downstream existing 42" pipe may also be undersized and would need to be replaced. This would disrupt multiple residential properties but would help alleviate area flooding.

Figure 5-10: Existing Conditions of Swale on Bonwood Road (inlet left, outlet right)

5.2.7.1. Improvement Benefits

Expanding the swale or converting the swale to storm sewer would provide immediate flood reduction for the area. To avoid disruption to multiple residential lots, expanding the wet swale on the city-owned property is considered the best solution. Wetland cells could be placed offline from the wet swale to provide storage during high flows. Unfortunately, the Virginia BMP Clearinghouse specifications state that maximum contributing drainage area to a wet swale is 5 acres meaning nutrient removal will not be credited for this improvement. The location for this improvement can be seen as AOI on proposed improvement map Zone D.

5.2.8. Northampton Neighborhood Amended Grass Swales

There are existing ditches in the residential alleys in the Northampton neighborhood from Patrician Drive east to Winchester Drive between Burton Street and Benjamin Terrace. The fences along these

alleys are offset leaving approximately a 10 foot alley. Figure 5-11 shows the residential alleys in the Northampton neighborhood.

Figure 5-11: Existing Grass Swales in Northampton Alleys

5.2.8.1. Improvement Benefit

This proposed improvement converts the existing grass ditches to amended soil grass swales. This improvement provides both pollutant load reduction and flood reduction for the watershed. This improvement could provide a runoff reduction of approximately 15,000 CF. Table 5-5 provides the pollutant load reduction for the Northampton Neighborhood swale conversions. The layout for this improvement can be seen on map Zone A and Zone C.

Pollutant	Load Reduction (lbs/yr)
TP	12.93
TN	100.46
TSS	3953

Table 5-5: Potential Amended Swale Load Reduction

5.2.9. 117 Winchester Improvements

The resident at 121 Winchester Drive has contacted and met with the City about drainage issues along his and his neighbors' back property lines. Figure 5-12 shows an existing 36" pipe that crosses the property at 117 Winchester. The headwall of the system is broken and falling into the channel. About a foot of sediment has diminished the capacity of the existing pipe causing water to back up into the existing swales on the Bethel Church property. This 36" pipe needs to be upsized to a 42" pipe and the headwall replaced. The new layout of the storm sewer system should follow the existing property lines of 117 and 115 Winchester. The City of Hampton should obtain a drainage easement along this system.

Figure 5-12: Existing 36" Storm Sewer Pipe on 117 Winchester Drive Property

5.2.9.1. Improvement Benefit

This proposed improvement will help stabilize the inlet of the storm sewer system and protect against erosion. It will also stabilize the existing conditions and help reduce flooding in the area. The layout for this improvement is shown on map Zone E.

5.2.10. Bethel Church Extended Detention Wetland Retrofit

The Bethel Church on Todds Lane between Patrician Drive and Winchester Drive has two large swales that converge at the 36" pipe shown in Figure 5-12. A large amount of runoff is conveyed through these swales and storm sewer system and sediment loading is a major concern at this junction. Additional acreage from outside the provided watershed boundary is conveyed through the swale transecting the Bethel Church property shown in Figure 5-13.

Figure 5-13: Existing Swale on Bethel Church Land and Site for Proposed Wetland

Figure 5-14: Existing Swale from Berkshire Terrace along Property Line

5.2.10.1. Improvement Benefit

Section 5.2.8 proposes upsizing the 36" pipe to a 42" pipe to help with flooding in the area. This proposed improvement includes converting the grass swale, in Figure 5-14 from Berkshire Terrace, to an amended grass swale and diverting it into an extended detention constructed wetland. The addition of the amended swale and an ED constructed wetland on the Bethel land provides a runoff reduction of approximately 3,400 CF and 8,700 CF of additional storage as well as nutrient load reduction. Table 5-6 provides the potential nutrient load reductions for this proposed improvement. The area of Interest (AOI) 1 shown on Zone E map in Appendix C is the Bethel Church lot.

Pollutant	Load Reduction (lbs/yr)
TP	5.02
TN	28.24
TSS	1826

Table 5-6: Potential Bethel Church Retrofit Pollutant Load Removal

5.2.11. I-64/Mercury Blvd Interchange Pond Conversion

As mentioned in section 2.2 of this plan, an existing SWM facility is located in the southwest cloverleaf of the I-64/Mercury Blvd interchange. From the 2009 project plan set, provided by the City of Hampton, it seems the pond was designed to be an extended detention pond. However, during each field visit, a permanent pool of water was observed in the pond as shown in Figure 5-15. Table 5-7 provides pollutant load reduction for a level 1 extended detention pond (existing), a level 2 wet pond (proposed), and the difference between the two (new).

Figure 5-15: Existing SWM Facility I-64/Mercury Blvd Interchange

5.2.11.1. Improvement Benefits

This proposed improvement provides additional nutrient removal to the watershed. The design plans and City GIS data were used to create an approximate existing model of the pond in Bentley's Pondpack. From this model, it was determined that additional storage is not available

in the pond. However, there is room for the conversion. A thorough survey and analysis should be done on the pond to determine accurate existing conditions. Table 5-7 provides the potential pollutant load reductions.

Pollutant	Existing Load Reduction (lbs/yr)	Proposed Load Reduction (lbs/yr)	New Load Reduction (lbs/yr)
TP	35.47	57.20	21.73
TN	170.05	175.73	5.68
TSS	1747	10479	8732

Table 5-7: Potential I-64/Mercury Conversion Pollutant Load Reductions

5.2.12. School Rooftop Disconnection

There are two public schools within the Back River/Lake Shore watershed. Kraft Elementary located in the Northampton neighborhood was discussed in section 5.2.5 and Aberdeen School Neighborhood Park located in Aberdeen Gardens was discussed in 5.2.6. Both of these schools have drainage downspouts. Some of the downspouts tie into the storm sewer system underground, as shown in Figure 5-16, and some discharge onto the ground.

Figure 5-16: Downspout on Kraft Elementary

5.2.12.1. *Improvement Benefits*

This proposed improvement could provide 5,500 CF of runoff reduction. There are a few end treatment options for rooftop disconnection that can provide nutrient load reductions. The pollutant load removals shown in Table 5-8 are for a dry well or French drain treatment.

Kraft	
Pollutant	Load Reduction (lbs/yr)
TP	2.58
TN	17.00

Aberdeen	
Pollutant	Load Reduction (lbs/yr)
TP	1.78
TN	11.40

Table 5-8: Potential Rooftop Disconnection Pollutant Load Reductions

5.2.13. North Walker Road Swale Retrofit

On the north side of North Walker Road is an existing swale that drains into the main channel in sub-watershed 1, shown in Figure 5-17. This proposed improvement converts the existing grass swale into an amended grass swale.

Figure 5-17: Existing Swale along North Walker Road

5.2.13.1. *Improvement Benefit*

This proposed improvement provides both pollutant load reduction and flood reduction for the watershed. The improvement could provide approximately 6,800 CF of runoff reduction. Table 5-9 provides the pollutant load reduction for the North Walker Road swale conversion.

Pollutant	Load Reduction (lbs/yr)
TP	5.81
TN	45.15
TSS	1863

Table 5-9: Potential North Walker Road Pollutant Load Reductions

5.2.14. Main Channel Stream Restoration

Approximately 1,650 feet of the lower portion of the main channel in sub-watershed 1 starting at East Weaver Road is experiencing severe erosion and has migrated to the north towards residential backyards. The area is also experiencing tidal flooding. Figure 5-18 shows the existing condition of the channel in this section.

Figure 5-18: Main Channel Existing Conditions

5.2.14.1. Improvement Benefit

This proposed improvement would restore the natural channel alignment and stabilize the eroding banks. Urban stream restoration also provides nutrient load reductions. Table 5-10 provides the pollutant load reductions.

Pollutant	Load Reduction (lbs/yr)
TP	80
TN	27.2
TSS	21000

Table 5-10: Potential Main Channel Stream Restoration Pollutant Reductions

5.2.15. 40 Hunt Club Blvd Retrofit

There is a privately-owned lot at 40 Hunt Club Blvd that could be used for a new stormwater retrofit. Approximately 30.5 acres of residential area could be diverted to this site with a couple new storm sewer pipes and manholes. The site is big enough to accommodate an extended-detention constructed wetland. The area of interest for this improvement is #3 on proposed improvement map zone E. Figure 5-19 shows the existing conditions at the proposed site.

Figure 5-19: Private lot 40 Hunt Club Blvd and Main Channel

5.2.15.1. Improvement Benefit

This proposed improvement provides both pollutant load reduction and flood reduction for the watershed. This improvement could provide approximately 41,000 CF of storage. Table 5-11 provides the pollutant load reduction for the 40 Hunt Club Blvd retrofit.

Pollutant	Load Reduction (lbs/yr)
TP	6.09
TN	47.30
TSS	1813

Table 5-11: Potential 40 Hunt Club Blvd Retrofit Pollutant Reductions

5.2.16. Bromsgrove Drive Swale Conversion

There is an existing concrete swale from Bromsgrove Drive to I-64 between the dead end of Bromsgrove Drive and the dead end of Lynnhaven Drive shown in Figure 5-20. This proposed improvement includes removing the concrete swale, amending the soil in the swale and widening the swale to provide pollutant removal and runoff reduction. This improvement also includes amending an upstream swale and redirecting a portion of the existing storm sewer system.

Figure 5-20: Existing Concrete Swale from Bromsgrove Drive

5.2.16.1. Improvement Benefits

Currently the area that would be redirected drains to the swale discussed in section 5.2.16 through an elliptical pipe located under a garage. According to the map in Appendix B, the area in 5.2.16 near the garage experiences constant flooding. Redirecting runoff from that area to the Bromsgrove swale will help to alleviate flooding problems. This proposed improvement could

also provide 6,300 CF of runoff reduction. Table 5-12 provides the pollutant load reduction for the Bromsgrove Swale Conversion.

Pollutant	Load Reduction (lbs/yr)
TP	5.40
TN	42.00
TSS	1537

Table 5-12: Potential Bromsgrove Swale Conversion Pollutant Reduction

5.2.17. Lynnhaven Drive/Olsen Court Swale Conversion

There is an existing concrete swale that goes from Lynnhaven Drive to I-64 between the dead end of Olsen Court and the dead end of Dover Road. This proposed improvement includes removing the concrete swale, amending the soils in the swale, and expanding the swale to provide additional pollutant and runoff reduction. There is room to expand this swale for additional storage. Figure 5-21 shows the existing concrete swale towards I-64 and Figure 5-22 shows the upstream portion of the channel towards the elliptical under the garage during a rain storm.

Figure 5-21: Existing Swale from Lynnhaven Drive to I-64

Figure 22: Existing Swale from Lynnhaven Drive to garage

5.2.17.1. Improvement Benefit

This proposed improvement provides both pollutant load reduction and flood reduction for the watershed. This improvement could provide a runoff reduction of 7,100 CF. Expanding the swale will provide additional storage and help alleviate existing flooding issues in the immediate area. Table 5-13 provides the pollutant load reduction for the Lynnhaven Drive/Olsen Court swale conversion.

Pollutant	Load Reduction (lbs/yr)
TP	6.09
TN	47.30
TSS	1813

Table 5-13: Potential Lynnhaven Drive/Olsen Drive Swale Conversion Pollutant Reduction

5.2.18. Hydrodynamic Separators Retrofit

Existing inlets on City owned properties can be retrofitted with manufactured stormwater BMPs, specifically the two school sites discussed in section 5.2.5 and 5.2.6 of this plan. Hydrodynamic separators could be retrofitted into the existing inlets and provide some pollutant load reductions. Hydrodynamic separators can provide 15-20% P removal and 85% TSS removal. Currently, hydrodynamic separators are on the approved BMP list in the City of Hampton.

5.2.19. Hunt Club Blvd Retrofit

This proposed improvement involves retrofitting the median located on Hunt Club road to treat runoff from the roadway. The total existing available space within the median is 0.59 acres. Bioretention systems placed in the median, shown in Figure 5-23, could provide stormwater treatment in a linear bioretention system.

Figure 5-23: Existing Conditions of Hunt Club Blvd

In order to get enough impervious surface area to the medians, the roadway surface would need to be redirected so they drain towards the medians. Curb cuts would be placed in the medians to allow the runoff to reach the treatment cells. This improvement would also require new storm sewer piping to redirect the discharges from the bioretention cells. This proposed improvement would be expensive to implement but beneficial. The layout for this proposed improvement is shown on map Zone D and Zone E.

5.2.19.1. Improvement Benefits

This proposed improvement could provide pollutant reduction and flood reduction. Table 5-14 provides the pollutant load reduction for the Hunt Club Blvd Retrofit.

Pollutant	Load Reduction (lbs/yr)
TP	6.09
TN	47.30
TSS	1813

Table 5-14: Potential Hunt Club Blvd Retrofit Pollutant Reduction

5.3.Potential Funding Sources

5.3.1. Chesapeake Bay Stewardship Fund

The National Fish and Wildlife Foundation (NFWF), in partnership with the EPA and the CBP, award approximately $8-$10 million in grants annually. Requests for proposals are usually due in May of each year. Grants are awarded in two main categories:

- Small Watershed Grants (SWGs) of $20,000 to $200,000 each will be awarded to nonprofit organizations and local governments working to protect and improve local waters that contribute to the overall health of the Chesapeake Bay, while building citizen-based resource stewardship. These grants require minimum matching contributions valued at 25% of total project costs.
- Innovative Nutrient and Sediment Reduction Grants (INSRGs) of $200,000 to $750,000 each will be awarded to nonprofit organizations, local governments, universities and state agencies to demonstrate innovative approaches to accelerate adoption of the most cost effective and sustainable approaches to reducing nutrient and sediment pollution to the Chesapeake Bay. These grants encourage non-Federal matching contributions valued at 50% of total project costs.

5.3.2. Chesapeake Bay Trust

Provides grants through a variety of grant programs that focus on environmental education, urban greening, fisheries, and remediation of water quality issues. Specifically the Targeted Watershed Grant Program provides funding for on-the ground solutions that address the most pressing nonpoint source pollution challenges facing a small watershed, and that result in measurable improvements in water quality and wildlife habitat. The program also seeks to support cost effective approaches to Chesapeake Bay restoration actions at the small watershed scale and establish a replicable model of restoration that can be transferred and used throughout the region.

5.3.3. Virginia DEQ Stormwater Local Assistance Fund (SLAF)

VDEQ's Clean Water Financing and Assistance Program is currently developing a SLAF that will provide up to $35 million of bonds to localities throughout Virginia to reduce non-point source pollution from stormwater runoff. A draft was released for public comment July 19, 2013 which stated:

"The purpose of the Fund is to provide matching grants to local governments for the planning, design, and implementation of stormwater best management practices that address cost efficiency and commitments related to reducing water quality pollutant loads. Moneys in the Fund shall be used to meet: i) obligations related to the Chesapeake Bay total maximum daily load (TMDL) requirements; ii)

requirements for local impaired stream TMDLs; iii) water quality requirements of the Chesapeake Bay Watershed Implementation Plan (WIP); and iv) water quality requirements related to the permitting of small municipal stormwater sewer systems. The grants shall be used solely for capital projects meeting all pre-requirements for implementation, including but not limited to: i) new stormwater best management practices; ii) stormwater best management practice retrofits; iii) stream restoration; iv) low impact development projects; v) buffer restoration; vi) pond retrofits; and vii) wetlands restoration."

A public meeting was conducted August 14, 2013 and the State Water Control Board met September 30th to approve the recommended guidelines. Remaining schedule for 2013 is as follows:

- Oct. 4 (est.) – DEQ solicitation/RFP issued
- Nov. (date TBD) – Local government grant applications due
- Dec. – DEQ/SWCB selection/approval

5.3.4. Chesapeake Bay Restoration Fund Grant Program

The Chesapeake Bay Restoration Advisory Committee accepts grant applications to conduct Chesapeake Bay-related education and restoration activities. To be eligible for receiving a grant, applicants should submit proposals emphasizing environmental education or restoration and conservation of the Chesapeake Bay. Applications are due October 1 annually.

5.4.Engineer's Probable Cost and Pollutant Removal Breakdown

Preliminary construction cost estimates were prepared for each of the proposed improvements discussed in section 5.2 of this plan. Table 5-15 is a summary of those construction cost estimates, pollutants removed and the cost per pound of pollutants removed for improvements that provide some type of nutrient removal. Detailed cost estimates for all proposed improvements are located in Appendix E.

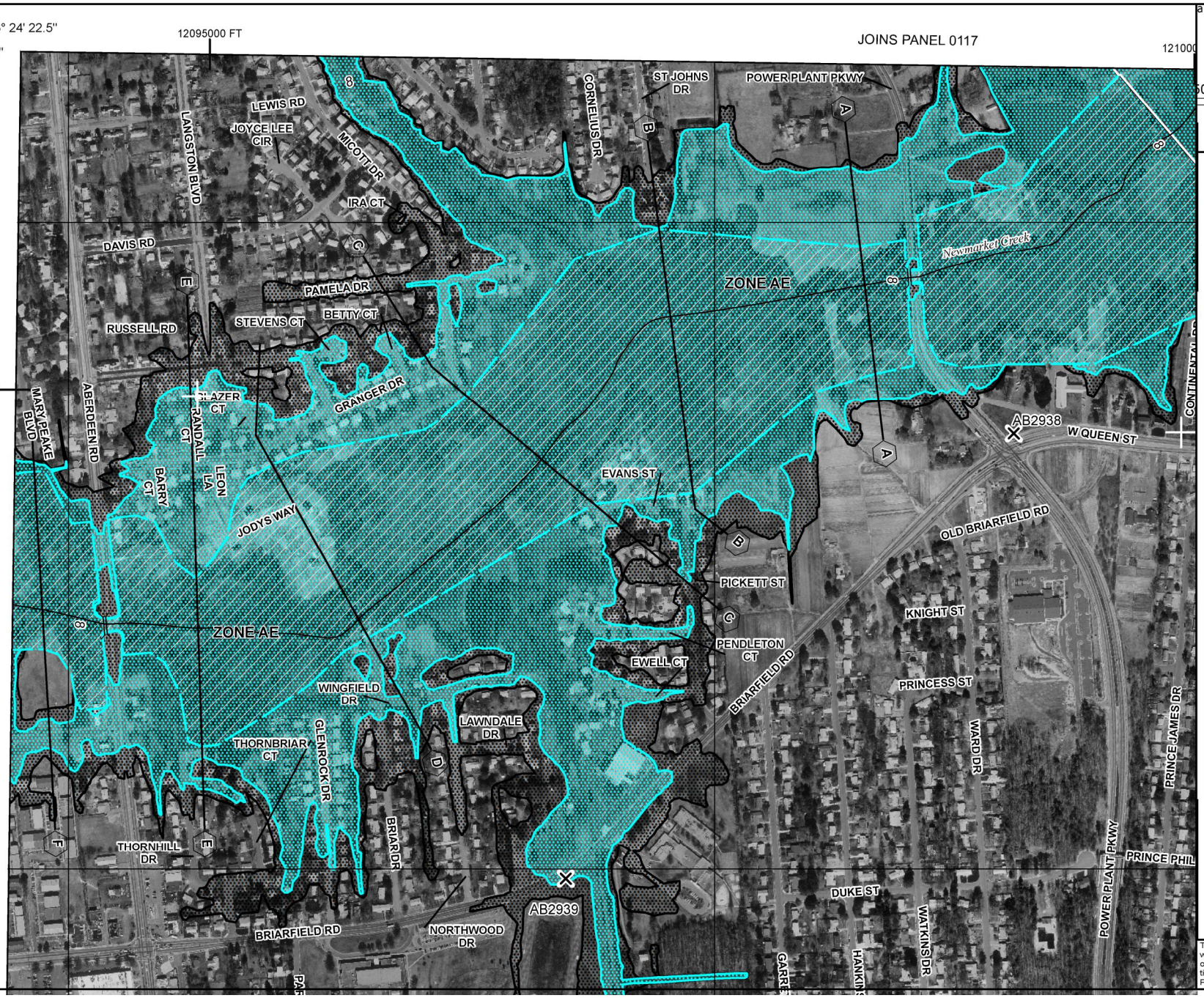
Option	Description	Cost	Pollutants Removed (lbs/year)			Cost per Pound of Pollutants Removed		
			TP	TN	TSS	TP	TN	TSS
5.2.5	Kraft Elementary Retrofits	$527,401	20.82	63.59	6595	$25,331	$8,294	$80
5.2.6	Aberdeen School Wetland Retrofit	$304,239	19.30	55.22	6794	$15,764	$5,510	$45
5.2.8	Amended Swales Retrofit	$304,500	12.93	100.46	3953	$23,550	$3,031	$77
5.2.10	Bethel Church Retrofit	$128,267	5.02	28.24	1826	$25,551	$4,542	$70
5.2.11	I-64/Mercury Blvd Interchange Conversion	$611,610	21.73	5.68	8732	$28,146	$107,678	$70
5.2.12	Schools Rooftop Disconnection	$20,000	4.36	28.4	NA	$4,587	$704	NA
5.2.13	Walker Road Swale Retrofit	$29,290	5.81	45.15	1863	$5,041	$649	$16
5.2.14	Main Channel Stream Restoration	$412,500	80	27.2	21000	$5,156	$15,165	$20
5.2.15a	40 Hunt Club Blvd Retrofit	$269,294	17.23	49.3	5882	$15,629	$5,462	$46
5.2.15b	1705 Todds Lane Retrofit	$190,856	11.13	31.85	3757	$17,148	$5,992	$51
5.2.16	Bromsgrove Drive Swales Retrofit	$112,636	5.4	42	1537	$20,859	$2,682	$73
5.2.17	Lynnhaven Drive-Olsen Court Retrofit	$97,933	6.09	47.3	1813	$16,081	$2,070	$54
5.2.18	Hydrodynamic Separator Retrofits	$60,000	0.38	NA	672	$157,895	NA	$89
5.2.19	Hunt Club Blvd Bioretention Retrofit	$429,225	9.44	78.56	4334	$45,469	$5,464	$99

Table 5-15: Summary of Cost and Pollutant Removal by Proposed Improvement

Cost Estimate Notes:

1. Cost estimates do not include cost for land acquisition, easements, right-of-way, surveying, geotechnical, private utility relocations or permitting.
2. These costs do not include erosion and sediment control measures.
3. These costs do not include stream/wetland mitigation fees.
4. Each improvement cost includes an estimated 25% for design costs.
5. Unit costs are based on current typical construction costs in the region. These unit costs may vary by the time projects are implemented.

Appendix A – FEMA Documents



ance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

50 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0119G

FIRM

FLOOD INSURANCE RATE MAP

CITY OF

HAMPTON, VIRGINIA

(INDEPENDENT CITY)

PANEL 119 OF 315

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HAMPTON, CITY OF	515527	0119	G

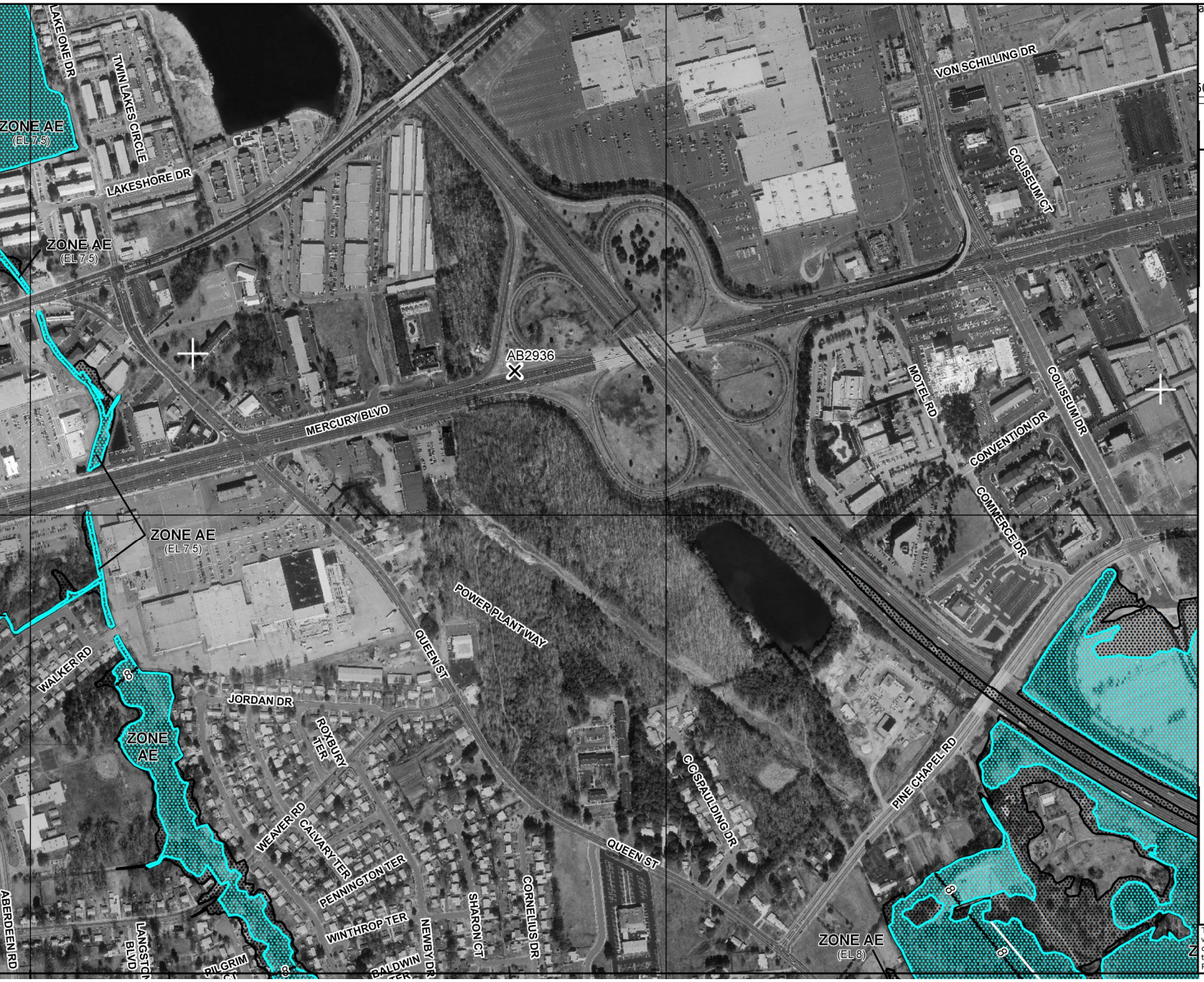
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
5155270119G

MAP REVISED
AUGUST 16, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



ance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

50 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0117G

FIRM

FLOOD INSURANCE RATE MAP

CITY OF

HAMPTON, VIRGINIA

(INDEPENDENT CITY)

PANEL 117 OF 315

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HAMPTON, CITY OF	515527	0117	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
5155270117G

MAP REVISED
AUGUST 16, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

ance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

50 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0116G

FIRM

FLOOD INSURANCE RATE MAP

CITY OF

HAMPTON, VIRGINIA

(INDEPENDENT CITY)

PANEL 116 OF 315

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HAMPTON, CITY OF	515527	0116	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
5155270116G

MAP REVISED
AUGUST 16, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Newmarket Creek								
A	22,221	650	2,865	1.0	7.5	5.2[3]	5.4[3]	0.2
B	23,221	1,350	6,325	0.4	7.5	5.4[3]	5.5[3]	0.1
C	24,221	850	3,858	0.7	7.5	5.4[3]	5.5[3]	0.1
D	25,471	1,000	4,422	0.6	7.5	5.5[3]	5.6[3]	0.1
E	26,321	850	3,999	1.1	7.5	5.6[3]	5.6[3]	0.0
F	27,121	900	5,877	0.7	7.5	7.4	7.4	0.0
G	28,571	400	2,240	1.2	7.5	7.5	7.5	0.0
H	29,621	400	2,428	1.1	7.6	7.6	7.7	0.1
I	31,336	400	2,462	1.1	8.8	8.8	9.0	0.2
J	32,071	400	2,208	1.1	8.9	8.9	9.1	0.2
K	42,256	202/294[2]	464	1.4	11.6	11.6	12.4	0.9
L	44,933	52/100[2]	220	2.3	13.9	13.9	14.9	1.0
M	46,033	52/100[2]	300	1.7	14.2	14.2	15.2	1.0
N	47,513	50/100[2]	950	2.7	14.6	14.6	15.6	1.0
O	48,563	70/100[2]	940	2.5	14.9	14.9	15.9	1.0
P	50,853	56/100[2]	720	2.6	16.4	16.4	16.5	0.1
Q	52,258	56/100[2]	710	2.3	17.3	17.3	17.3	0.0
R	54,533	51/100[2]	570	2.6	17.4	17.4	17.4	0.0

[1]Feet above Mouth

[2]Width within City of Hampton / Total Width

[3]Elevations computed without considering backwater effects from the Back River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HAMPTON, VA
INDEPENDENT CITY

FLOODWAY DATA

NEWMARKET CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Newmarket Creek (continued)								
S	55,633	41/100[2]	580	2.4	17.7	17.7	17.7	0.0
T	57,383	41/100[2]	520	2.6	18.1	18.1	18.1	0.0
U	58,783	66[3]	406	2.0	18.3	18.3	18.3	0.0
V	59,783	65[3]	390	2.0	18.5	18.5	18.5	0.0
W	60,483	58[3]	308	2.4	19.2	19.2	19.2	0.0
X	61,283	57[3]	303	2.4	19.4	19.4	19.2	0.0
Y	62,783	57[3]	293	2.5	19.8	19.8	19.8	0.0
Z	63,282	50[3]	226	3.3	19.9	19.9	19.9	0.0
AA	64,683	49[3]	222	3.0	20.8	20.8	20.8	0.0

[1]Feet above mouth

[2]Width within City of Hampton / Total Width

[3]Cross-section falls outside of corporate limits

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HAMPTON, VA
INDEPENDENT CITY

FLOODWAY DATA

NEWMARKET CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Newmarket Creek Tributary								
A	394	28/31	94	2.9	21.7	21.7	21.7	0
B	794	12/23	43	1.6	22.1	22.1	22.1	0

[1]Feet above confluence with Newmarket Creek

[2]Width within City of Hampton / Total Width

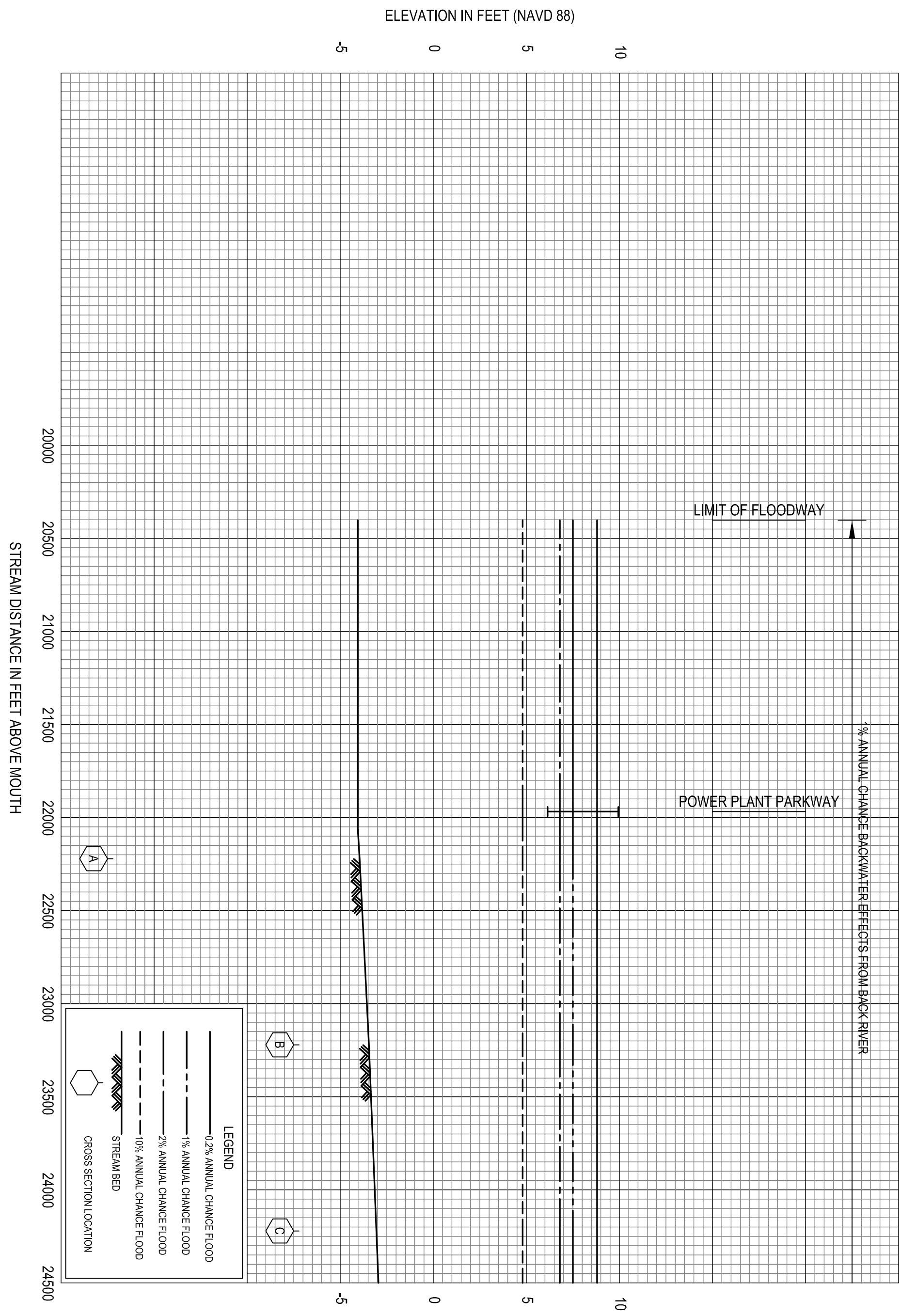
TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HAMPTON, VA
INDEPENDENT CITY

FLOODWAY DATA

NEWMARKET CREEK TRIBUTARY



FEDERAL EMERGENCY MANAGEMENT AGENCY

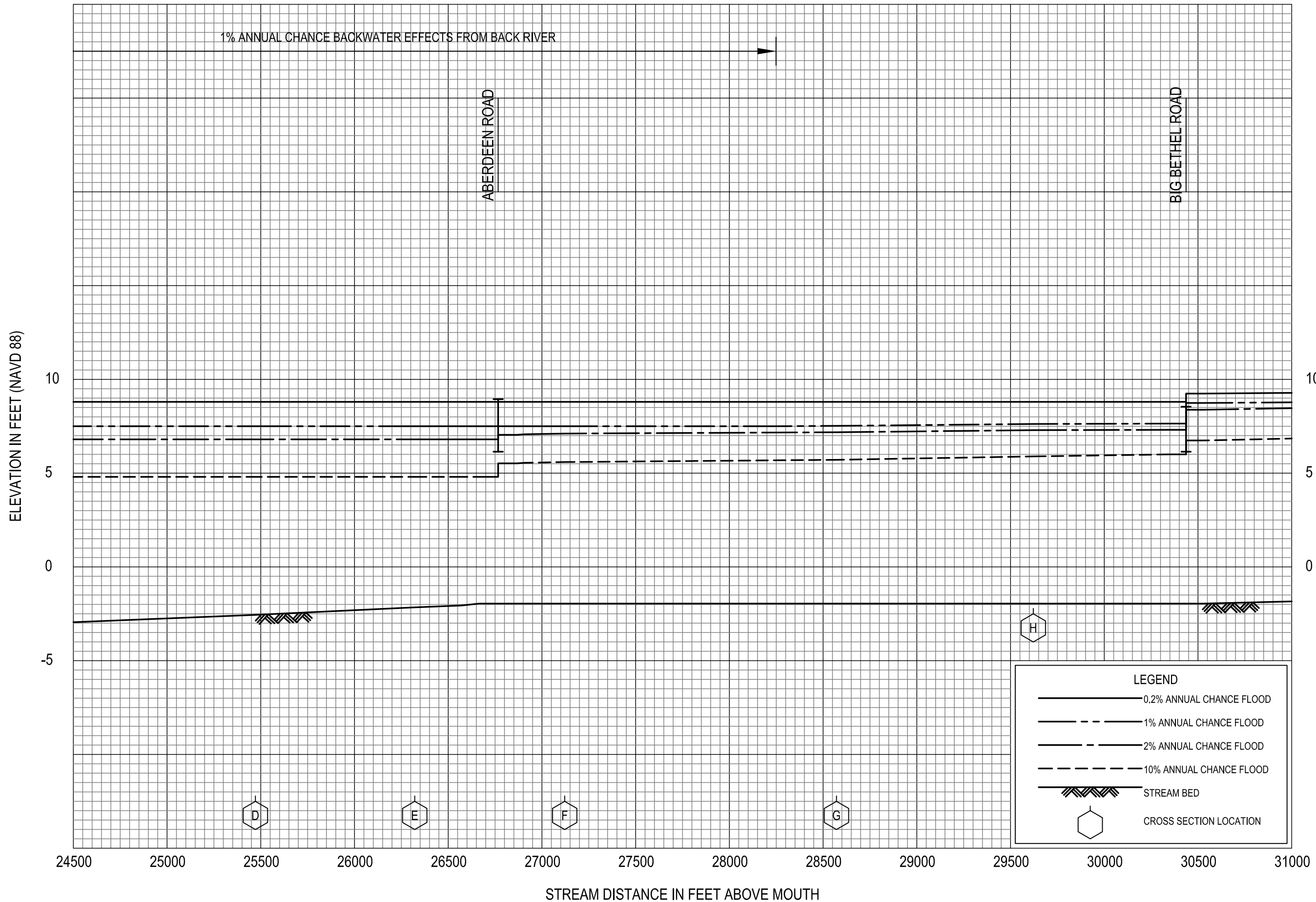
CITY OF HAMPTON, VA

INDEPENDENT CITY

FLOOD PROFILES

NEWMARKET CREEK

01P



FLOOD PROFILES

NEWMARKET CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HAMPTON, VA

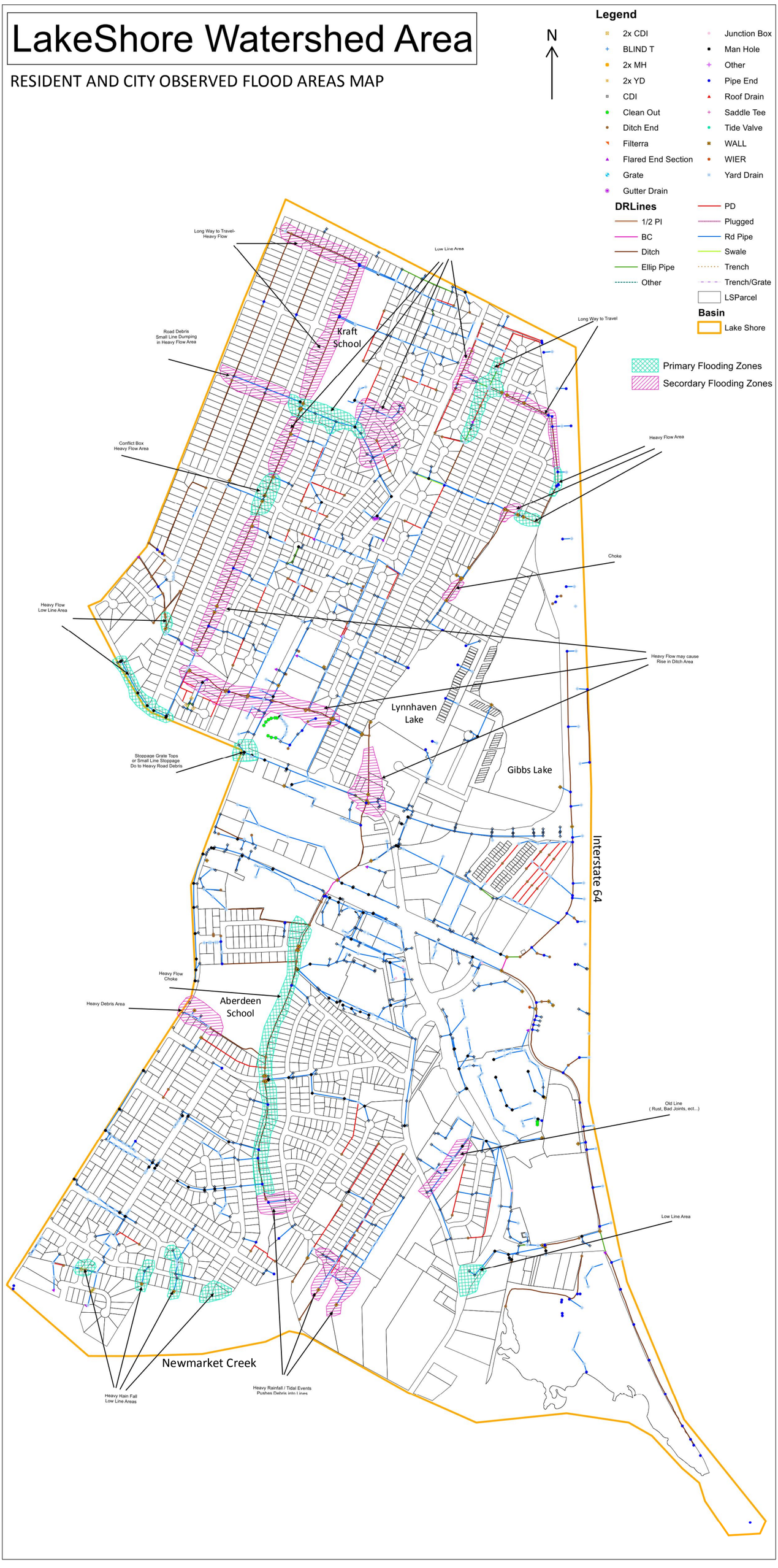
INDEPENDENT CITY

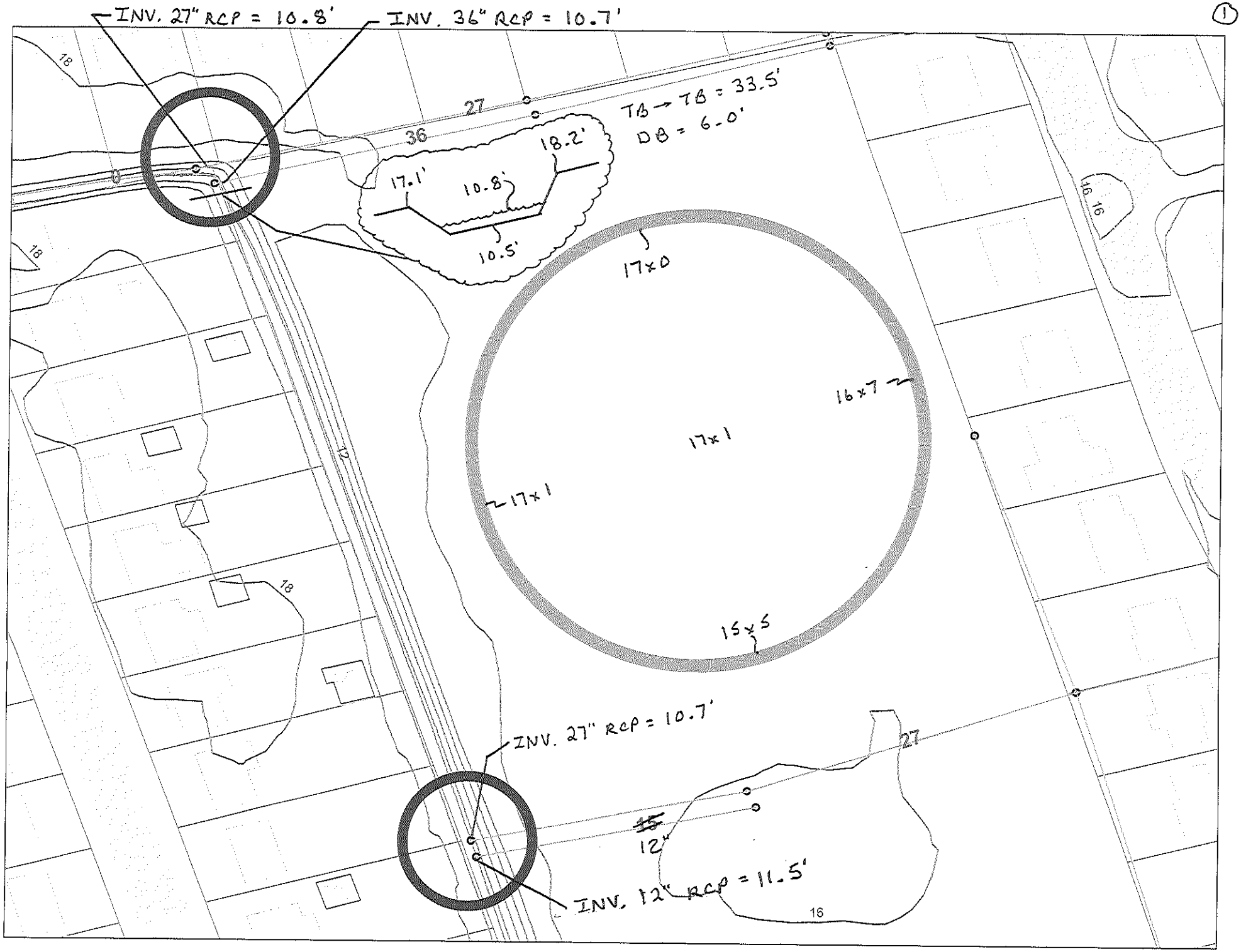
02P

Appendix B – Existing Data

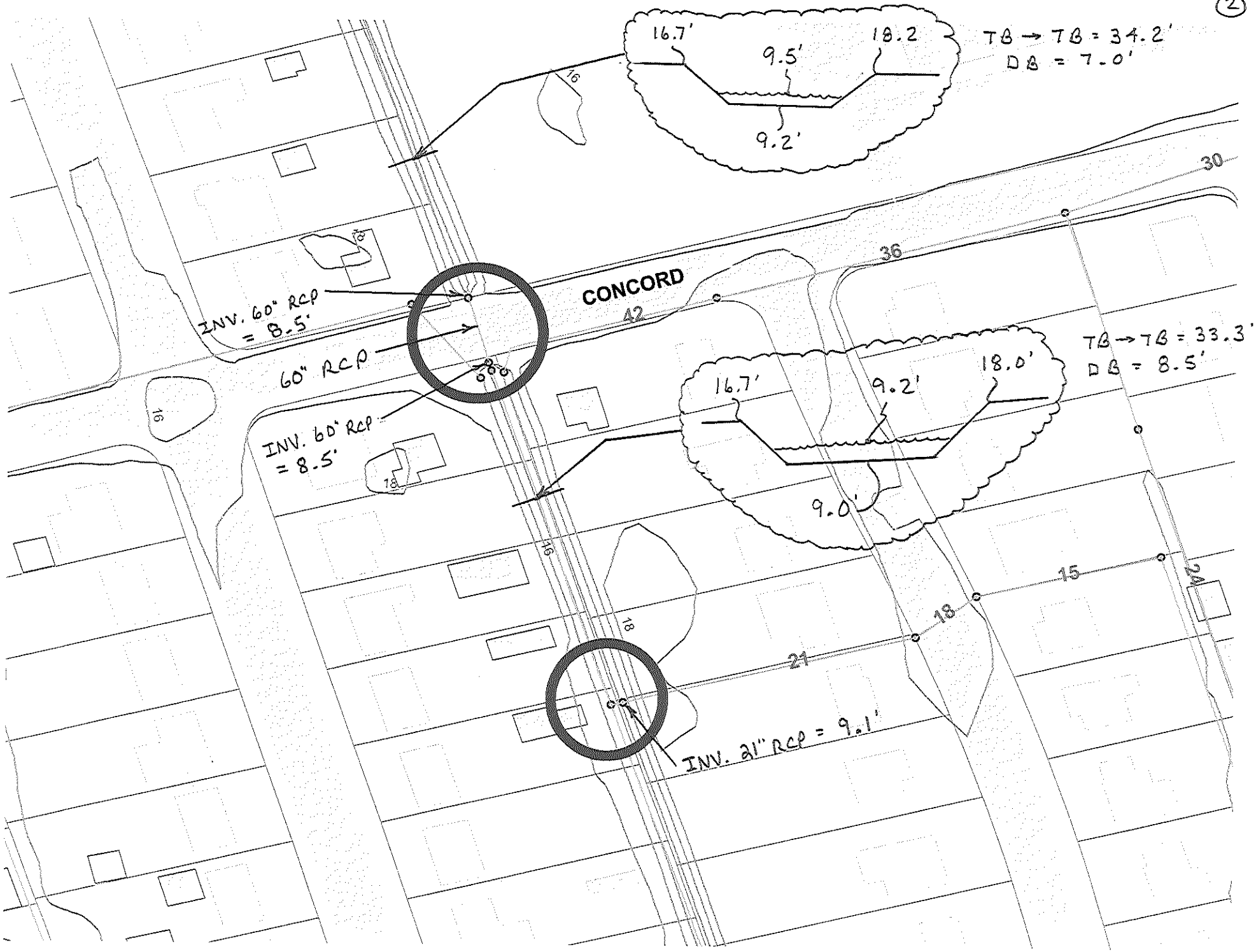
LakeShore Watershed Area

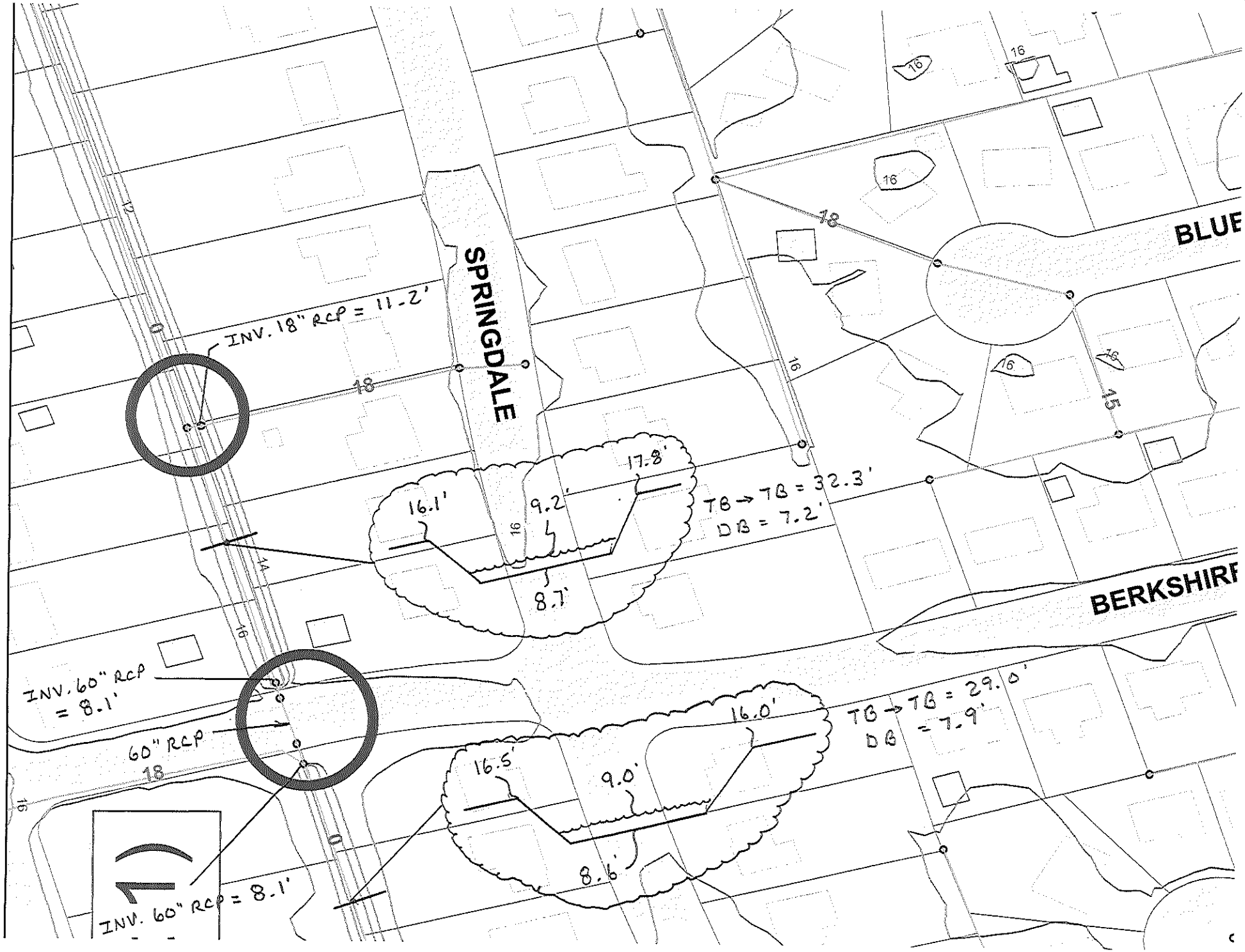
RESIDENT AND CITY OBSERVED FLOOD AREAS MAP



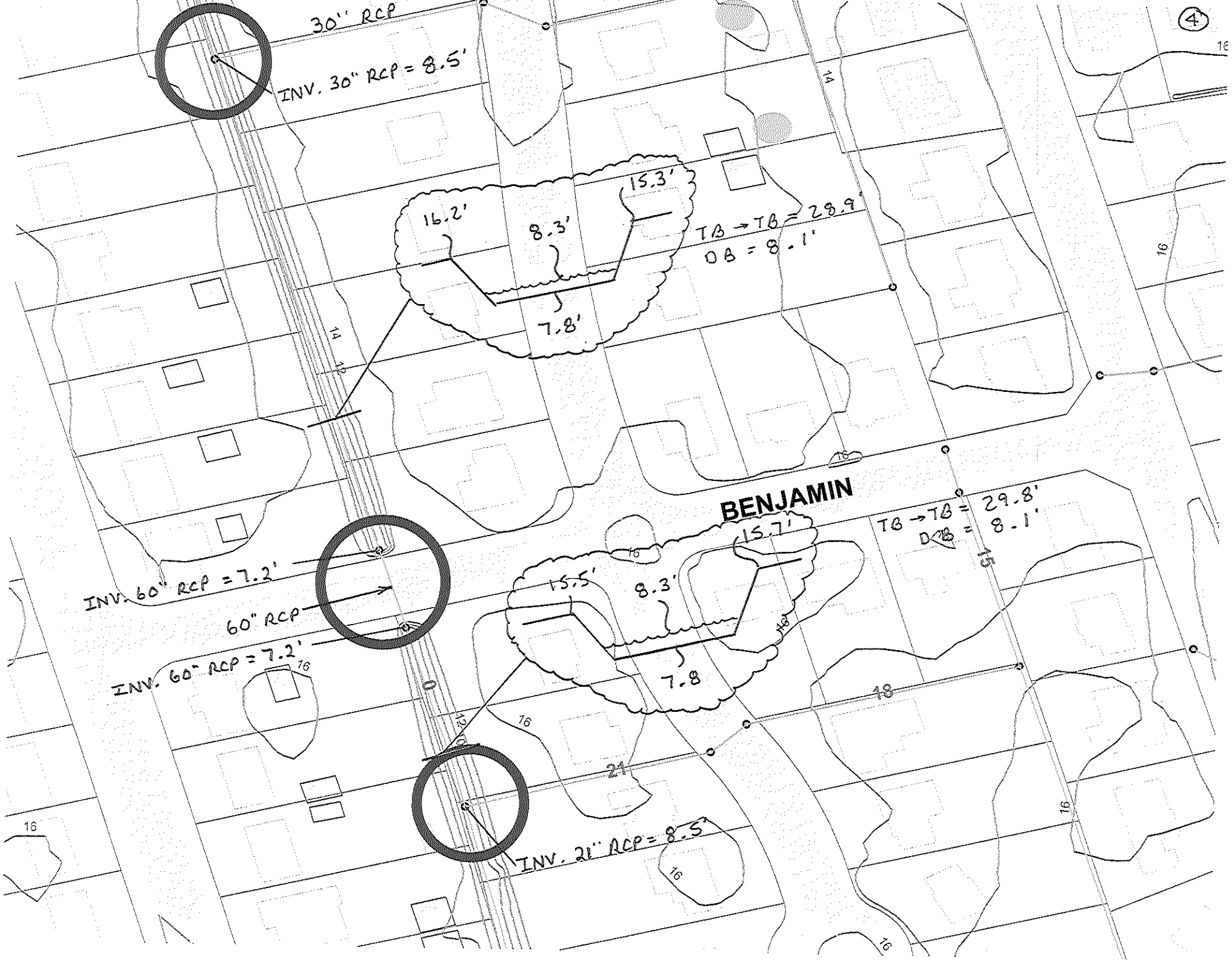


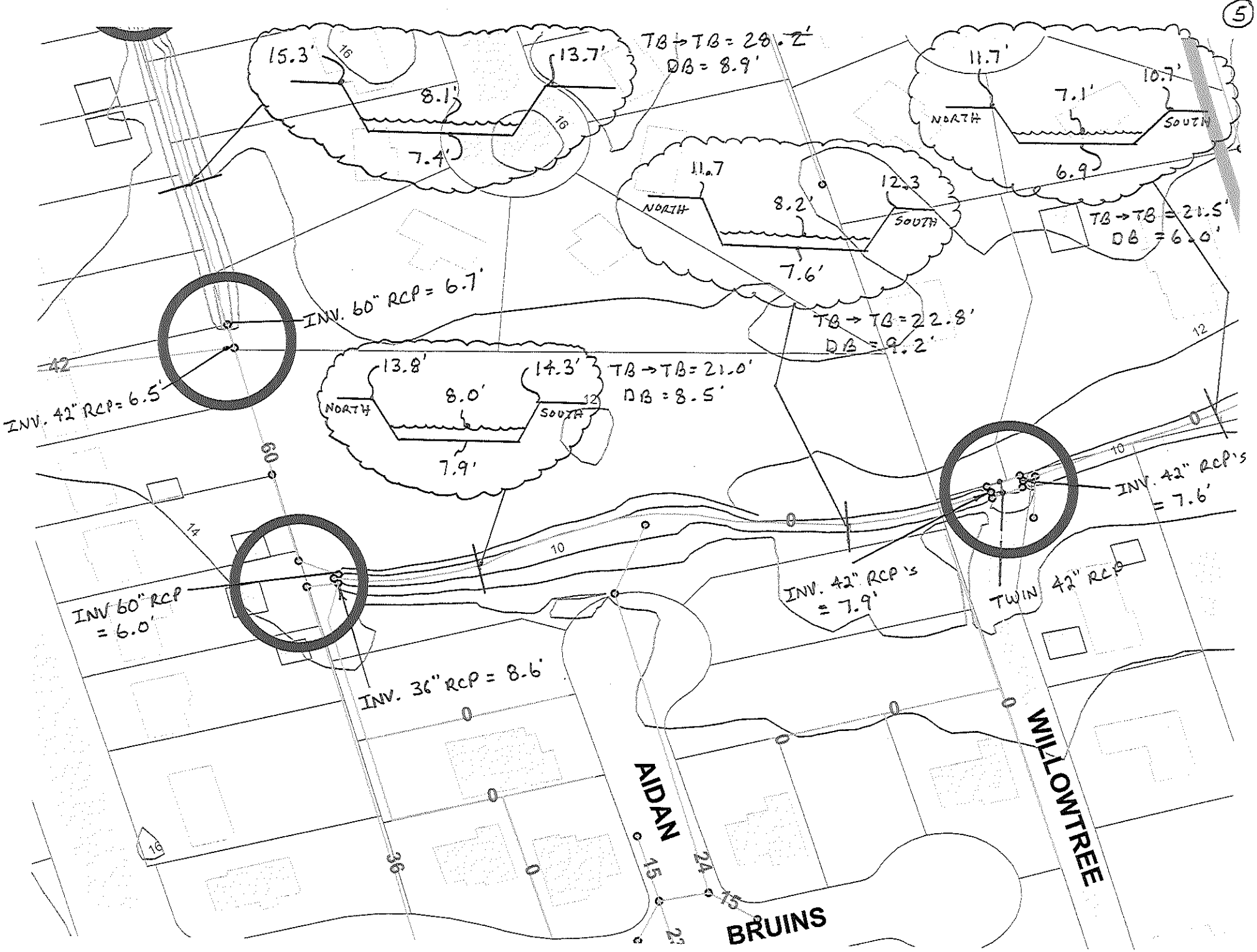
INV. 27" RCP = 10.8'
INV. 36" RCP = 10.7'
TB → TB = 33.5'
DB = 6.0'
18.2'
17.1'
10.8'
10.5'
17x0
16x7
17x1
17x1
15x5
INV. 27" RCP = 10.7'
~~15~~
12"
INV. 12" RCP = 11.5'
27
36
18
12
16

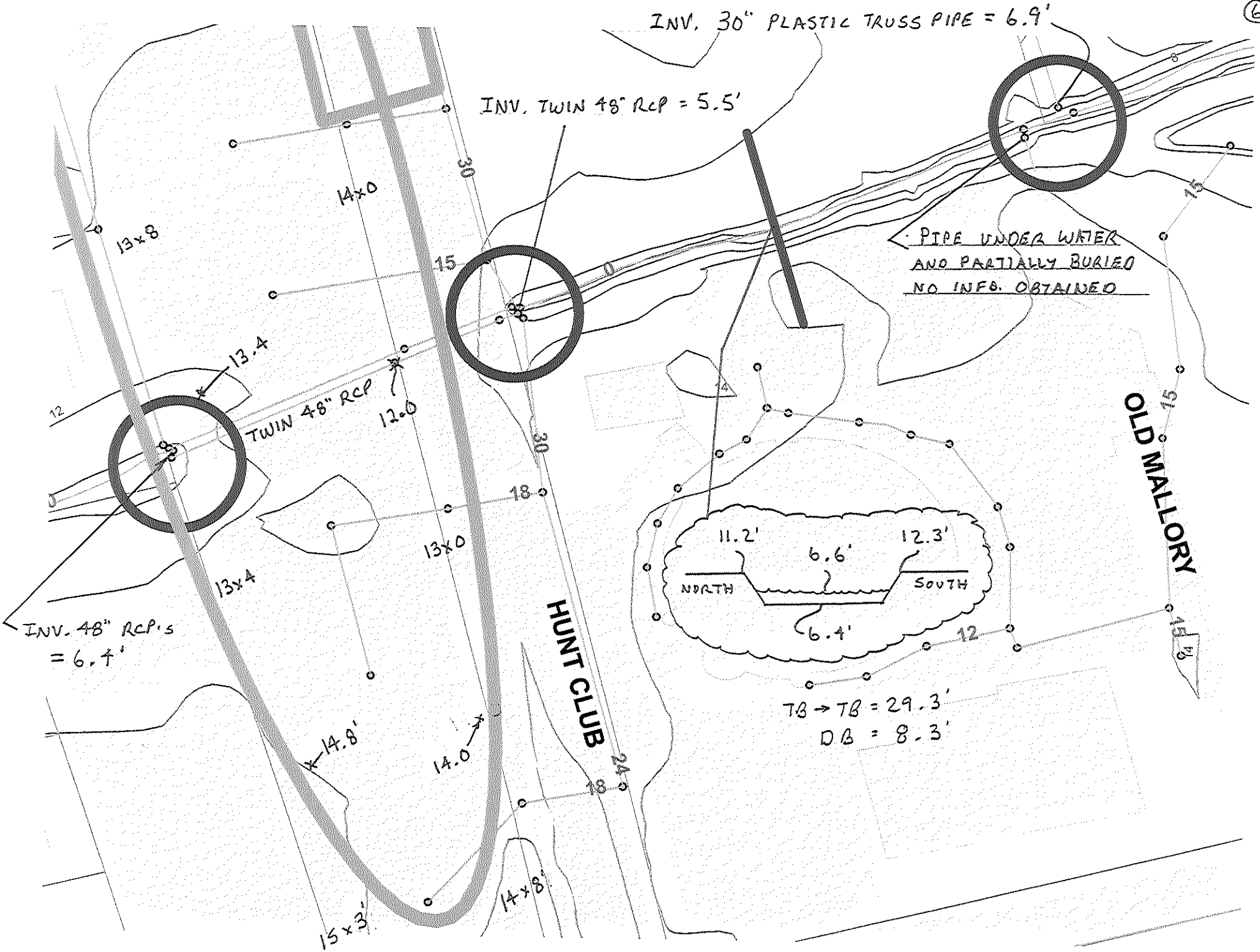

16.7'
9.5'
18.2
9.2'
TB → TB = 34.2'
DB = 7.0'
16
30
36
CONCORD
42
INV. 60" RCP
= 8.5'
60" RCP
INV. 60" RCP
= 8.5'
16.7'
9.2'
18.0'
9.0'
TB → TB = 33.3'
DB = 8.5'
16
18
15
18
21
INV. 21" RCP = 9.1'


SPRINGDALE
BLUE
BERKSHIRE
INV. 18" RCP = 11.2'
16.1'
9.2'
17.8'
8.7'
TB → TB = 32.3'
DB = 7.2'
INV. 60" RCP = 8.1'
60" RCP
16.5'
9.0'
16.0'
8.6'
TB → TB = 29.0'
DB = 7.9'
INV. 60" RCP = 8.1'

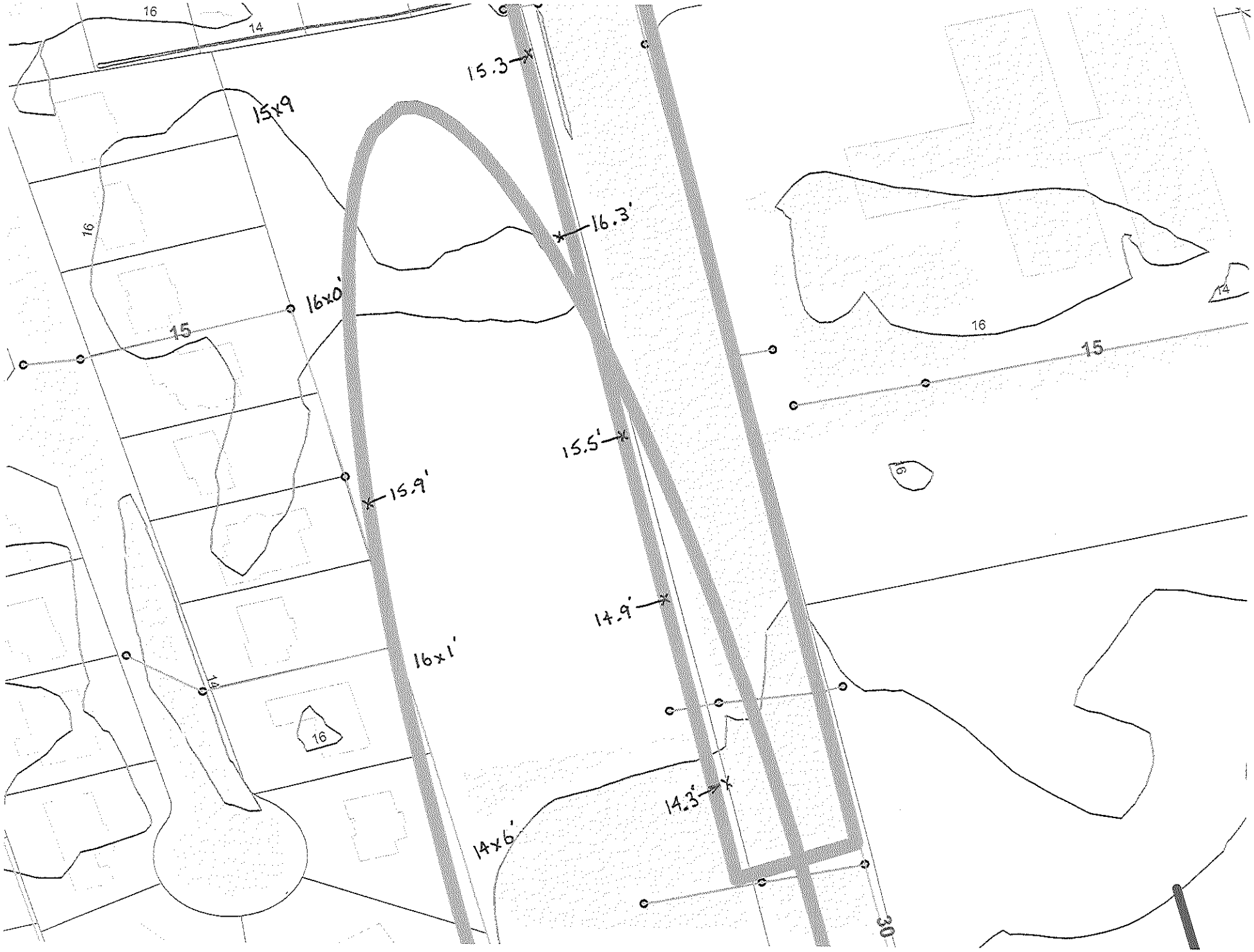
3A

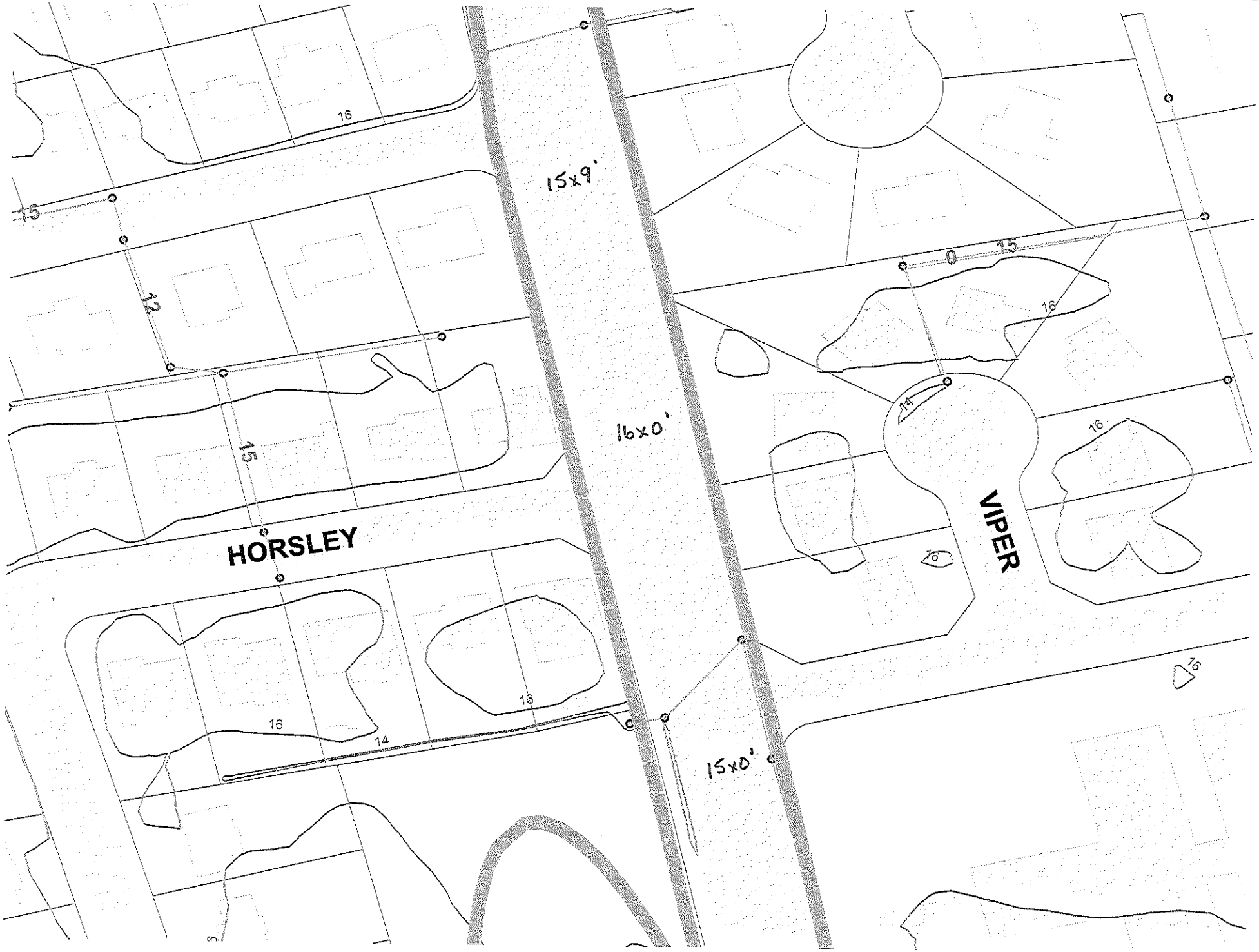

4
30" RCP
INV. 30" RCP = 8.5'
16.2'
8.3'
15.3'
7.8'
TB → TB = 28.9'
OB = 8.1'
BENJAMIN
15.7'
15.5'
8.3'
7.8
TB → TB = 29.8'
OB = 8.1'
INV. 60" RCP = 7.2'
60" RCP
INV. 60" RCP = 7.2'
INV. 21" RCP = 8.5'
18
21
14
16
15


15.3'
13.7'
8.1'
7.4'
TB → TB = 28.2'
DB = 8.9'
11.7'
10.7'
7.1'
NORTH
SOUTH
6.9
11.7
12.3
8.2'
7.6'
TB → TB = 21.5'
DB = 6.0'
TB → TB = 22.8'
DB = 9.2'
INV. 60" RCP = 6.7'
INV. 42" RCP = 6.5'
13.8'
14.3'
8.0'
7.9'
TB → TB = 21.0'
DB = 8.5'
INV. 42" RCP's = 7.6'
INV 60" RCP = 6.0'
INV. 36" RCP = 8.6'
INV. 42" RCP's = 7.9'
TWIN 42" RCP
AIDAN
BRUINS
WILLOWTREE



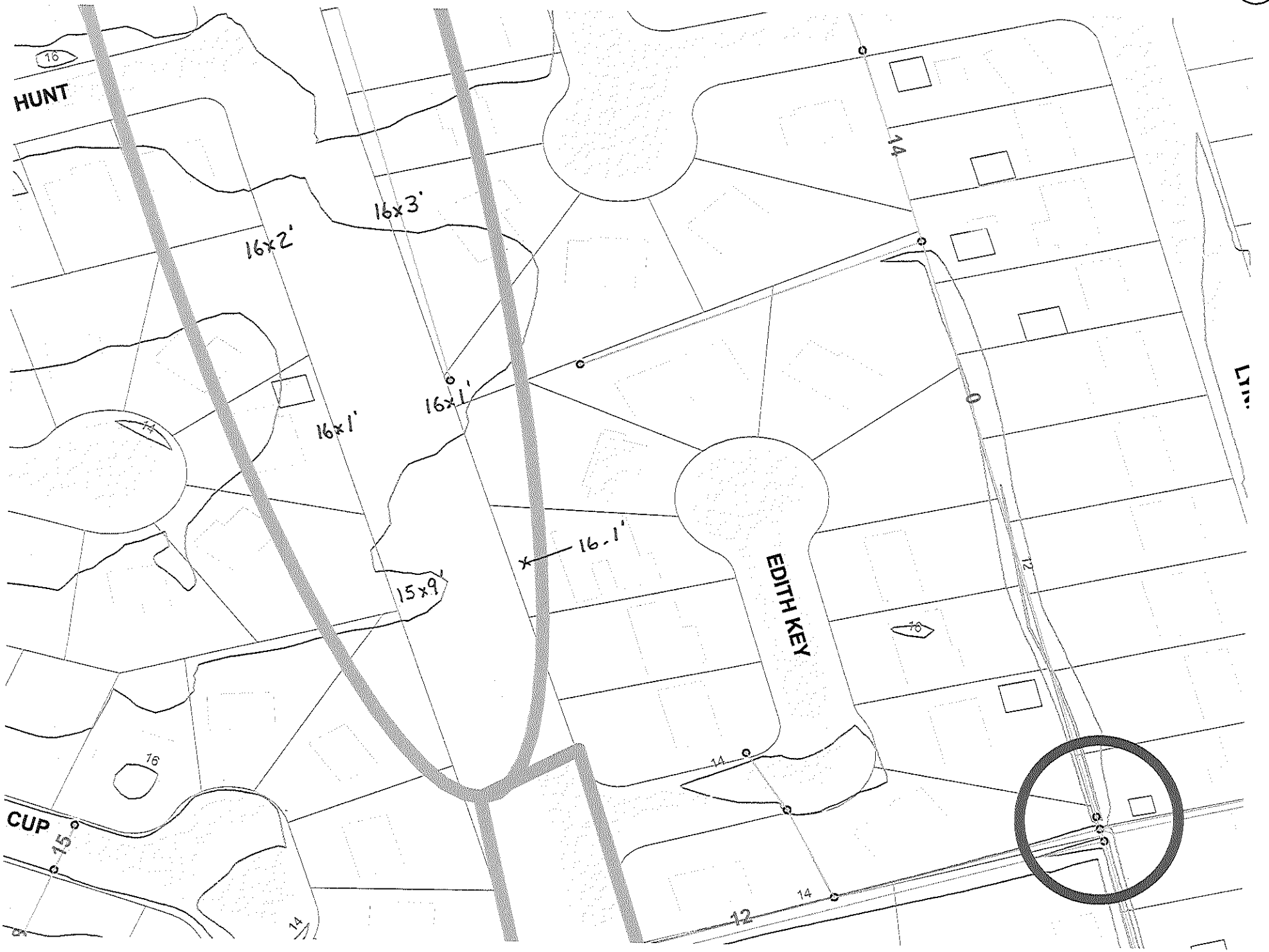
6
INV. 30" PLASTIC TRUSS PIPE = 6.9'
INV. TWIN 48" RCP = 5.5'
PIPE UNDER WATER
AND PARTIALLY BURIED
NO INFO. OBTAINED
13x8
14x0
13.4
TWIN 48" RCP
12.0
13x0
13x4
INV. 48" RCP's
= 6.4'
14.8'
14.0
14x8'
15x3'
HUNT CLUB
OLD MALLORY
11.2'
6.6'
12.3'
NORTH
SOUTH
6.4'
TB → TB = 29.3'
DB = 8.3'

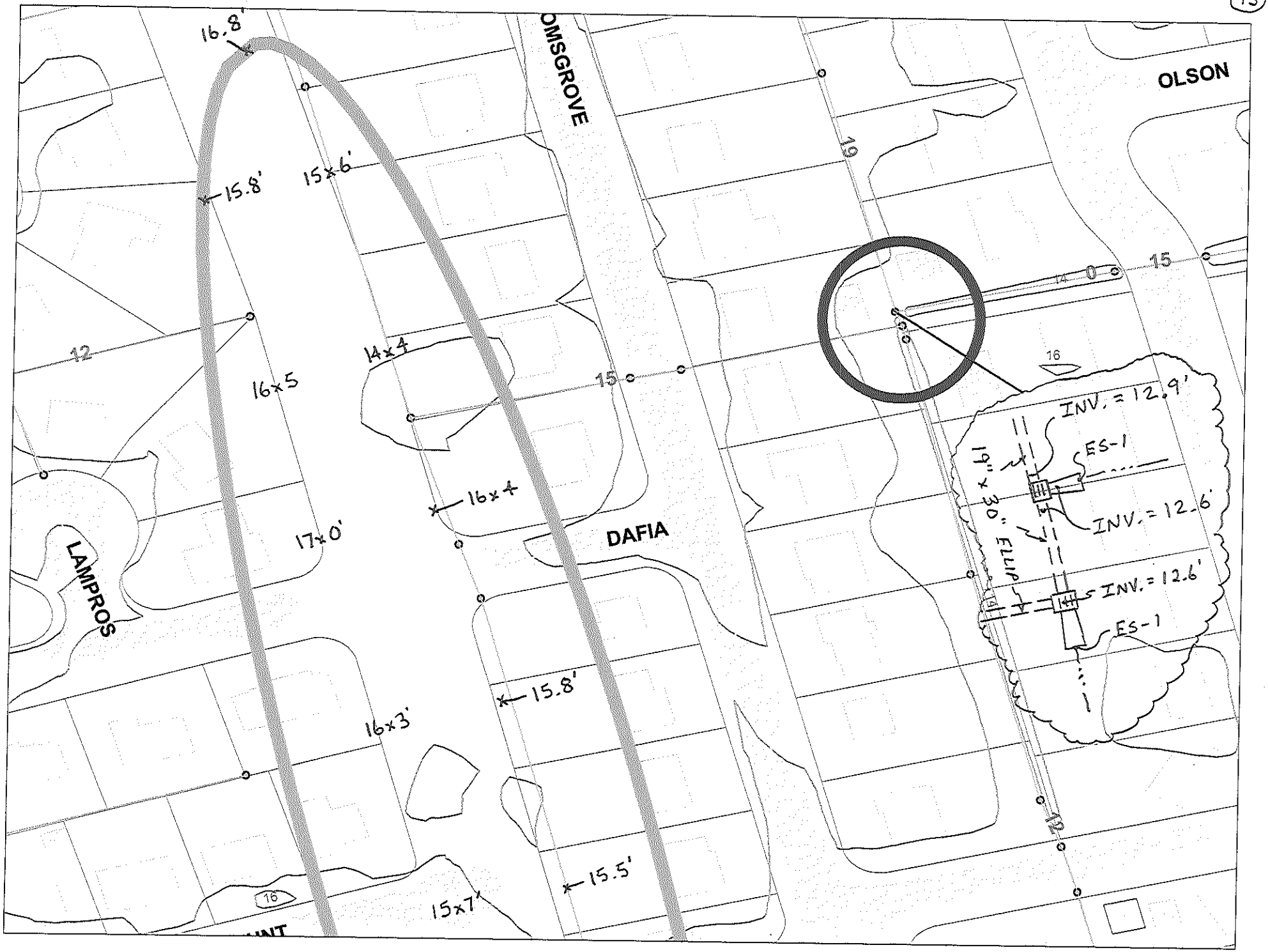

16
14
15.3
15x9
16.3'
16
16x0'
15
15.5'
15.9'
14.9'
16x1'
14
16
14.3'
14x6'
30
16
15
14
16

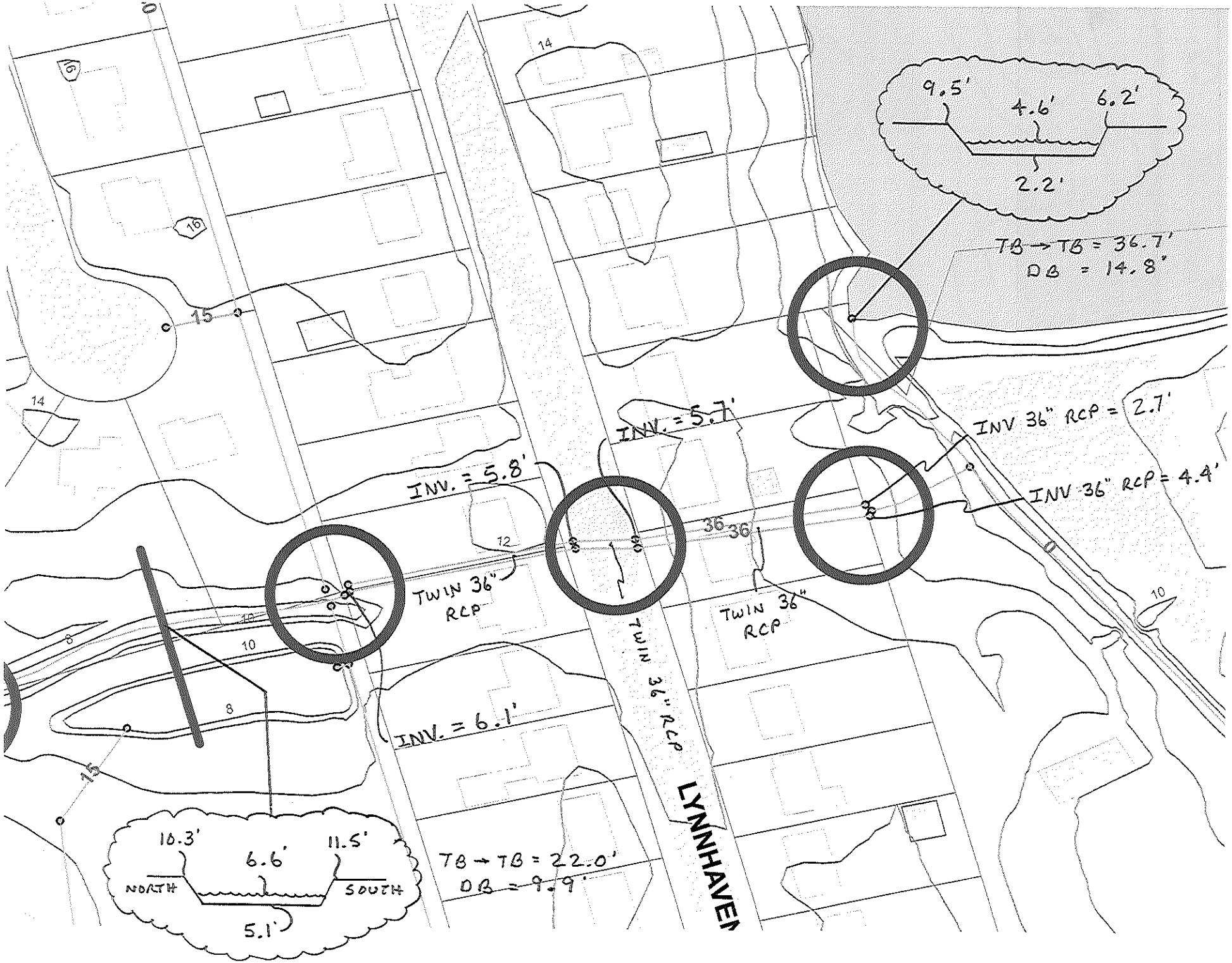

HORSLEY
VIPER
15x9'
16x0'
15x0'
16
15
12
14
0

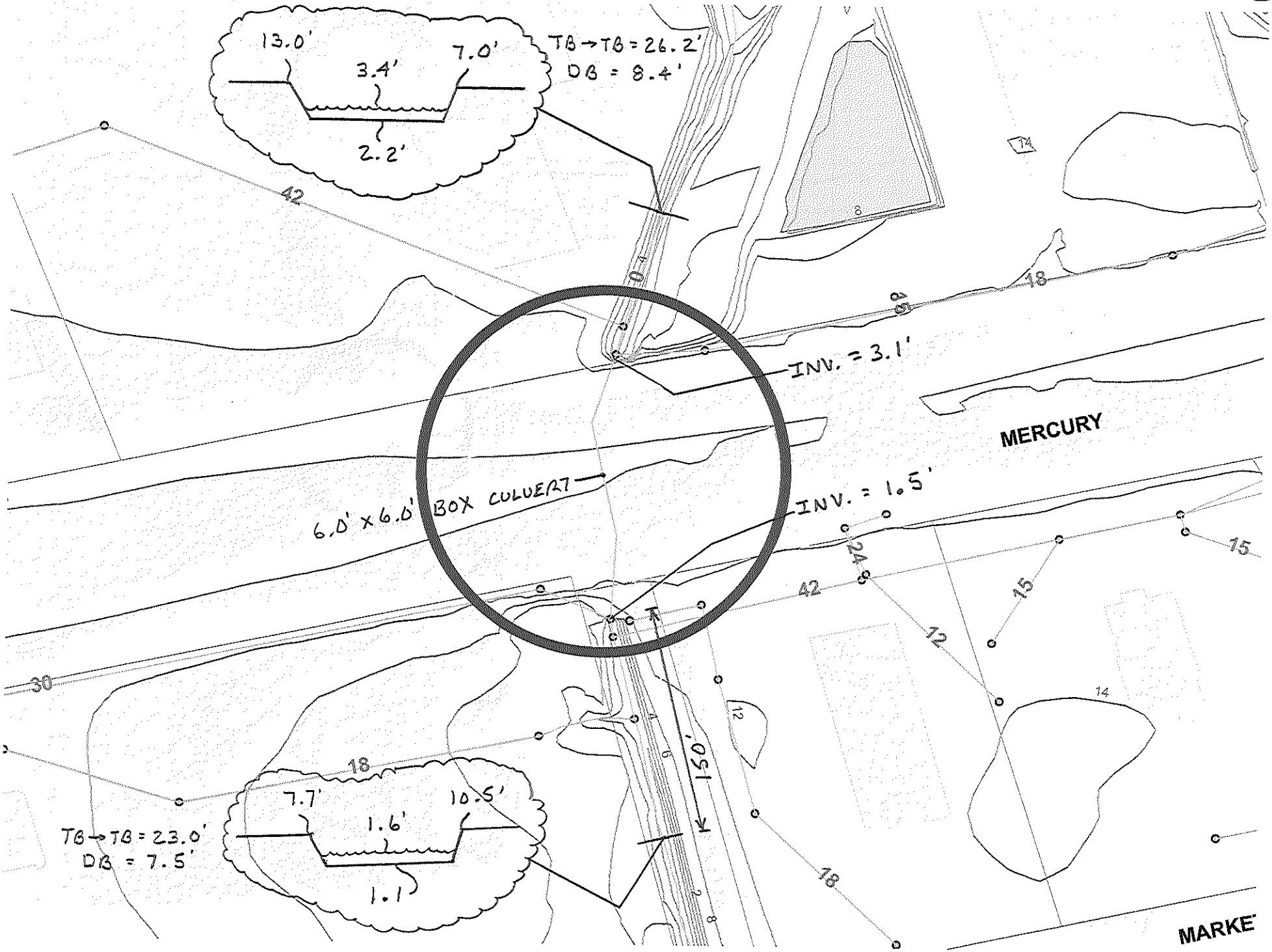
16x2'
16x0'
16x7'
16x6'
16x0'
EEPLECHASE
TALLYHO
15
16
18
21
24
16

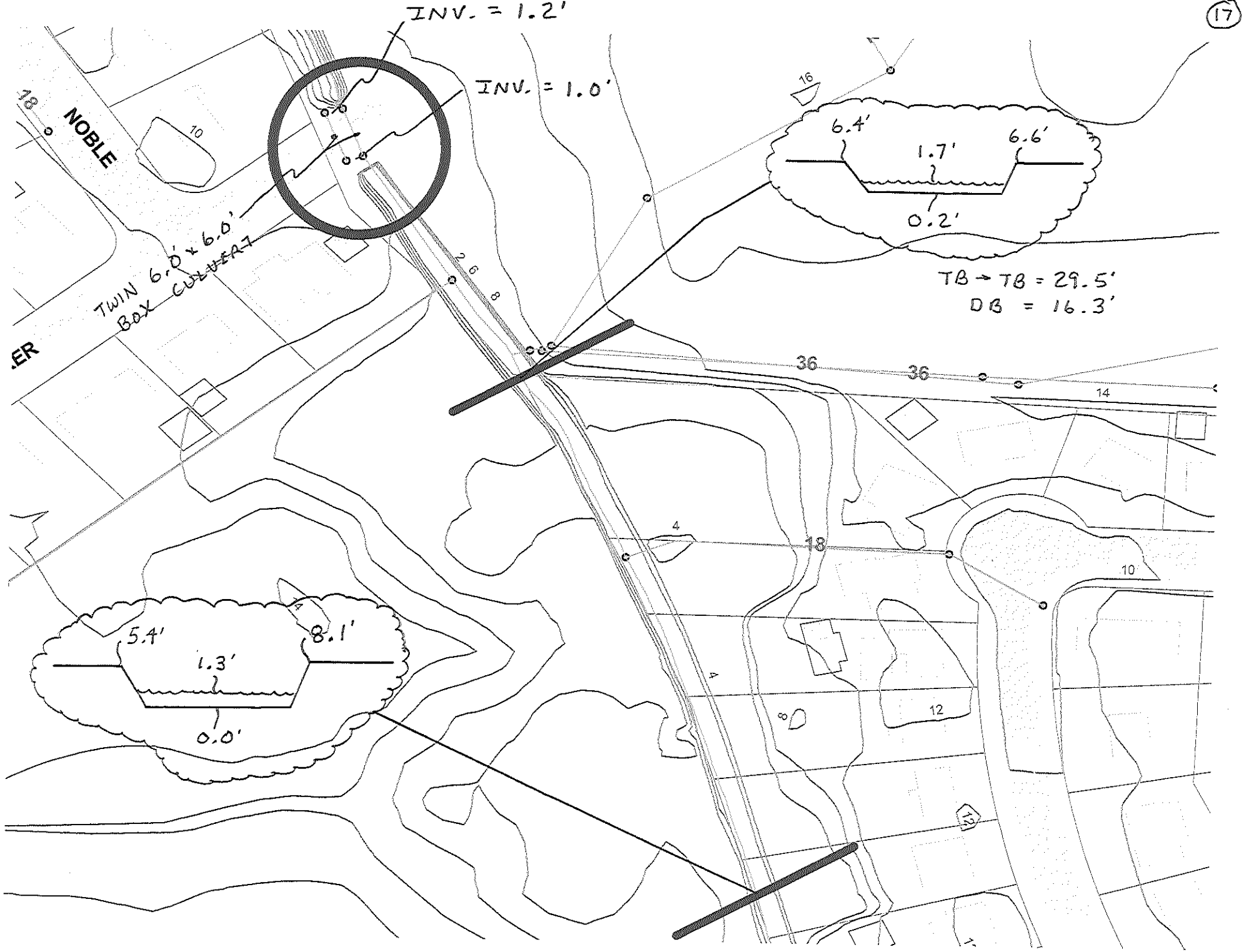
INV. YD = 3.0'
TH KEY
CUP
VERNON
15.7'
16.0'
15.2'
15.5'
15.6'
15.3'
15.3'
15.6'
15" RCP
18" RCP
21" RCP
15" RCP

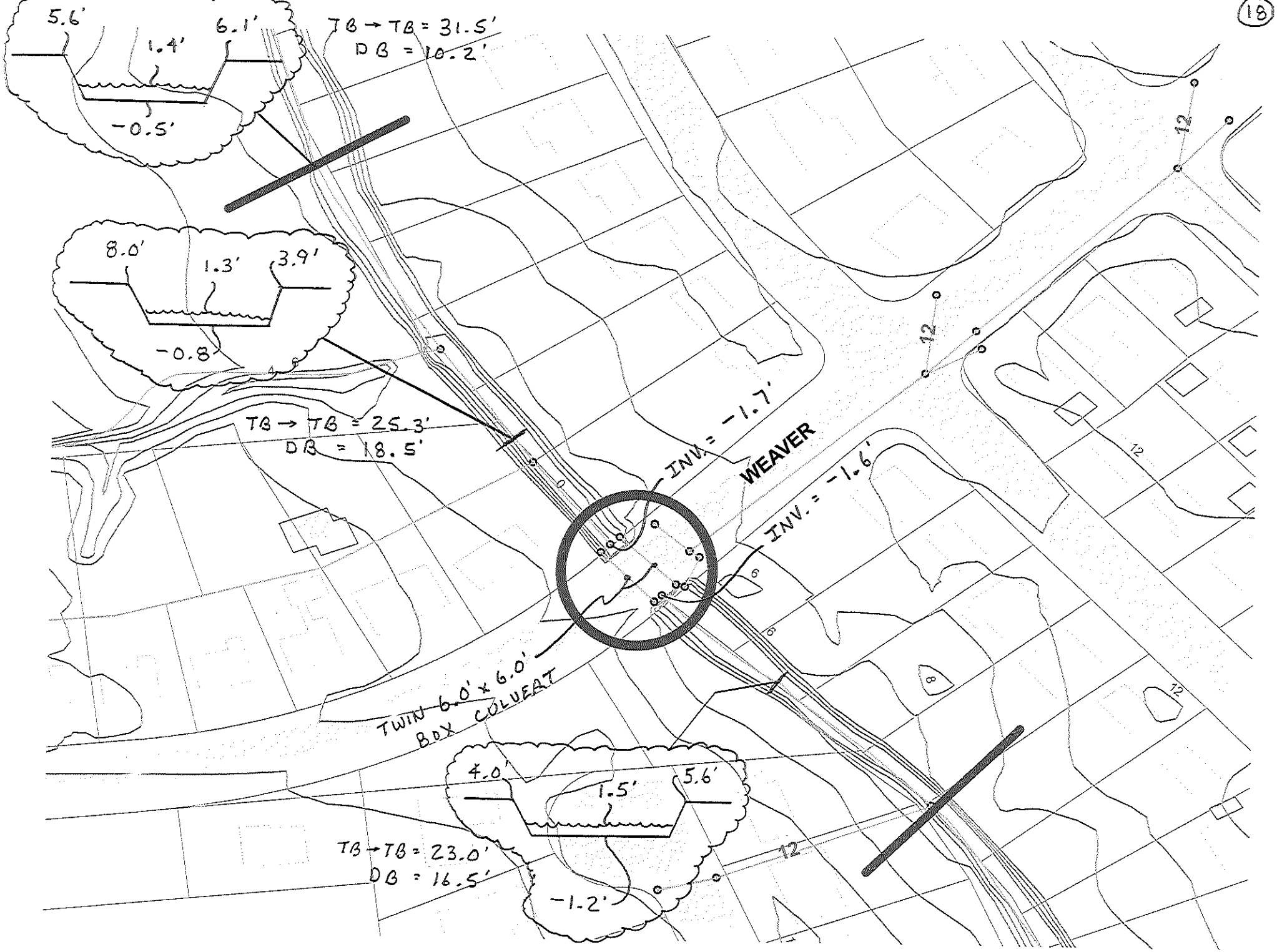

HUNT
CUP
EDITH KEY
16x3'
16x2'
16x1'
16x1'
16.1'
15x9'
16
14
15
12

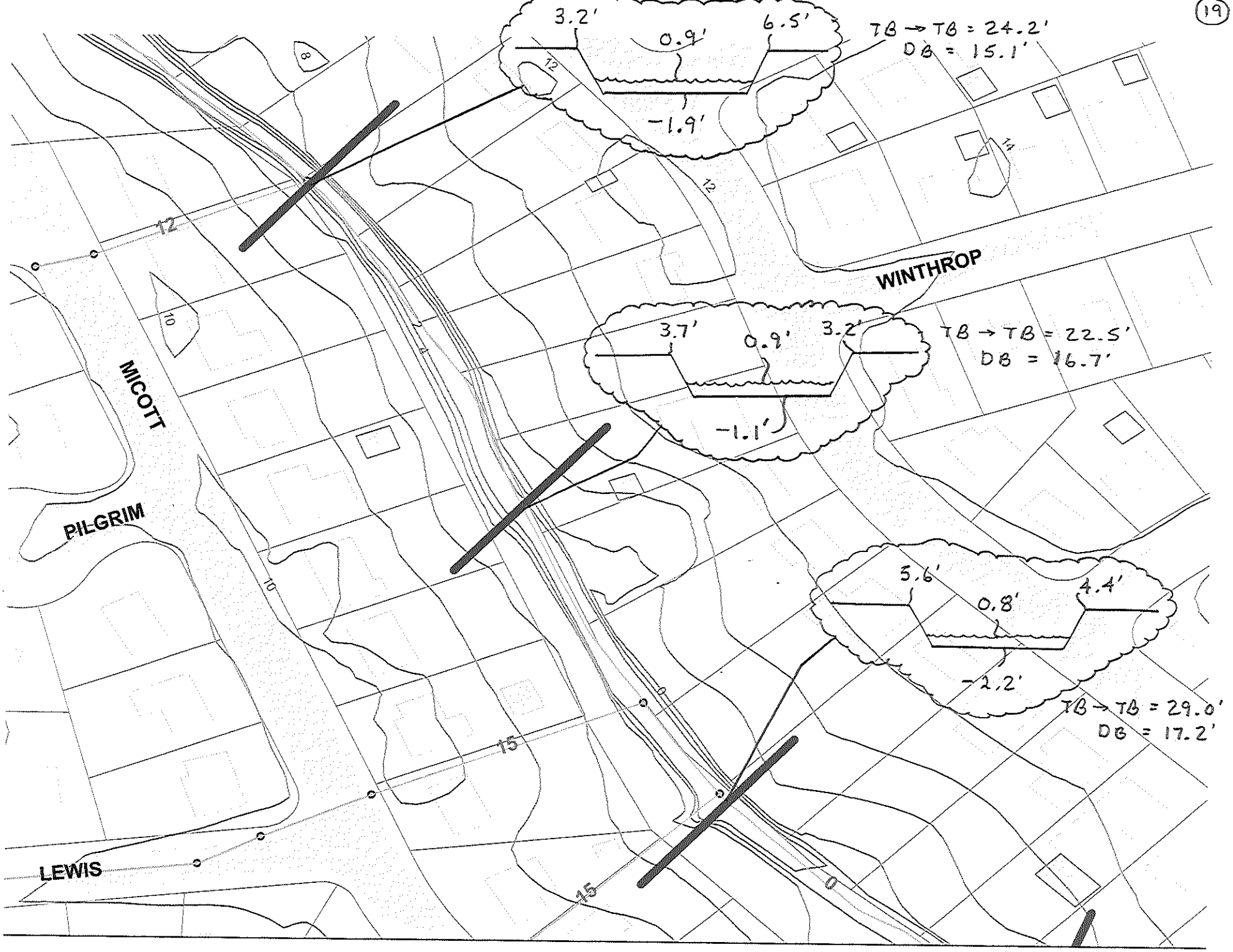

16.8'
15.8'
15x6'
OMSGROVE
OLSON
19
15
14
0
12
16x5
14x4
15
16
INV. = 12.9'
ES-1
19" x 30" FLUP
INV. = 12.6'
INV. = 12.6'
ES-1
16x4
17x0'
DAFIA
LAMPROS
15.8'
16x3'
15.5'
15x7'
16
12

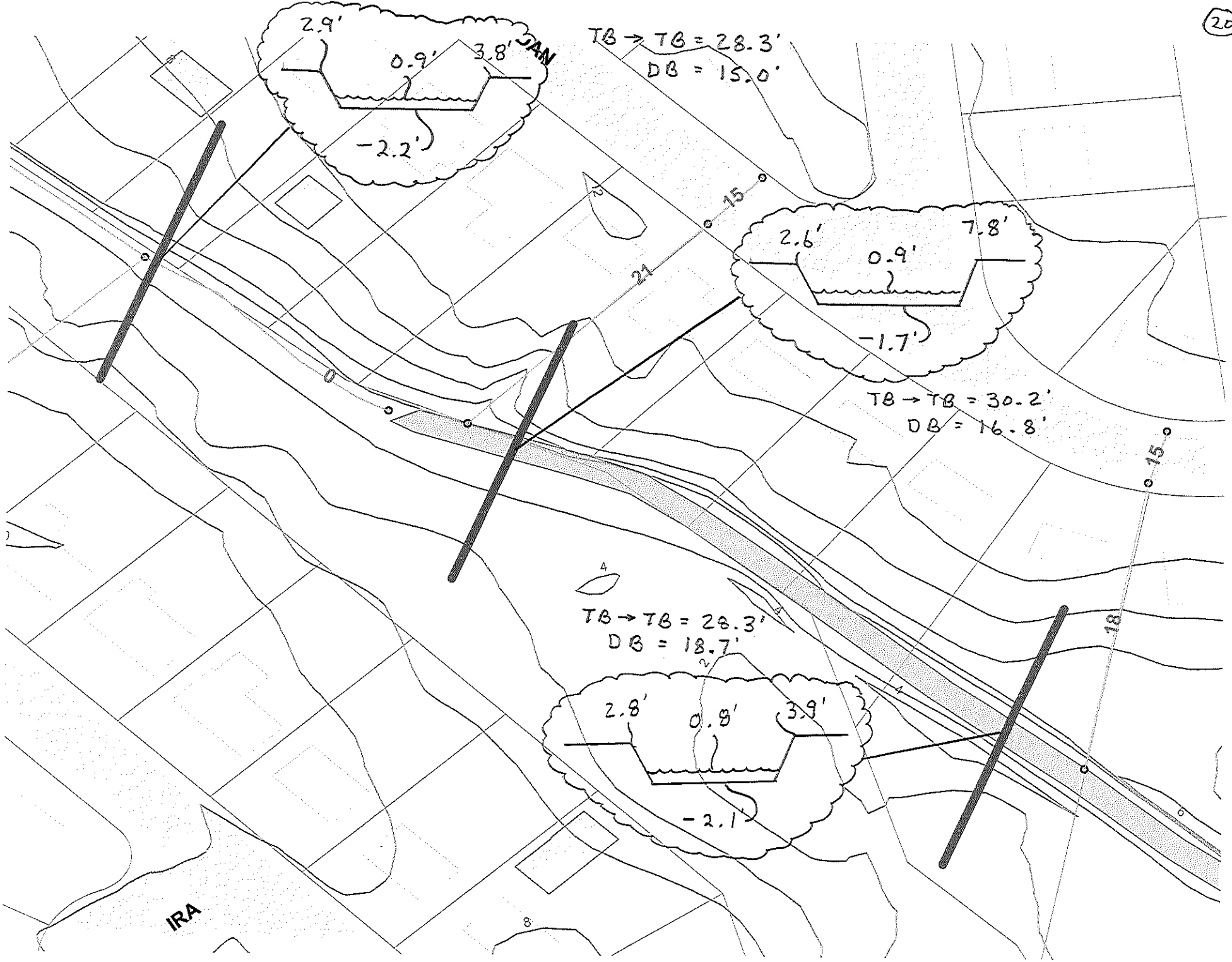

9.5'
4.6'
6.2'
2.2'
TB → TB = 36.7'
DB = 14.8'
INV. = 5.7'
INV. = 5.8'
INV 36" RCP = 2.7'
INV 36" RCP = 4.4'
TWIN 36" RCP
TWIN 36" RCP
TWIN 36" RCP
INV. = 6.1'
10.3'
6.6'
11.5'
NORTH
SOUTH
5.1'
TB → TB = 22.0'
DB = 9.9'
LYNNHAVEN

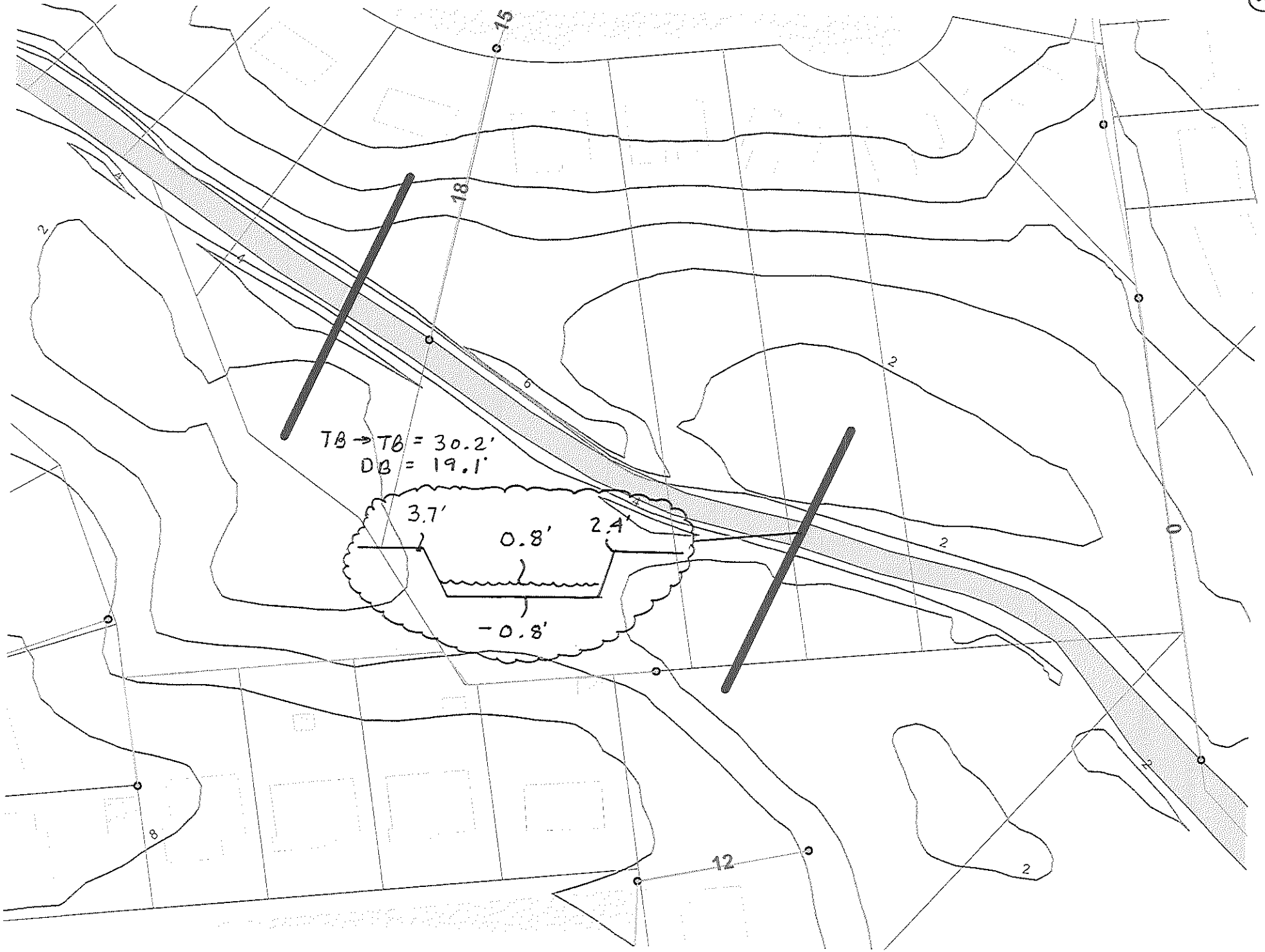

13.0'
3.4'
7.0'
2.2'
TB → TB = 26.2'
DB = 8.4'
INV. = 3.1'
MERCURY
6.0' x 6.0' BOX CULVERT
INV. = 1.5'
150'
7.7'
1.6'
10.5'
1.1
TB → TB = 23.0'
DB = 7.5'
MARKE


INV. = 1.2'
INV. = 1.0'
NOBLE
TWIN 6.0' x 6.0'
BOX CULVERT
6.4'
1.7'
6.6'
0.2'
TB → TB = 29.5'
DB = 16.3'
5.4'
1.3'
8.1'
0.0'
36
36
18
10
12
14
16
4
8
2
6
8

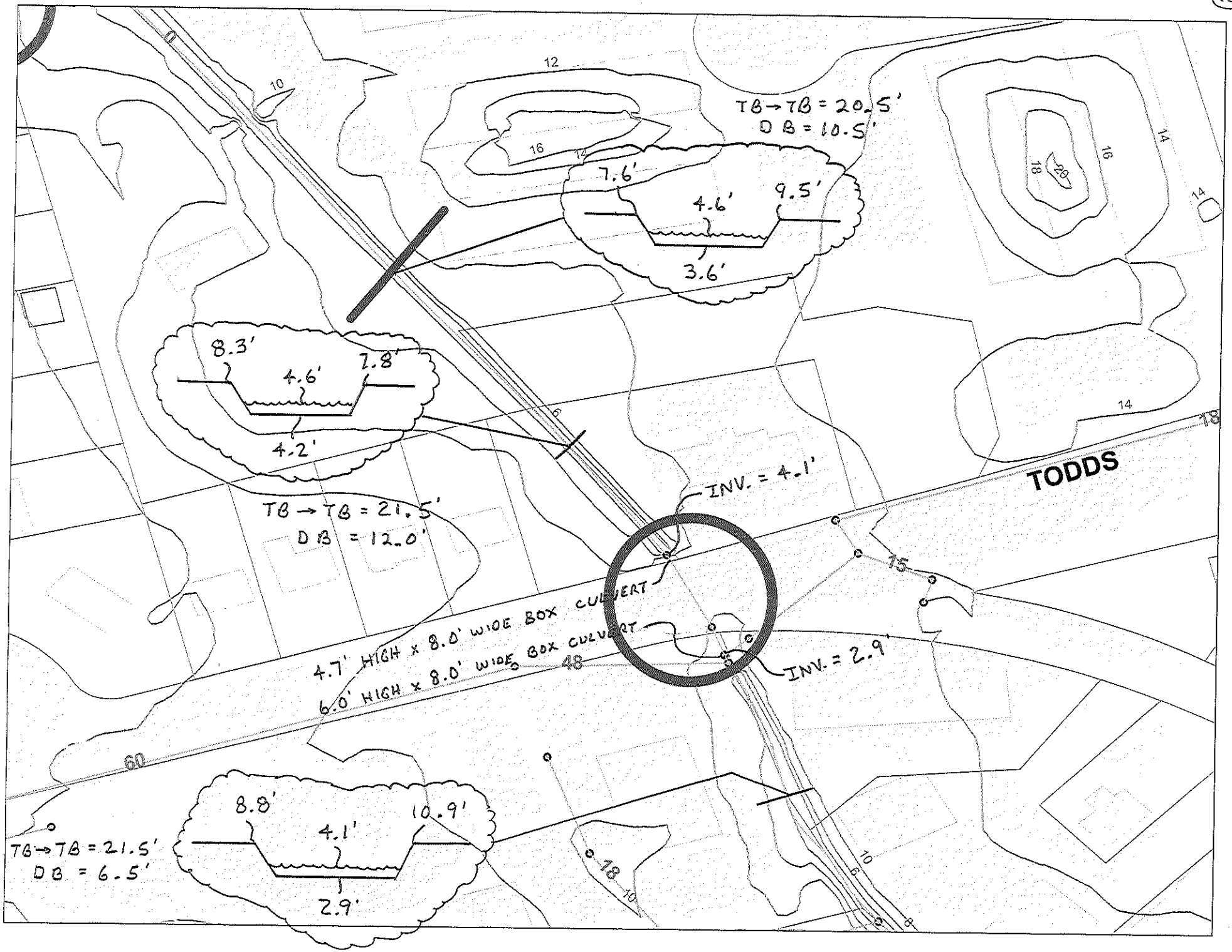

5.6'
1.4'
6.1'
-0.5'
TB → TB = 31.5'
DB = 10.2'
8.0'
1.3'
3.9'
-0.8
TB → TB = 25.3'
DB = 18.5'
INV. = -1.7'
WEAVER
INV. = -1.6'
TWIN 6.0' x 6.0'
BOX CULVERT
4.0'
1.5'
5.6'
-1.2'
TB → TB = 23.0'
DB = 16.5'
12
12
12
6
6
8
12


3.2'
0.9'
6.5'
-1.9'
TB → TB = 24.2'
DB = 15.1'
3.7'
0.9'
3.2'
-1.1'
TB → TB = 22.5'
DB = 16.7'
5.6'
0.8'
4.4'
-2.2'
TB → TB = 29.0'
DB = 17.2'
WINTHROP
MICOTT
PILGRIM
LEWIS
12
10
15
14
8


2.9'
0.9'
3.8'
-2.2'
TB → TB = 28.3'
DB = 15.0'
2.6'
0.9'
7.8'
-1.7'
TB → TB = 30.2'
DB = 16.8'
TB → TB = 28.3'
DB = 18.7'
2.8'
0.8'
3.9'
-2.1'
15
21
0
15
18
IRA


15
18
12
2
4
6
8
0
TB → TB = 30.2'
DB = 19.1'
3.7'
0.8'
2.4'
-0.8'

BEATRICE
OLD MALLORY
DEEP RUN
VERNON
16x2'
15x9'
15x7'
18
14
16
15
24

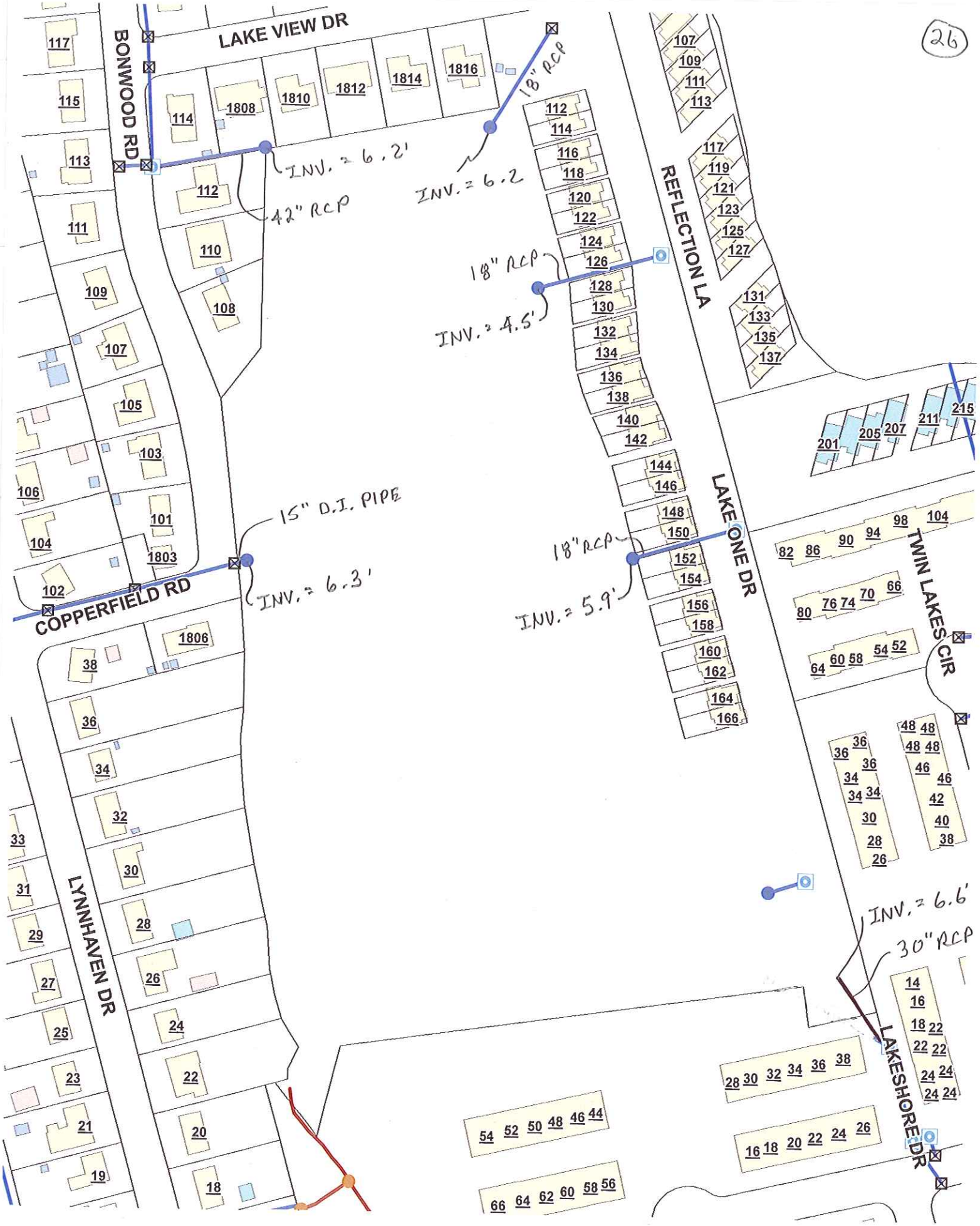

TB → TB = 20.5'
DB = 10.5'
7.6'
4.6'
9.5'
3.6'
8.3'
4.6'
7.8'
4.2'
TB → TB = 21.5'
DB = 12.0'
INV. = 4.1'
TODDS
4.7' HIGH x 8.0' WIDE BOX CULVERT
6.0' HIGH x 8.0' WIDE BOX CULVERT
INV. = 2.9'
8.8'
4.1'
10.9'
2.9'
TB → TB = 21.5'
DB = 6.5'
12
10
16
14
18
20
6
15
48
60
8

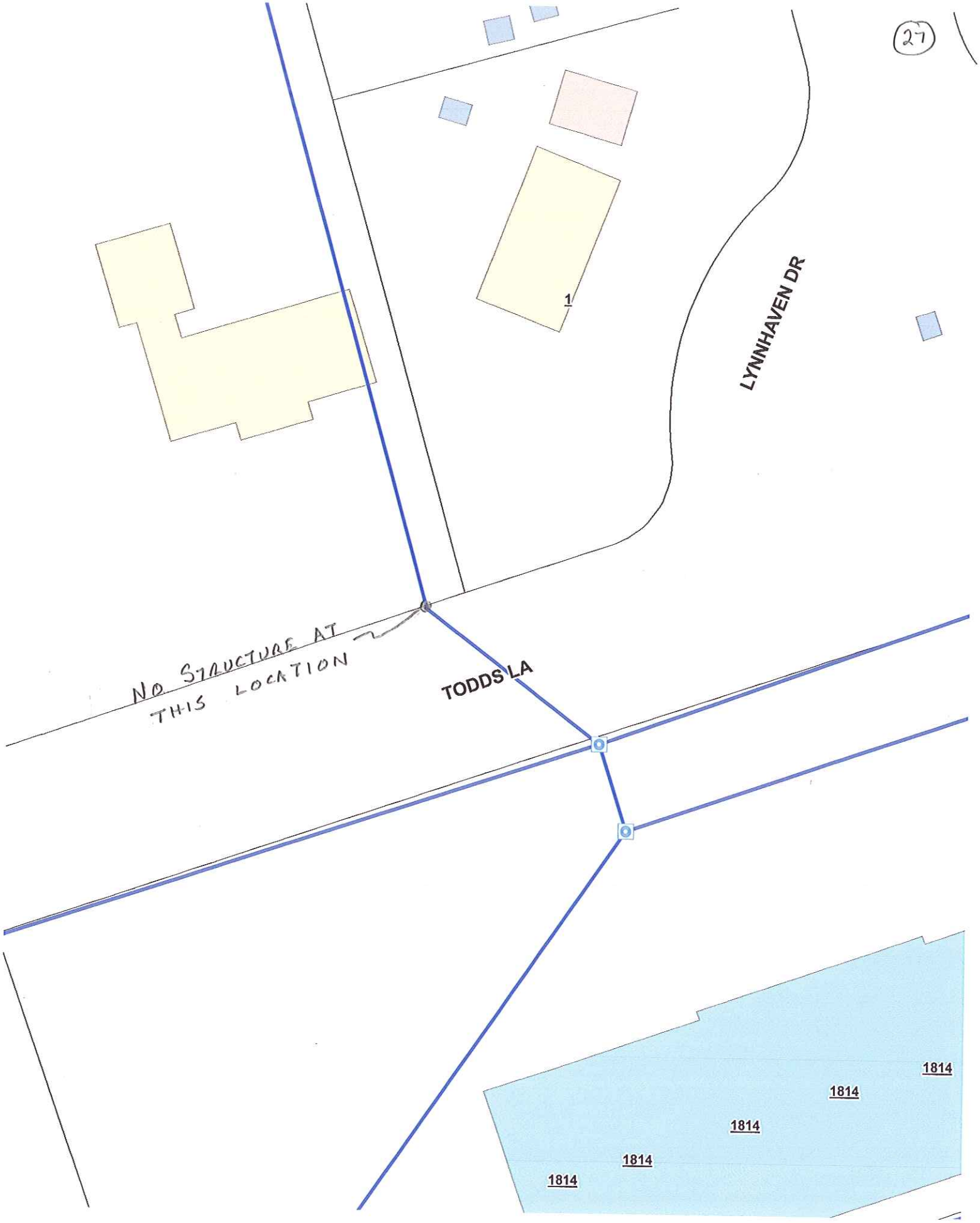
22
BURTON ST
1
606
608
513
515
517
519
601
603
605
607
609
539
537
535
418
416
36" RCP
INV. = 11.0'
27" RCP
INV. = 10.9'
27" RCP
36" RCP
27" RCP
36" RCP
2.3' x 2.7' (VERT.)
BOX CULVERT
INV = 11.1'
CONC. TOP (NO ACCESS)
INV. = @ 11.0

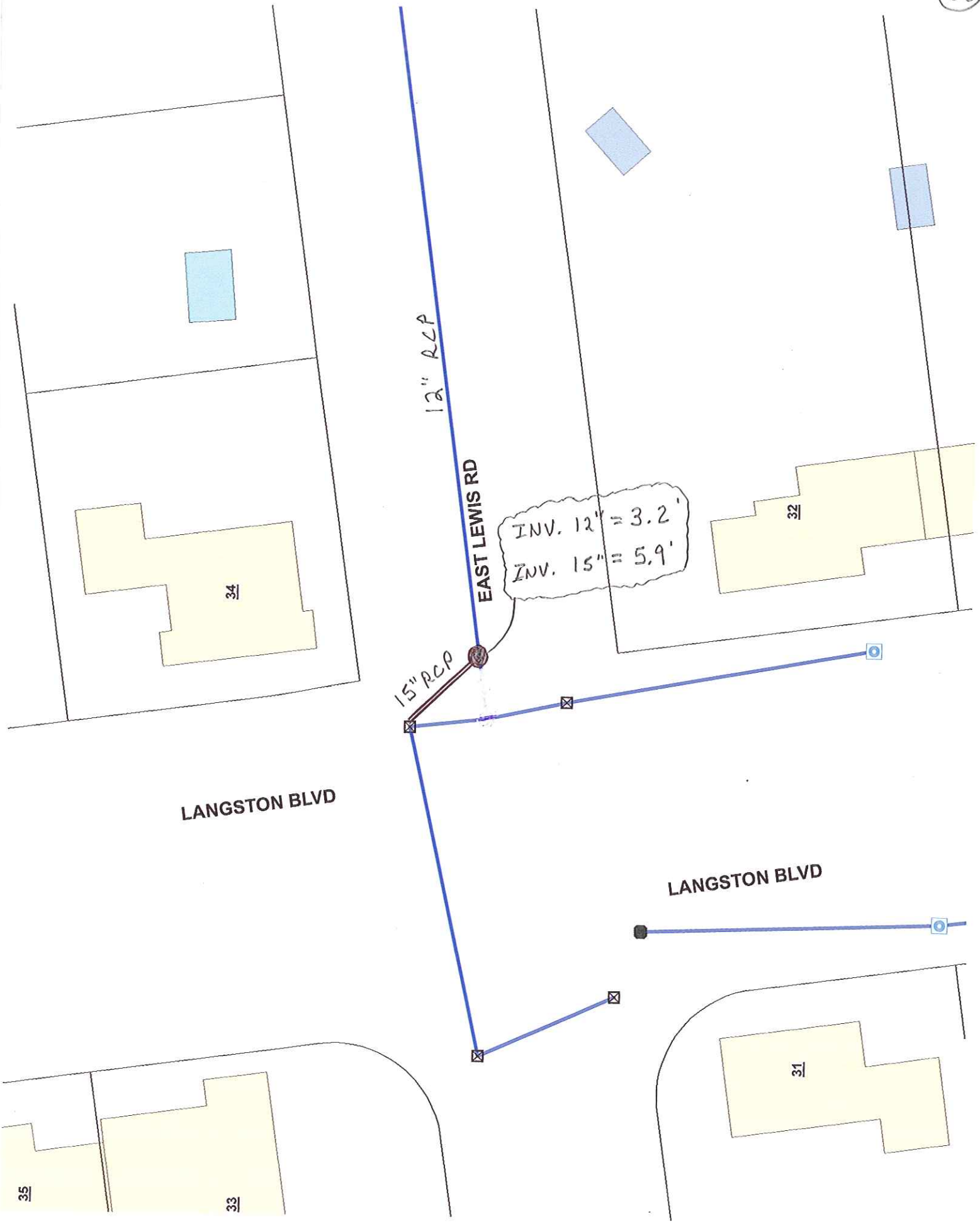
DAFIA DR
529
527
525
523
521
519
402
400
24" RCP
27" RCP
INV. = 11.3'
INV. = 11.3'
27" RCP
12" RCP
INV. = 12.5'

205
203
201
24" RCP
INV. = 9.2'
24" RCP
30" RCP
INV. = 8.6'
INV. = 8.2'
36" RCP
24" RCP
42" RCP
INV. = 8.1'
CONCORD DR
302
300
153
152
228
151
227
226
149
225
224
147
223
222
145
221
220
SPRINGDALE WAY
MIDDLEBERG HUNT RD
228
226
224

25
333
330
325
331
328
323
329
326
321
327
324
319
325
322
317
323
320
315
321
318
313
18
319
316
317
314
302
315
312
300
310
LYNNHAVEN DR
BROMSGROVE DR
DAFIA DR
INV. = 14.0'
INV. = 13.6'
INV. = 12.9'
INV. = 12.8'
12" RCP
12" RCP
15" RCP
15" RCP
15" RCP
30"x19" ELLIP RCP


LAKE VIEW DR
BONWOOD RD
COPPERFIELD RD
LYNNHAVEN DR
REFLECTION LA
LAKE ONE DR
TWIN LAKES CIR
LAKESHORE DR
18" RCP
INV. = 6.2'
INV. = 6.2
42" RCP
18" RCP
INV. = 4.5'
15" D.I. PIPE
INV. = 6.3'
18" RCP
INV. = 5.9'
INV. = 6.6'
30" RCP

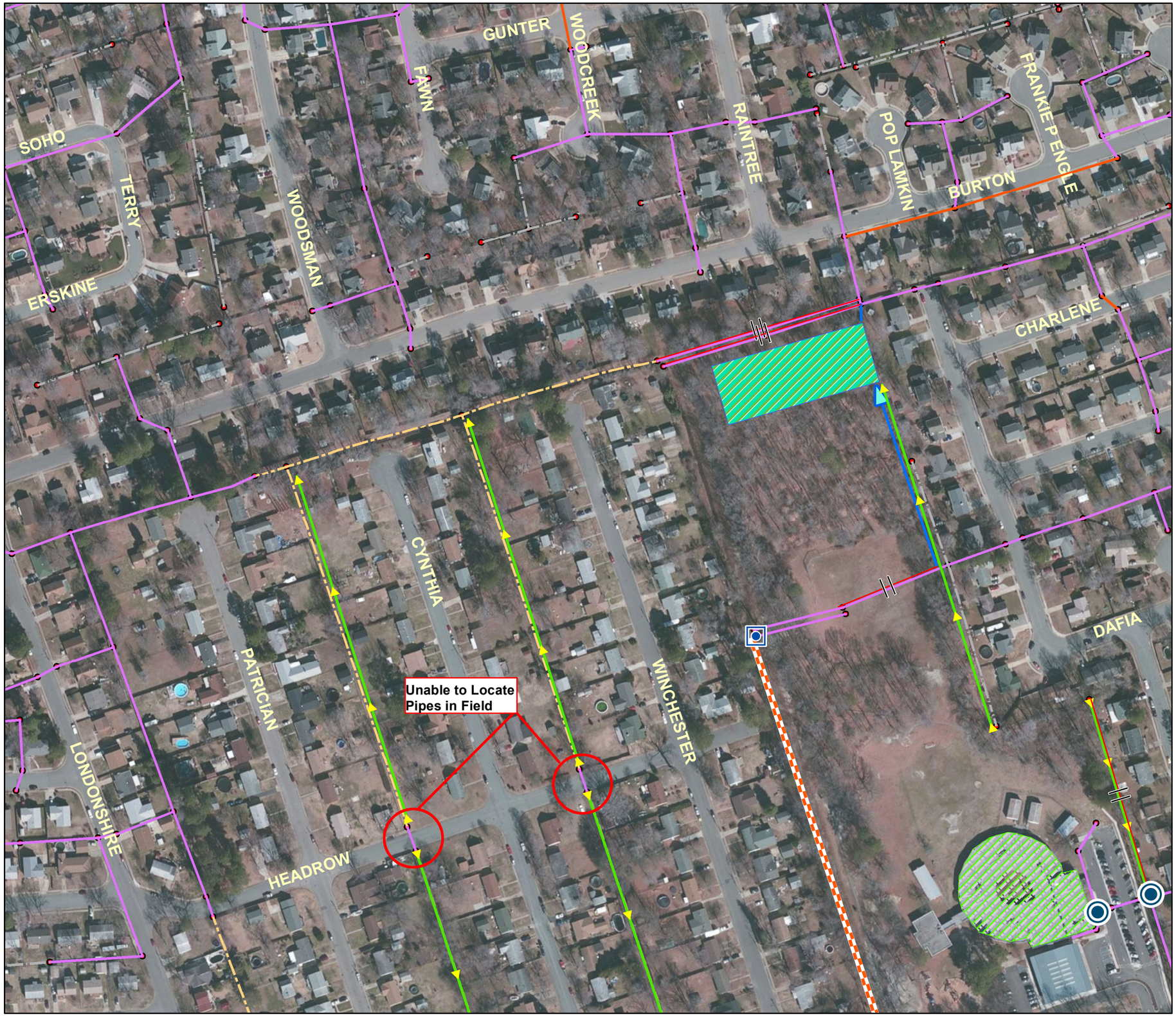

1
LYNNHAVEN DR
NO STRUCTURE AT THIS LOCATION
TODDS LA
1814
1814
1814
1814
1814


12" RCP
EAST LEWIS RD
INV. 12" = 3.2'
INV. 15" = 5.9'
15" RCP
34
32
LANGSTON BLVD
LANGSTON BLVD
31
35
33

Appendix C – Proposed Improvement Maps

Back River - Lake Shores

WATERSHED - ZONE A



LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

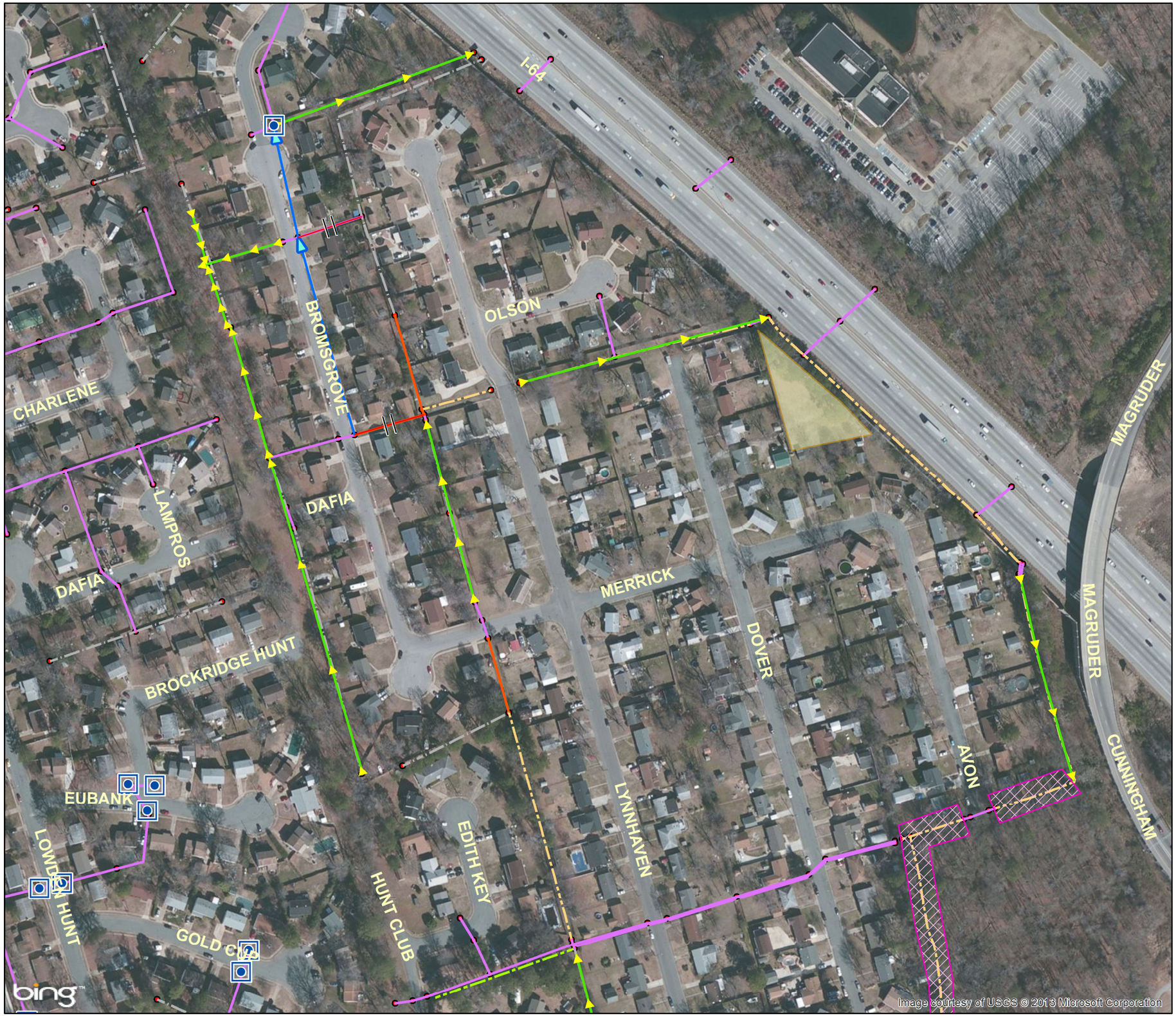
0 100 200 400

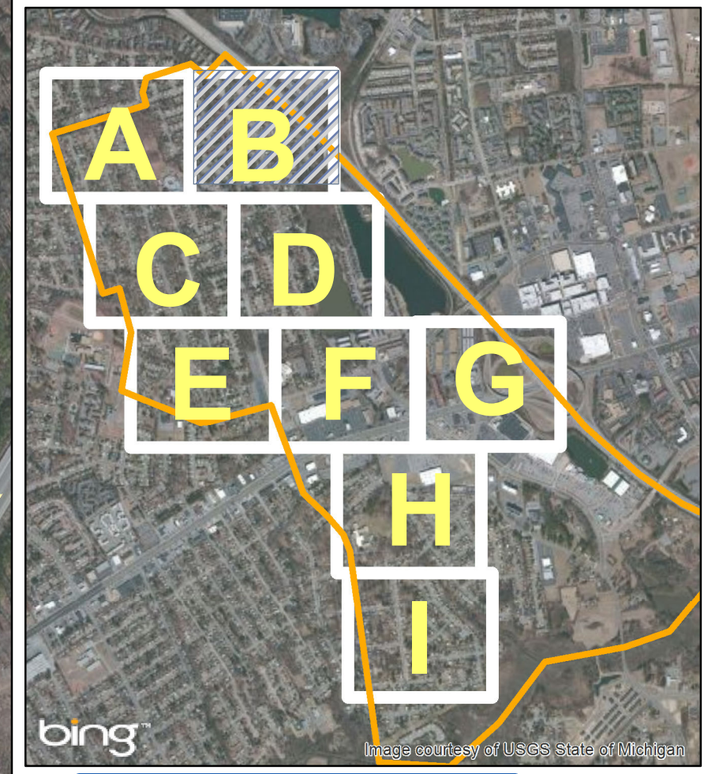
Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE B





LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

N

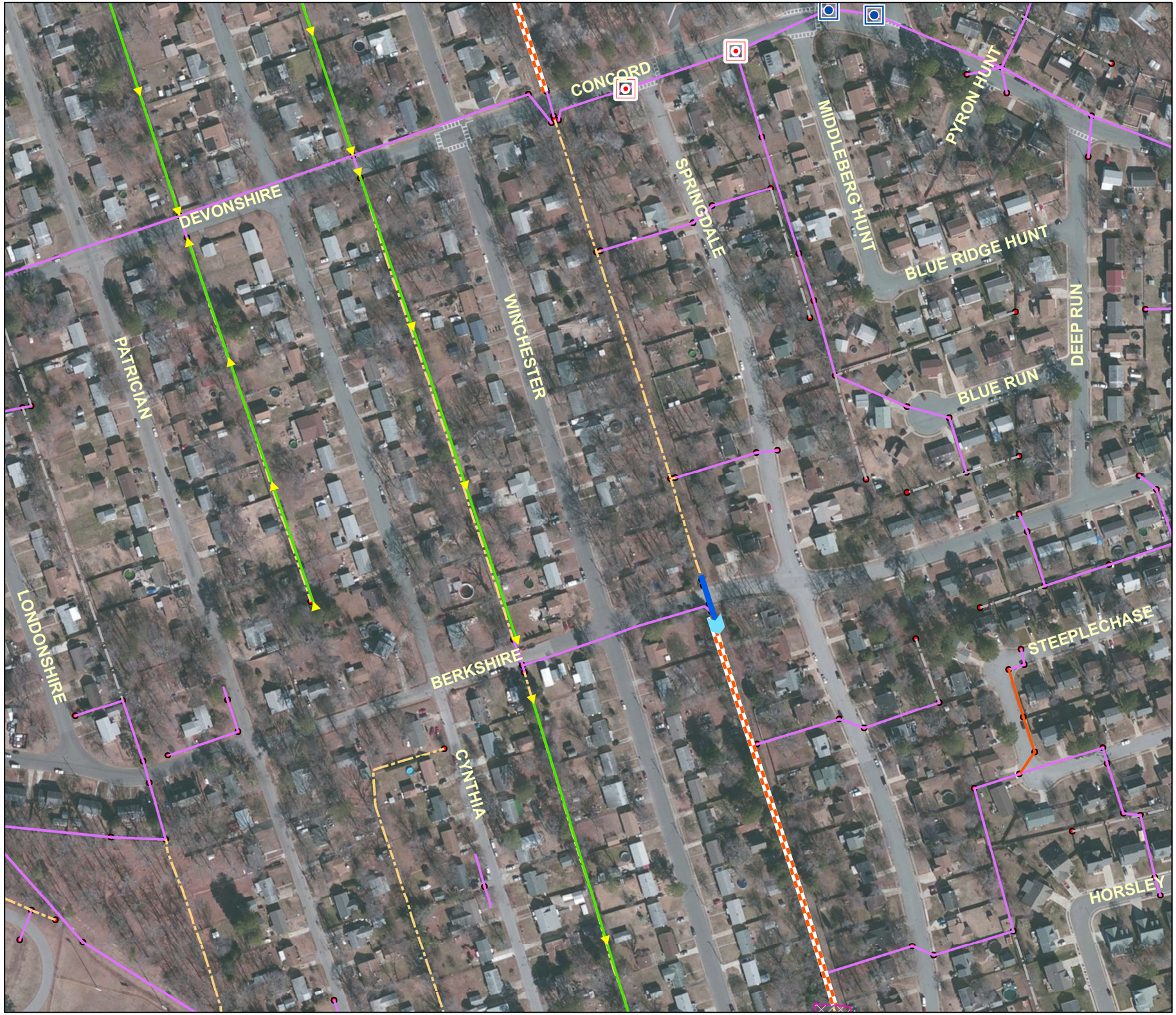
0 100 200 400

Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE C



LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

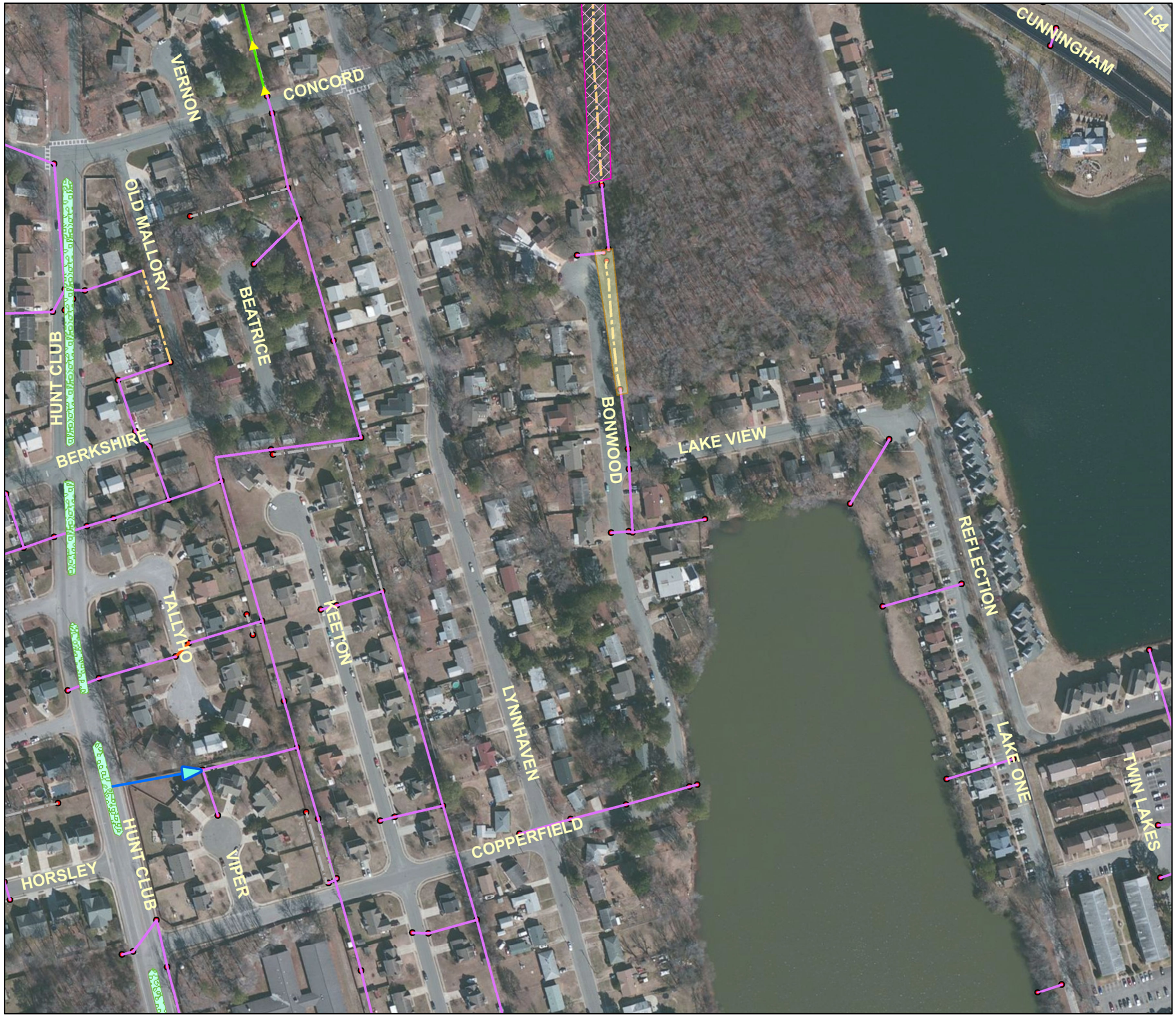
0 100 200 400

Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE D



LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

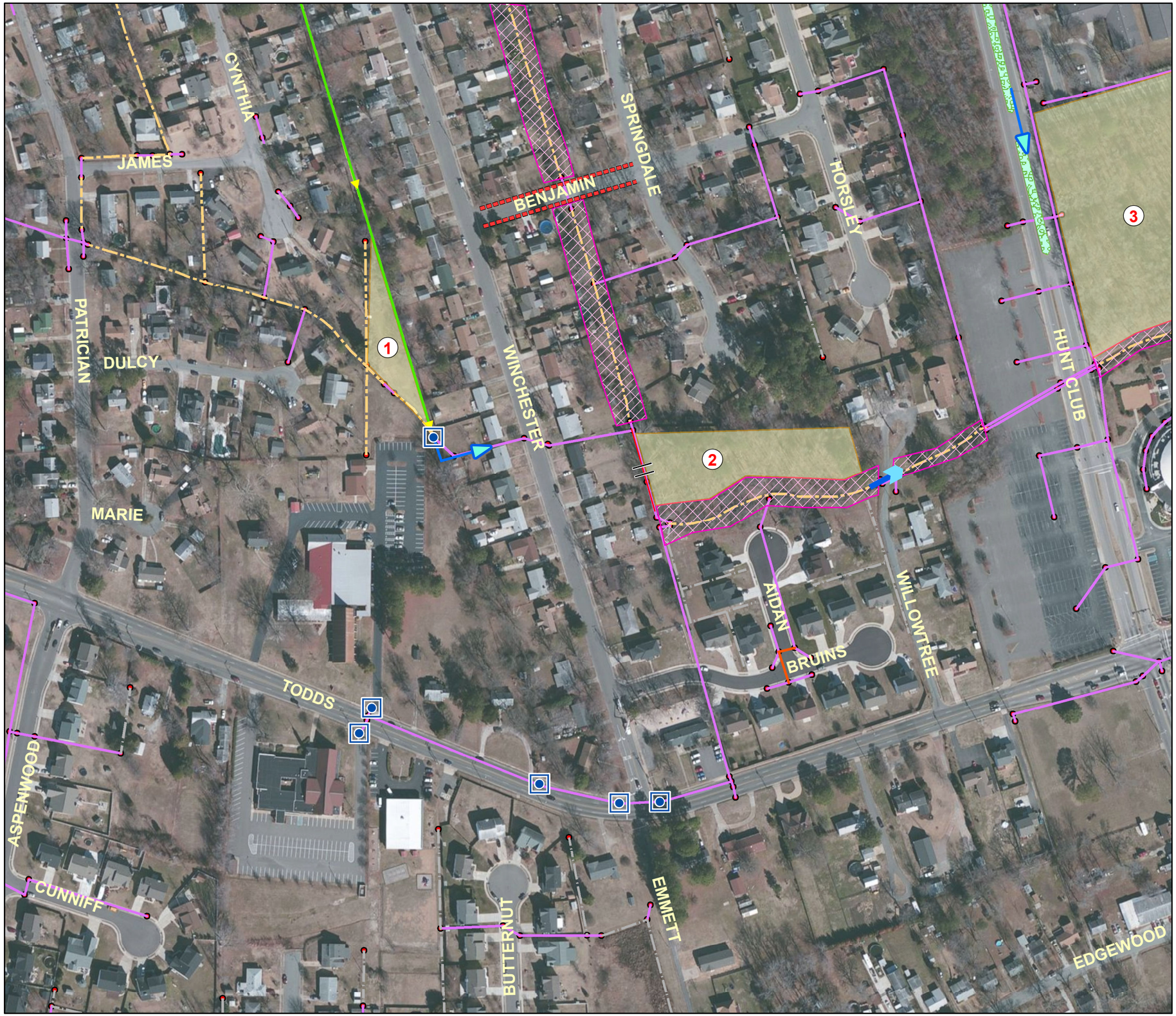
0 100 200 400

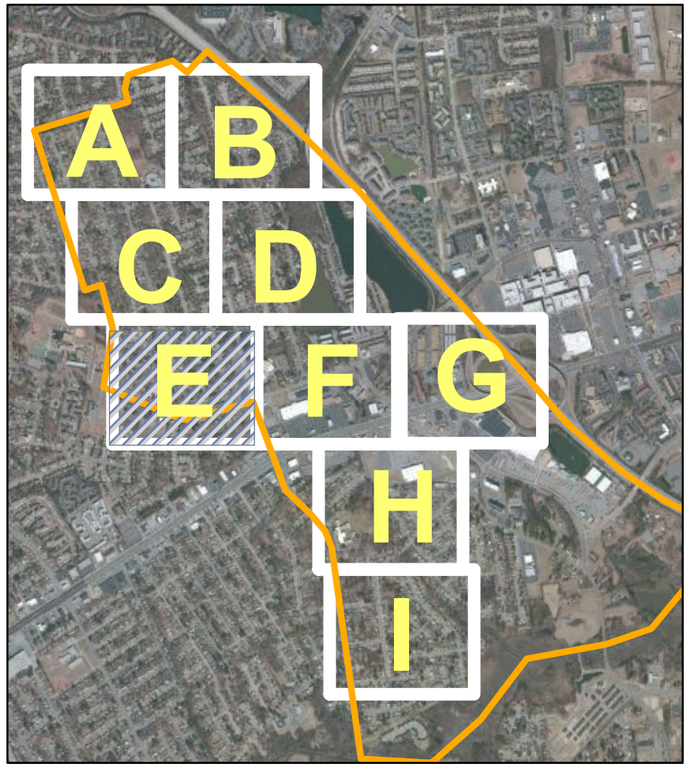
Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE E





LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

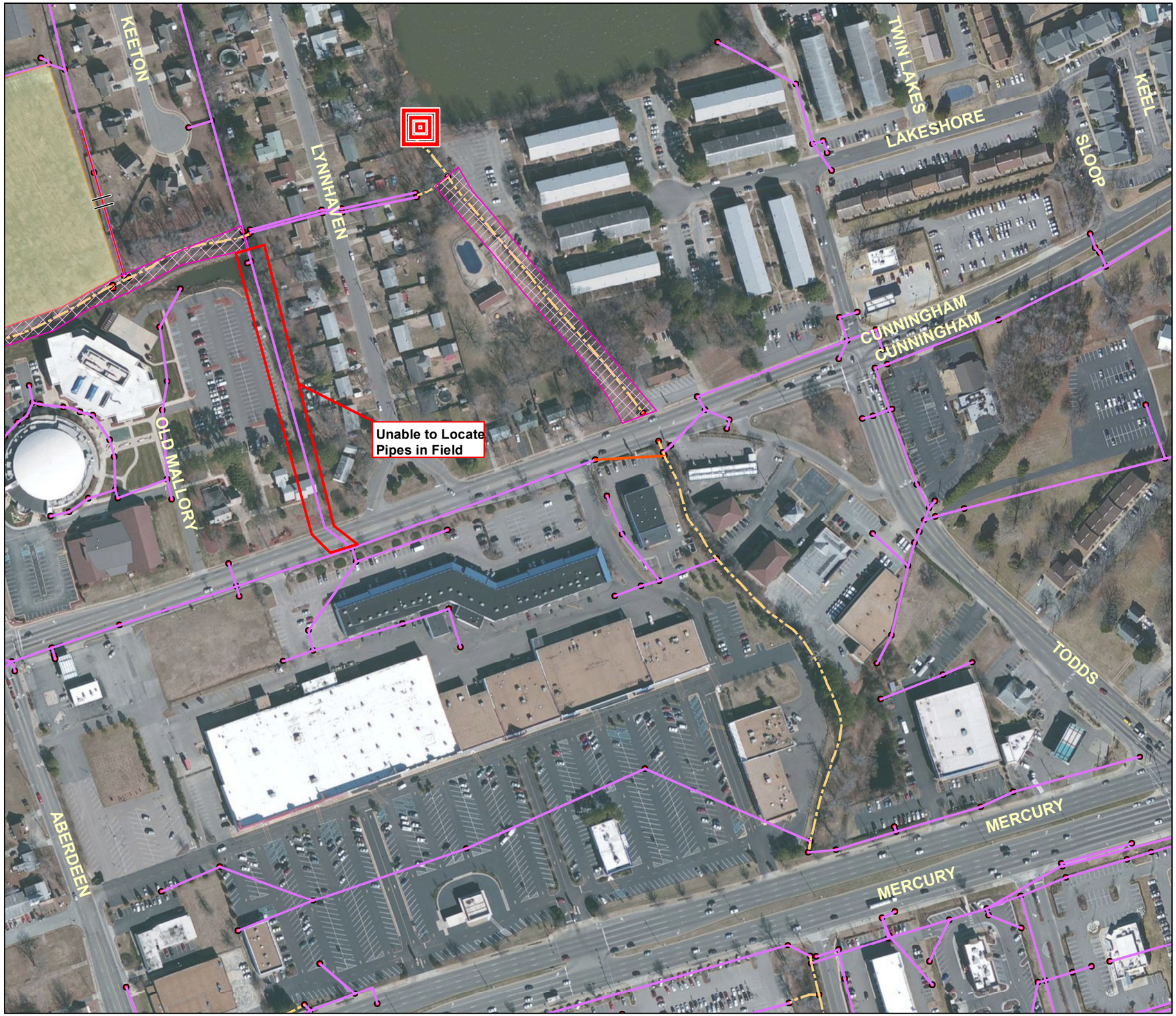
0 100 200 400

Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE F



LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

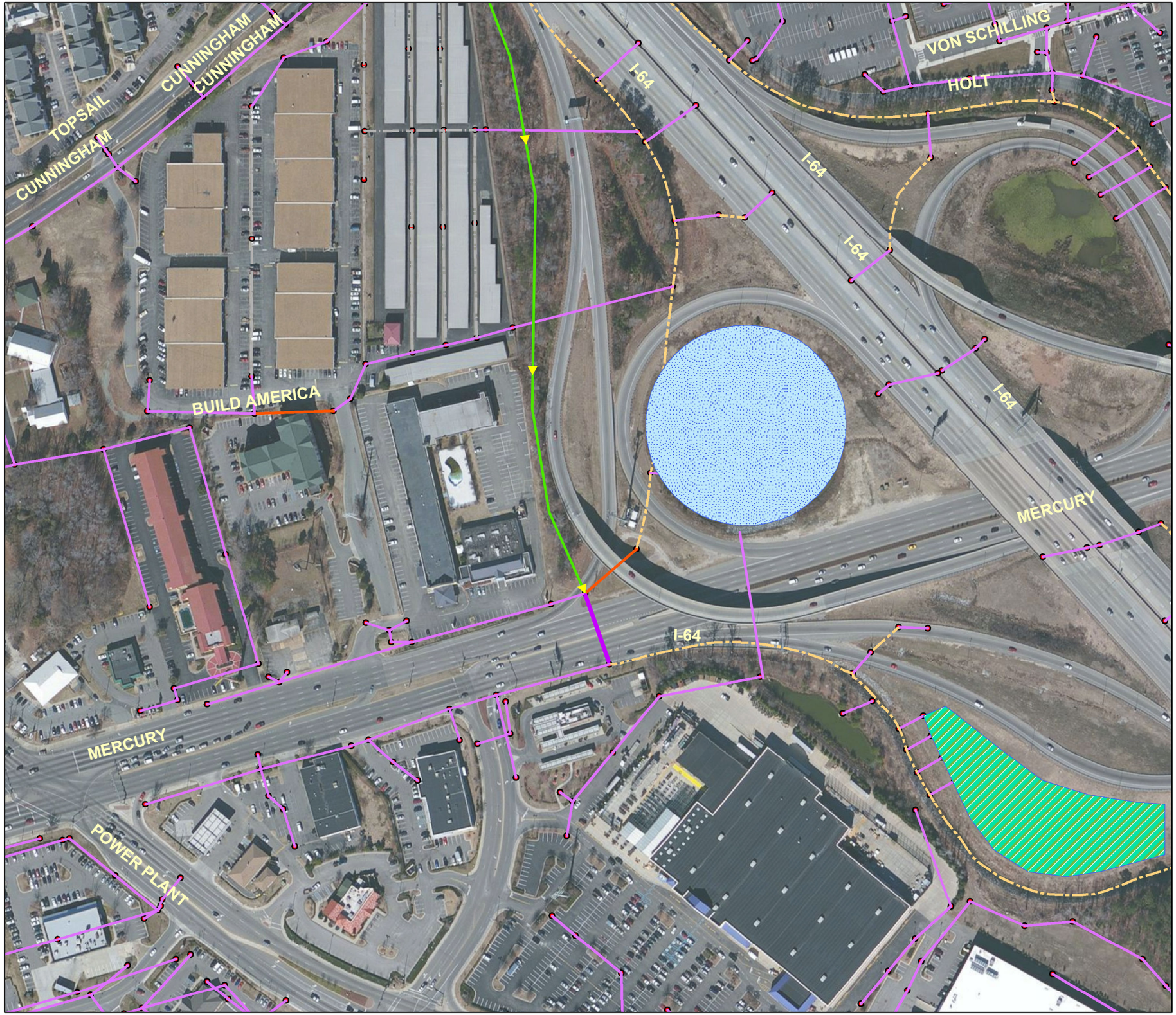
0 100 200 400

Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE G



LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

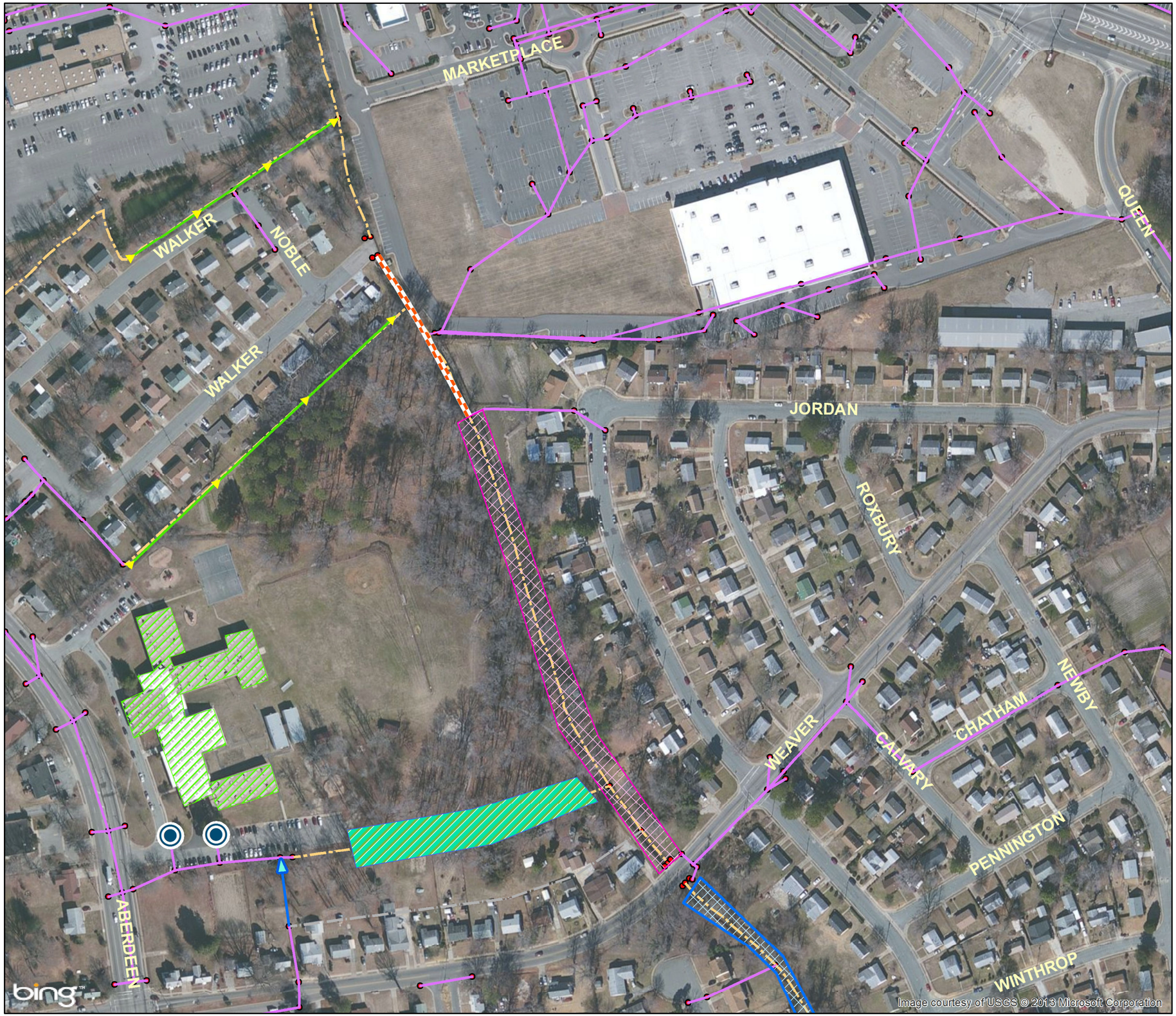
0 100 200 400

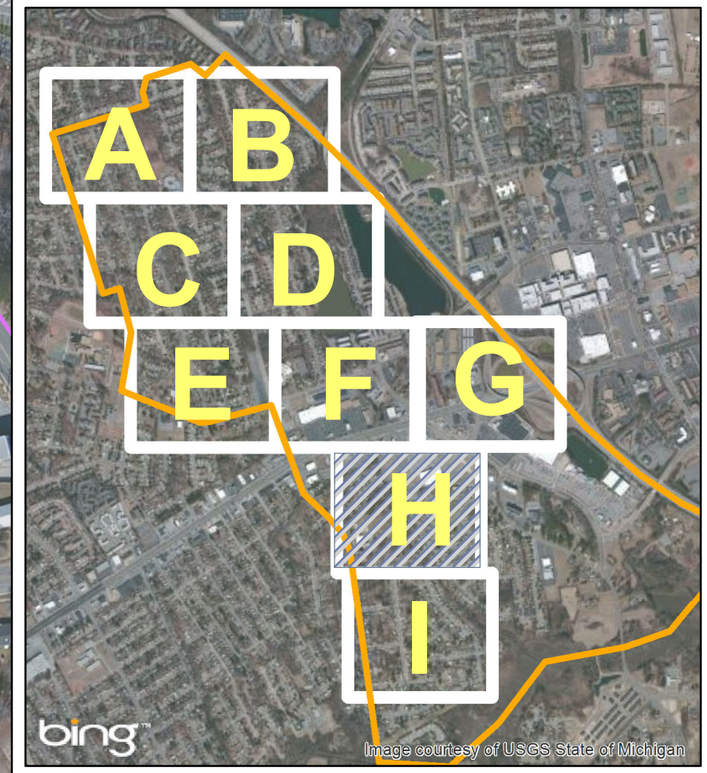
Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE H





LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

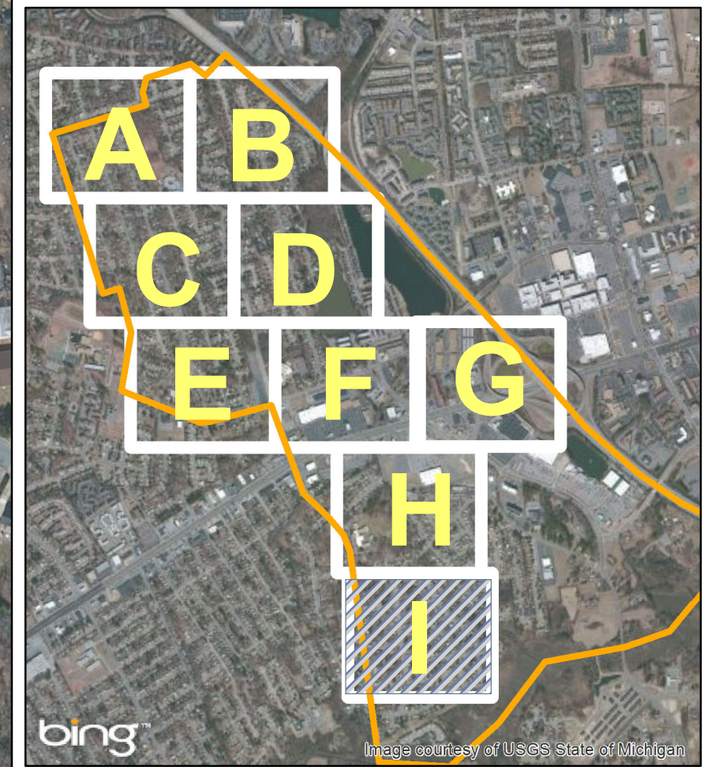
0 100 200 400

Feet

PARSONS BRINCKERHOFF

Back River - Lake Shores

WATERSHED - ZONE I



LEGEND

- Proposed Structure
- Replace Structure
- Stormceptor
- Control Structure
- Curb&GutterReplacement
- Abandon Pipe
- Replace Pipe
- Proposed Pipe
- Amended Grass Swale
- Stabalize Banks
- Retrofit Pond
- Rooftop Disconnection
- AOI
- Urban Bioretention
- Bioretention
- Stream Restoration
- Grade and Stabalize Channel
- Constructed Wetlands

Existing Stormwater Line

- Ditch
- Elliptical RCP
- Paved Ditch
- Round RCP
- Swale
- Trench

N

0 100 200 400

Feet

PARSONS BRINCKERHOFF

Appendix D – Calculations and Summaries

Virginia Runoff Reduction Method Worksheet -- Revised -- 03/25/2011 - Redevelopment

Site Data

Project Name: Kraft Elementary Retrofit

Date: 8-16-2013

	data input cells
	calculation cells
	constant values

Post-Development Project & Land Cover Information

Constants

Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26			Nitrogen EMC (mg/L)	1.86
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				

Pre-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	3.36	3.36
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	17.49	17.49
Impervious Cover (acres)	0.00	0.00	0.00	12.97	12.97
				Total	33.82

Post-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	1.39	1.39
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	18.45	18.45
Impervious Cover (acres)	0.00	0.00	0.00	13.98	13.98
				Total	33.82

Rv Coefficients

	A soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Land Cover Summary			**Land Cover Summary**	
Pre-Development			**Post-Development**	
Forest/Open Space Cover (acres)	3.36		Forest/Open Space Cover (acres)	1.39
Weighted Rv(forest)	0.05		Weighted Rv(forest)	0.05
% Forest	10%		% Forest	4%
Managed Turf Cover (acres)	17.49		Managed Turf Cover (acres)	18.45
Weighted Rv(turf)	0.25		Weighted Rv(turf)	0.25
% Managed Turf	52%		% Managed Turf	55%
Impervious Cover (acres)	12.97		Impervious Cover (acres)	13.98
Rv(impervious)	0.95		Rv(impervious)	0.95
% Impervious	38%		% Impervious	41%
Total Site Area (acres)	33.82		**Total Site Area (acres)**	33.82
Site Rv	0.50		**Site Rv**	0.53
Pre-Development Treatment Volume (acre-ft)	1.4052		Post-Development Treatment Volume (acre-ft)	1.4969
Pre-Development Treatment Volume (cubic feet)	61,209		Post-Development Treatment Volume (cubic feet)	65,206
Pre-Development Load (TP) (lb/yr)	40.25		Post-Development Load (TP) (lb/yr)	42.87
		Maximum % Reduction Required Below Pre-Development Load		20%
			Total Load (TP) Reduction Required (lb/yr)	**10.68**

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	1.39	1.39
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	18.45	18.45
Impervious Cover (acres)	0.00	0.00	0.00	13.98	13.98
				Total	33.82

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Vegetated Roof														**1. Green Roof**				
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2. Rooftop Disconnection														**2. Impervious Surface Disconnection**				
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design spreadsheet (See Spec #6)	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
3. Permeable Pavement														**3. Permeable Pavement**				
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious pavement	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
4. Grass Channel														**4. Grass Channel**				
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.c. Grass Channel Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	0.41	0	424	990	15	0.00	0.93	0.38	0.55	12.a. Constructed Wetland #1	20	0.00	6.64	2.92	3.72
	turf acres draining to grass channels	30% runoff volume reduction	0.30	1.38	0	376	877	15	0.00	0.82	0.33	0.49	12.a. Constructed Wetland #1	20	0.00	5.88	2.58	3.30
5. Dry Swale														**5. Dry Swale**				
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
6. Bioretention														**6. Bioretention**				
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
7. Infiltration														**7. Infiltration**				
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond														**8. Extended Detention Pond**				
8.a. ED #1 (Spec #15)	impervious acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	impervious acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
9. Sheetflow to Filter/Open Space														**9. Sheetflow to Conservation Area or Filter Strip**				
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

TOTAL PHOSPHOROUS REMOVAL REQUIRED ON SITE (lb/yr)	10.68
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	800
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	0.71
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	800
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	5.51

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)										**10. Wet Swale (Coastal Plain)**				
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11. Filtering Practices										**11. Filtering Practices**				
11.a. Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12. Constructed Wetland										**12. Constructed Wetland**				
12.a. Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	13.57	50	989.72	0.55	30.73	15.64	15.64		20	3.72	219.87	44.72	178.87
	turf acres draining to wetland	17.07	50	876.66	0.49	10.17	5.33	5.33		20	3.30	72.78	15.22	60.86
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13. Wet Ponds										**13. Wet Ponds**				
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
14. Manufactured BMP										**14. Manufactured BMP**				
	impervious acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	20.98
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	21.68
NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	59.93
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	65.45

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Virginia Runoff Reduction Method Worksheet -- Revised -- 03/25/2011 - Redevelopment

Site Data

Project Name: Aberdeen School Wetland Retrofit

Date: 8-16-2013

	data input cells
	calculation cells
	constant values

Post-Development Project & Land Cover Information

Constants

Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26			Nitrogen EMC (mg/L)	1.86
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				

Pre-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	4.00	0.00	0.30	4.30
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	3.70	0.00	8.62	12.32
Impervious Cover (acres)	0.00	2.81	0.00	11.26	14.07
				Total	30.69

Post-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	4.00	0.00	0.20	4.20
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	3.70	0.00	7.80	11.50
Impervious Cover (acres)	0.00	2.81	0.00	12.18	14.99
				Total	30.69

Rv Coefficients

	A soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Land Cover Summary		**Land Cover Summary**	
Pre-Development		**Post-Development**	
Forest/Open Space Cover (acres)	4.30	Forest/Open Space Cover (acres)	4.20
Weighted Rv(forest)	0.03	Weighted Rv(forest)	0.03
% Forest	14%	% Forest	14%
Managed Turf Cover (acres)	12.32	Managed Turf Cover (acres)	11.50
Weighted Rv(turf)	0.23	Weighted Rv(turf)	0.23
% Managed Turf	40%	% Managed Turf	37%
Impervious Cover (acres)	14.07	Impervious Cover (acres)	14.99
Rv(impervious)	0.95	Rv(impervious)	0.95
% Impervious	46%	% Impervious	49%
Total Site Area (acres)	30.69	**Total Site Area (acres)**	30.69
Site Rv	0.53	**Site Rv**	0.56
Pre-Development Treatment Volume (acre-ft)	1.3664	Post-Development Treatment Volume (acre-ft)	1.4217
Pre-Development Treatment Volume (cubic feet)	59,519	Post-Development Treatment Volume (cubic feet)	61,930
Pre-Development Load (TP) (lb/yr)	39.14	Post-Development Load (TP) (lb/yr)	40.72
		Maximum % Reduction Required Below Pre-Development Load	20%
		Total Load (TP) Reduction Required (lb/yr)	**9.41**

Drainage Area A

Drainage Area A Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	4.00	0.00	0.20	4.20
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	3.70	0.00	7.80	11.50
Impervious Cover (acres)	0.00	2.81	0.00	12.18	14.99
				Total	30.69

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Vegetated Roof														**1. Green Roof**				
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2. Rooftop Disconnection														**2. Impervious Surface Disconnection**				
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design spreadsheet (See Spec #6)	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
3. Permeable Pavement														**3. Permeable Pavement**				
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious pavement	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
4. Grass Channel														**4. Grass Channel**				
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.c. Grass Channel Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
5. Dry Swale														**5. Dry Swale**				
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	12.a. Constructed Wetland #1	25	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	12.a. Constructed Wetland #1	25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
6. Bioretention														**6. Bioretention**				
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
7. Infiltration														**7. Infiltration**				
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond														**8. Extended Detention Pond**				
8.a. ED #1 (Spec #15)	impervious acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	impervious acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
9. Sheetflow to Filter/Open Space														**9. Sheetflow to Conservation Area or Filter Strip**				
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

TOTAL PHOSPHOROUS REMOVAL REQUIRED ON SITE (lb/yr)	9.41
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	0.00
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	0.00

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)										**10. Wet Swale (Coastal Plain)**				
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11. Filtering Practices										**11. Filtering Practices**				
11.a. Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12. Constructed Wetland										**12. Constructed Wetland**				
12.a. Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	14.99	50	0.00	0.00	33.95	16.98	16.98		20	0.00	242.88	48.58	194.30
	turf acres draining to wetland	11.50	50	0.00	0.00	6.44	3.22	3.22		20	0.00	46.09	9.22	36.87
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13. Wet Ponds										**13. Wet Ponds**				
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
14. Manufactured BMP										**14. Manufactured BMP**				
	impervious acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	20.20
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	20.20
NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	57.79
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	57.79

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Virginia Runoff Reduction Method Worksheet -- Revised 03/25/2011					
Site Data					
Project Name: Nothampton Neighborhood Amended Swales					
Date: 8-16-2013					
	data input cells				
	calculation cells				
	constant values				
1. Post-Development Project & Land Cover Information					
Constants					
Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26		Nitrogen EMC (mg/L)	1.86	
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	14.57	14.57
Impervious Cover (acres)	0.00	0.00	0.00	9.71	9.71
				Total	24.28
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95	0.95	0.95	0.95	
Land Cover Summary					
Forest/Open Space Cover (acres)	0.00				
Weighted Rv(forest)	0.00				
% Forest	0%				
Managed Turf Cover (acres)	14.57				
Weighted Rv(turf)	0.25				
% Managed Turf	60%				
Impervious Cover (acres)	9.71				
Rv(impervious)	0.95				
% Impervious	40%				
Total Site Area (acres)	24.28				
Site Rv	0.53				
Post-Development Treatment Volume (acre-ft)	1.07				
Post-Development Treatment Volume (cubic feet)	46,707				
Post_Development Load (TP) (lb/yr)	30.71		Post_Development Load (TN) (lb/yr)	219.70	
Total Load (TP) Reduction Required (lb/yr)	20.76				

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	7.39	7.39
Impervious Cover (acres)	0.00	0.00	0.00	4.92	4.92
				Total	12.31

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Vegetated Roof														**1. Green Roof**				
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2. Rooftop Disconnection														**2. Impervious Surface Disconnection**				
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		80	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
3. Permeable Pavement														**3. Permeable Pavement**				
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
4. Grass Channel														**4. Grass Channel**				
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	4.92	0	5080	11877	15	0.00	1114	4.51	6.63		20	0.00	79.72	35.08	44.64
	turf acres draining to grass channels	30% runoff volume reduction	0.30	7.39	0	2012	4694	15	0.00	440	1.78	2.62		20	0.00	31.51	13.86	17.65
5. Dry Swale														**5. Dry Swale**				
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
6. Bioretention														**6. Bioretention**				
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
7. Infiltration														**7. Infiltration**				
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond														**8. Extended Detention Pond**				
8.a. ED #1 (Spec #15)	impervious acres draining to turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	impervious acres draining to turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
9. Sheetflow to Filter/Open Space														**9. Sheetflow to Conservation Area or Filter Strip**				
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

TOTAL PHOSPHORUS REMOVAL REQUIRED ON SITE (lb/yr)	20.76
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	7,102
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	6.32

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

TOTAL RUNOFF REDUCTION IN D.A. A (cf)	7,102
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	48.94

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)										**10. Wet Swale (Coastal Plain)**				
10.a. Wet Swale #1 (Spec #1)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #1)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11. Filtering Practices										**11. Filtering Practices**				
11.a Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12. Constructed Wetland										**12. Constructed Wetland**				
12.a.Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13. Wet Ponds										**13. Wet Ponds**				
13.a- Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec. #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
14. Manufactured BMP										**14. Manufactured BMP**				
14. Insert Name of Device	impervious acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	6.32

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	48.94

Virginia Runoff Reduction Method Worksheet -- Revised -- 03/25/2011 - Redevelopment

Site Data

Project Name: Bethel Church Amended Swale and Wetland Retrofit

Date: 8-16-2013

	data input cells
	calculation cells
	constant values

Post-Development Project & Land Cover Information

Constants

Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26			Nitrogen EMC (mg/L)	1.86
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				

Pre-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	3.55	3.55
Impervious Cover (acres)	0.00	0.00	0.00	2.37	2.37
				Total	5.92

Post-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	3.38	3.38
Impervious Cover (acres)	0.00	0.00	0.00	2.54	2.54
				Total	5.92

Rv Coefficients

	A soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Land Cover Summary		**Land Cover Summary**	
Pre-Development		**Post-Development**	
Forest/Open Space Cover (acres)	0.00	Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00	Weighted Rv(forest)	0.00
% Forest	0%	% Forest	0%
Managed Turf Cover (acres)	3.55	Managed Turf Cover (acres)	3.38
Weighted Rv(turf)	0.25	Weighted Rv(turf)	0.25
% Managed Turf	60%	% Managed Turf	57%
Impervious Cover (acres)	2.37	Impervious Cover (acres)	2.54
Rv(impervious)	0.95	Rv(impervious)	0.95
% Impervious	40%	% Impervious	43%
Total Site Area (acres)	5.92	**Total Site Area (acres)**	5.92
Site Rv	0.53	**Site Rv**	0.55
Pre-Development Treatment Volume (acre-ft)	0.2616	Post-Development Treatment Volume (acre-ft)	0.2715
Pre-Development Treatment Volume (cubic feet)	11,395	Post-Development Treatment Volume (cubic feet)	11,827
Pre-Development Load (TP) (lb/yr)	7.49	Post-Development Load (TP) (lb/yr)	7.78
		Maximum % Reduction Required Below Pre-Development Load	20%
		Total Load (TP) Reduction Required (lb/yr)	**1.78**

Drainage Area A

Drainage Area A Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	4.00	0.00	0.20	4.20
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	3.70	0.00	7.80	11.50
Impervious Cover (acres)	0.00	2.81	0.00	12.18	14.99
				Total	30.69

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
1. Vegetated Roof													
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2. Rooftop Disconnection													
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.d. To Dry Well or French Drain #1 (Microinfilration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design spreadsheet (See Spec #6)	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3. Permeable Pavement													
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious pavement	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
4. Grass Channel													
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.c. Grass Channel Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	2.37	0	2452	5721	15	0.00	5.37	2.17	3.19	12.a. Constructed Wetland #1
	turf acres draining to grass channels	30% runoff volume reduction	0.30	3.55	0	966	2255	15	0.00	2.12	0.86	1.26	12.a. Constructed Wetland #1
5. Dry Swale													
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
6. Bioretention													
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration													
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond													
8.a. ED #1 (Spec #15)	impervious acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	impervious acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
9. Sheetflow to Filter/Open Space													
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	

Credit	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Green Roof					
1.a. Vegetated Roof #1 (Spec #5)	0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	0	0.00	0.00	0.00	0.00
2. Impervious Surface Disconnection					
2.a. Simple Disconnection to A/B Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfilration #1) (Spec #8)	15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	60	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	40	0.00	0.00	0.00	0.00
3. Permeable Pavement					
3.a. Permeable Pavement #1 (Spec #7)	25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	25	0.00	0.00	0.00	0.00
4. Grass Channel					
4.a. Grass Channel A/B Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.c. Grass Channel Compost Amended Soils as per specs (see Spec #4)	20	0.00	38.40	16.90	21.50
	20	0.00	15.14	6.66	8.48
5. Dry Swale					
5.a. Dry Swale #1 (Spec #10)	25	0.00	0.00	0.00	0.00
	25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	35	0.00	0.00	0.00	0.00
	35	0.00	0.00	0.00	0.00
6. Bioretention					
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	40	0.00	0.00	0.00	0.00
	40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	60	0.00	0.00	0.00	0.00
	60	0.00	0.00	0.00	0.00
7. Infiltration					
7.a. Infiltration #1 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
8. Extended Detention Pond					
8.a. ED #1 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
9. Sheetflow to Conservation Area or Filter Strip					
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

TOTAL PHOSPHOROUS REMOVAL REQUIRED ON SITE (lb/yr)	1.78
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	3.418
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	3.03
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	3.418
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	23.56

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
10. Wet Swale (Coastal Plain)									
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
11. Filtering Practices									
11.a.Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
12. Constructed Wetland									
12.a.Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	5721.06	3.19	0.00	1.60	1.60	
	turf acres draining to wetland	0.00	50	2255.14	1.26	0.00	0.63	0.63	
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
13. Wet Ponds									
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
14. Manufactured BMP									
	impervious acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00	

Practice	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)					
10.a. Wet Swale #1 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11. Filtering Practices					
11.a.Filtering Practice #1 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
12. Constructed Wetland					
12.a.Constructed Wetland #1 (Spec #13)	20	21.50	0.00	4.30	17.20
	20	8.48	0.00	1.70	6.78
12.b. Constructed Wetland #2 (Spec #13)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13. Wet Ponds					
13.a. Wet Pond #1 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
14. Manufactured BMP					
	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	2.23
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	5.26

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	6.00
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	29.55

Virginia Runoff Reduction Method Worksheet -- Revised 03/25/2011					
Site Data					
Project Name: I-64/Mercury Blvd Interchange Pond Conversion					
Date: 8-16-2013					
	data input cells				
	calculation cells				
	constant values				
1. Post-Development Project & Land Cover Information					
Constants					
Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26		Nitrogen EMC (mg/L)	1.86	
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	1.00	1.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	9.73	9.73
Impervious Cover (acres)	0.00	0.00	0.00	35.60	35.60
				Total	46.33
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95	0.95	0.95	0.95	
Land Cover Summary					
Forest/Open Space Cover (acres)	1.00				
Weighted Rv(forest)	0.05				
% Forest	2%				
Managed Turf Cover (acres)	9.73				
Weighted Rv(turf)	0.25				
% Managed Turf	21%				
Impervious Cover (acres)	35.60				
Rv(impervious)	0.95				
% Impervious	77%				
Total Site Area (acres)	46.33				
Site Rv	0.78				
Post-Development Treatment Volume (acre-ft)	3.03				
Post-Development Treatment Volume (cubic feet)	131,778				
Post_Development Load (TP) (lb/yr)	86.65		Post_Development Load (TN) (lb/yr)	619.86	
Total Load (TP) Reduction Required (lb/yr)	67.65				

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	1.00	1.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	9.73	9.73
Impervious Cover (acres)	0.00	0.00	0.00	35.60	35.60
				Total	46.33

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Vegetated Roof														**1. Green Roof**				
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2. Rooftop Disconnection														**2. Impervious Surface Disconnection**				
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		80	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
3. Permeable Pavement														**3. Permeable Pavement**				
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
4. Grass Channel														**4. Grass Channel**				
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
5. Dry Swale														**5. Dry Swale**				
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
6. Bioretention														**6. Bioretention**				
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
7. Infiltration														**7. Infiltration**				
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond														**8. Extended Detention Pond**				
8.a. ED #1 (Spec #15)	impervious acres draining to	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	impervious acres draining to	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
9. Sheetflow to Filter/Open Space														**9. Sheetflow to Conservation Area or Filter Strip**				
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

TOTAL PHOSPHOROUS REMOVAL REQUIRED ON SITE (lbs/yr)	67.65
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	0.00

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	0.00

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)										**10. Wet Swale (Coastal Plain)**				
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	21.12	20	0.00	0.00	47.83	9.57	38.27	Pond #2 (Coastal Plain)	20	0.00	342.20	68.44	273.76
	turf acres draining to wet swale	8.05	20	0.00	0.00	4.80	0.96	3.84	Pond #2 (Coastal Plain)	20	0.00	34.32	6.86	27.46
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11. Filtering Practices										**11. Filtering Practices**				
11.a. Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12. Constructed Wetland										**12. Constructed Wetland**				
12.a Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13. Wet Ponds										**13. Wet Ponds**				
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	14.48	65	72832.32	36.27	32.80	46.19	24.87		20	273.76	234.62	101.68	406.70
	turf acres draining to wet pond	1.68	65	7305.38	3.84	1.00	3.15	1.69		20	27.46	7.16	6.92	27.70
14. Manufactured BMP										**14. Manufactured BMP**				
14. Insert Name of Device	impervious acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	59.86
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	59.86

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	183.90
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	183.90

Virginia Runoff Reduction Method Worksheet -- Revised 03/25/2011					
Site Data					
Project Name: Schools Rooftop Disconnection to French Drain or Dry Well					
Date: 8-16-2013					
	data input cells				
	calculation cells				
	constant values				
1. Post-Development Project & Land Cover Information					
Constants					
Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26		Nitrogen EMC (mg/L)	1.86	
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	3.19	3.19
				Total	3.19
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95	0.95	0.95	0.95	
Land Cover Summary					
Forest/Open Space Cover (acres)	0.00				
Weighted Rv(forest)	0.00				
% Forest	0%				
Managed Turf Cover (acres)	0.00				
Weighted Rv(turf)	0.00				
% Managed Turf	0%				
Impervious Cover (acres)	3.19				
Rv(impervious)	0.95				
% Impervious	100%				
Total Site Area (acres)	3.19				
Site Rv	0.95				
Post-Development Treatment Volume (acre-ft)	0.25				
Post-Development Treatment Volume (cubic feet)	11,001				
Post_Development Load (TP) (lb/yr)	7.23		Post_Development Load (TN) (lb/yr)	51.75	
Total Load (TP) Reduction Required (lb/yr)	5.93				

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	3.19	3.19
				Total	3.19

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
1. Vegetated Roof													
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2. Rooftop Disconnection													
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	3.19	0	5500	5500	25	0.00	7.23	4.52	2.71	
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3. Permeable Pavement													
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
4. Grass Channel													
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
5. Dry Swale													
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
6. Bioretention													
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration													
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond													
8.a. ED #1 (Spec #15)	impervious acres draining to	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	impervious acres draining to	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
9. Sheetflow to Filter/Open Space													
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	

TOTAL PHOSPHOROUS REMOVAL REQUIRED ON SITE (lbs/yr)	5.93
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	5,500
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	4.52

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs)	Remaining Nitrogen Load (lbs.)
1. Green Roof					
1.a. Vegetated Roof #1 (Spec #5)	0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	0	0.00	0.00	0.00	0.00
2. Impervious Surface Disconnection					
2.a. Simple Disconnection to A/B Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	15	0.00	51.69	29.72	21.97
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	80	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	40	0.00	0.00	0.00	0.00
3. Permeable Pavement					
3.a. Permeable Pavement #1 (Spec #7)	25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	25	0.00	0.00	0.00	0.00
4. Grass Channel					
4.a. Grass Channel A/B Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
5. Dry Swale					
5.a. Dry Swale #1 (Spec #10)	25	0.00	0.00	0.00	0.00
	25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	35	0.00	0.00	0.00	0.00
	35	0.00	0.00	0.00	0.00
6. Bioretention					
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	40	0.00	0.00	0.00	0.00
	40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	60	0.00	0.00	0.00	0.00
	60	0.00	0.00	0.00	0.00
7. Infiltration					
7.a. Infiltration #1 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
8. Extended Detention Pond					
8.a. ED #1 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
9. Sheetflow to Conservation Area or Filter Strip					
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

TOTAL RUNOFF REDUCTION IN D.A. A (cf)	5,500
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	29.72

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
10. Wet Swale (Coastal Plain)									
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
11. Filtering Practices									
11.a.Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
12. Constructed Wetland									
12.a.Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
13. Wet Ponds									
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
14. Manufactured BMP									
14. Insert Name of Device	impervious acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00	

	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)					
10.a. Wet Swale #1 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11. Filtering Practices					
11.a.Filtering Practice #1 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
12. Constructed Wetland					
12.a.Constructed Wetland #1 (Spec #13)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
12.b. Constructed Wetland #2 (Spec #13)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13. Wet Ponds					
13.a. Wet Pond #1 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
14. Manufactured BMP					
14. Insert Name of Device	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	4.52

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	29.72

Virginia Runoff Reduction Method Worksheet -- Revised 03/25/2011					
Site Data					
Project Name: Walker Road Swale Retrofit					
Date: 8-16-2013					
	data input cells				
	calculation cells				
	constant values				
1. Post-Development Project & Land Cover Information					
Constants					
Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26		Nitrogen EMC (mg/L)	1.86	
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	4.78	4.78
Impervious Cover (acres)	0.00	0.00	0.00	5.37	5.37
				Total	10.15
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95	0.95	0.95	0.95	
Land Cover Summary					
Forest/Open Space Cover (acres)	0.00				
Weighted Rv(forest)	0.00				
% Forest	0%				
Managed Turf Cover (acres)	4.78				
Weighted Rv(turf)	0.25				
% Managed Turf	47%				
Impervious Cover (acres)	5.37				
Rv(impervious)	0.95				
% Impervious	53%				
Total Site Area (acres)	10.15				
Site Rv	0.62				
Post-Development Treatment Volume (acre-ft)	0.52				
Post-Development Treatment Volume (cubic feet)	22,856				
Post_Development Load (TP) (lb/yr)	15.03		Post_Development Load (TN) (lb/yr)	107.51	
Total Load (TP) Reduction Required (lb/yr)	10.87				

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	4.78	4.78
Impervious Cover (acres)	0.00	0.00	0.00	5.37	5.37
				Total	10.15

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
1. Vegetated Roof													
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2. Rooftop Disconnection													
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3. Permeable Pavement													
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
4. Grass Channel													
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	5.37	0	5956	12963	15	0.00	1216	4.93	7.24	
	turf acres draining to grass channels	30% runoff volume reduction	0.30	4.78	0	1301	3036	15	0.00	285	1.15	1.70	
5. Dry Swale													
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
6. Bioretention													
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration													
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond													
8.a. ED #1 (Spec #15)	impervious acres draining to	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	impervious acres draining to	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
9. Sheetflow to Filter/Open Space													
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	

TOTAL PHOSPHORUS REMOVAL REQUIRED ON SITE (lbs/yr)	10.87
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	6,857
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	6.08

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Credit	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Green Roof					
1.a. Vegetated Roof #1 (Spec #5)	0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	0	0.00	0.00	0.00	0.00
2. Impervious Surface Disconnection					
2.a. Simple Disconnection to A/B Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	60	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	40	0.00	0.00	0.00	0.00
3. Permeable Pavement					
3.a. Permeable Pavement #1 (Spec #7)	25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	25	0.00	0.00	0.00	0.00
4. Grass Channel					
4.a. Grass Channel A/B Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	20	0.00	87.01	38.28	48.72
	20	0.00	20.38	8.97	11.41
5. Dry Swale					
5.a. Dry Swale #1 (Spec #10)	25	0.00	0.00	0.00	0.00
	25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	35	0.00	0.00	0.00	0.00
	35	0.00	0.00	0.00	0.00
6. Bioretention					
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	40	0.00	0.00	0.00	0.00
	40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	60	0.00	0.00	0.00	0.00
	60	0.00	0.00	0.00	0.00
7. Infiltration					
7.a. Infiltration #1 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
8. Extended Detention Pond					
8.a. ED #1 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
9. Sheetflow to Conservation Area or Filter Strip					
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

TOTAL RUNOFF REDUCTION IN D.A. A (cf)	6,857
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	47.25

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
10. Wet Swale (Coastal Plain)									
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
11. Filtering Practices									
11.a.Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
12. Constructed Wetland									
12.a.Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
13. Wet Ponds									
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
14. Manufactured BMP									
14. Insert Name of Device	impervious acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00	

Credit	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)					
10.a. Wet Swale #1 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11. Filtering Practices					
11.a.Filtering Practice #1 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
12. Constructed Wetland					
12.a.Constructed Wetland #1 (Spec #13)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
12.b. Constructed Wetland #2 (Spec #13)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13. Wet Ponds					
13.a. Wet Pond #1 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
14. Manufactured BMP					
14. Insert Name of Device	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	6.08

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	47.25

Virginia Runoff Reduction Method Worksheet -- Revised -- 03/25/2011 - Redevelopment

Site Data

Project Name: 40 Hunt Club Wetland Retrofit

Date: 8-16-2013

	data input cells
	calculation cells
	constant values

Post-Development Project & Land Cover Information

Constants

Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26			Nitrogen EMC (mg/L)	1.86
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				

Pre-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	6.90	6.90
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	12.09	12.09
Impervious Cover (acres)	0.00	0.00	0.00	11.51	11.51
				Total	30.50

Post-Development Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	5.00	5.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	13.00	13.00
Impervious Cover (acres)	0.00	0.00	0.00	12.50	12.50
				Total	30.50

Rv Coefficients

	A soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Land Cover Summary			**Land Cover Summary**	
Pre-Development			**Post-Development**	
Forest/Open Space Cover (acres)	6.90		Forest/Open Space Cover (acres)	5.00
Weighted Rv(forest)	0.05		Weighted Rv(forest)	0.05
% Forest	23%		% Forest	16%
Managed Turf Cover (acres)	12.09		Managed Turf Cover (acres)	13.00
Weighted Rv(turf)	0.25		Weighted Rv(turf)	0.25
% Managed Turf	40%		% Managed Turf	43%
Impervious Cover (acres)	11.51		Impervious Cover (acres)	12.50
Rv(impervious)	0.95		Rv(impervious)	0.95
% Impervious	38%		% Impervious	41%
Total Site Area (acres)	30.50		**Total Site Area (acres)**	30.50
Site Rv	0.47		**Site Rv**	0.50
Pre-Development Treatment Volume (acre-ft)	1.1918		Post-Development Treatment Volume (acre-ft)	1.2813
Pre-Development Treatment Volume (cubic feet)	51,916		Post-Development Treatment Volume (cubic feet)	55,811
Pre-Development Load (TP) (lb/yr)	34.14		Post-Development Load (TP) (lb/yr)	36.70
		Maximum % Reduction Required Below Pre-Development Load		20%
			Total Load (TP) Reduction Required (lb/yr)	**9.39**

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	5.00	5.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	13.00	13.00
Impervious Cover (acres)	0.00	0.00	0.00	12.50	12.50
				Total	30.50

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Vegetated Roof														**1. Green Roof**				
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2. Rooftop Disconnection														**2. Impervious Surface Disconnection**				
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design spreadsheet (See Spec #6)	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
3. Permeable Pavement														**3. Permeable Pavement**				
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious pavement	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
4. Grass Channel														**4. Grass Channel**				
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.c. Grass Channel Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
5. Dry Swale														**5. Dry Swale**				
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
6. Bioretention														**6. Bioretention**				
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
7. Infiltration														**7. Infiltration**				
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond														**8. Extended Detention Pond**				
8.a. ED #1 (Spec #15)	impervious acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	impervious acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
9. Sheetflow to Filter/Open Space														**9. Sheetflow to Conservation Area or Filter Strip**				
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

TOTAL PHOSPHOROUS REMOVAL REQUIRED ON SITE (lb/yr)	9.39
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	0.00
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	0.00

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)										**10. Wet Swale (Coastal Plain)**				
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11. Filtering Practices										**11. Filtering Practices**				
11.a. Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12. Constructed Wetland										**12. Constructed Wetland**				
12.a. Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	12.50	50	0.00	0.00	28.31	14.16	14.16		20	0.00	202.53	40.51	162.03
	turf acres draining to wetland	13.00	50	0.00	0.00	7.75	3.87	3.87		20	0.00	55.43	11.09	44.34
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13. Wet Ponds										**13. Wet Ponds**				
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
14. Manufactured BMP										**14. Manufactured BMP**				
	impervious acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to device	0.00	15	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	18.03
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	18.03
NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	51.59
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	51.59

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Virginia Runoff Reduction Method Worksheet -- Revised 03/25/2011					
Site Data					
Project Name: Bromsgrove Drive Amended Swale Retrofit					
Date: 8-16-2013					
	data input cells				
	calculation cells				
	constant values				
1. Post-Development Project & Land Cover Information					
Constants					
Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26		Nitrogen EMC (mg/L)	1.86	
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	6.63	6.63
Impervious Cover (acres)	0.00	0.00	0.00	4.42	4.42
				Total	11.05
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95	0.95	0.95	0.95	
Land Cover Summary					
Forest/Open Space Cover (acres)	0.00				
Weighted Rv(forest)	0.00				
% Forest	0%				
Managed Turf Cover (acres)	6.63				
Weighted Rv(turf)	0.25				
% Managed Turf	60%				
Impervious Cover (acres)	4.42				
Rv(impervious)	0.95				
% Impervious	40%				
Total Site Area (acres)	11.05				
Site Rv	0.53				
Post-Development Treatment Volume (acre-ft)	0.49				
Post-Development Treatment Volume (cubic feet)	21,259				
Post_Development Load (TP) (lb/yr)	13.98		Post_Development Load (TN) (lb/yr)	100.00	
Total Load (TP) Reduction Required (lb/yr)	9.45				

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	6.63	6.63
Impervious Cover (acres)	0.00	0.00	0.00	4.42	4.42
				Total	11.05

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs)	Phosphorus Removed By Practice (lbs)	Remaining Phosphorus Load (lbs)	Downstream Treatment to be Employed
1. Vegetated Roof													
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2. Rooftop Disconnection													
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3. Permeable Pavement													
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
4. Grass Channel													
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	4.42	0	4573	10670	15	0.00	10.01	4.05	5.96	
	turf acres draining to grass channels	30% runoff volume reduction	0.30	6.63	0	1805	4212	15	0.00	3.95	1.60	2.35	
5. Dry Swale													
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
6. Bioretention													
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration													
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond													
8.a. ED #1 (Spec #15)	impervious acres draining to	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	impervious acres draining to	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
9. Sheetflow to Filter/Open Space													
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	

	Credit	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Green Roof						
	1.a. Vegetated Roof #1 (Spec #5)	0	0.00	0.00	0.00	0.00
	1.b. Vegetated Roof #2 (Spec #5)	0	0.00	0.00	0.00	0.00
2. Impervious Surface Disconnection						
	2.a. Simple Disconnection to A/B Soils (Spec #1)	0	0.00	0.00	0.00	0.00
	2.b. Simple Disconnection to C/D Soils (Spec #1)	0	0.00	0.00	0.00	0.00
	2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	0	0.00	0.00	0.00	0.00
	2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	15	0.00	0.00	0.00	0.00
	2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	15	0.00	0.00	0.00	0.00
	2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	40	0.00	0.00	0.00	0.00
	2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	80	0.00	0.00	0.00	0.00
	2.h. To Rainwater Harvesting (Spec #6)	0	0.00	0.00	0.00	0.00
	2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	40	0.00	0.00	0.00	0.00
3. Permeable Pavement						
	3.a. Permeable Pavement #1 (Spec #7)	25	0.00	0.00	0.00	0.00
	3.b. Permeable Pavement #2 (Spec #7)	25	0.00	0.00	0.00	0.00
4. Grass Channel						
	4.a. Grass Channel A/B Soils (Spec #3)	20	0.00	0.00	0.00	0.00
		20	0.00	0.00	0.00	0.00
	4.b. Grass Channel C/D Soils (Spec #3)	20	0.00	0.00	0.00	0.00
		20	0.00	0.00	0.00	0.00
	4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	20	0.00	71.62	31.51	40.10
		20	0.00	28.27	12.44	15.83
5. Dry Swale						
	5.a. Dry Swale #1 (Spec #10)	25	0.00	0.00	0.00	0.00
		25	0.00	0.00	0.00	0.00
	5.b. Dry Swale #2 (Spec #10)	35	0.00	0.00	0.00	0.00
		35	0.00	0.00	0.00	0.00
6. Bioretention						
	6.a. Bioretention #1 or Urban Bioretention (Spec #9)	40	0.00	0.00	0.00	0.00
		40	0.00	0.00	0.00	0.00
	6.b. Bioretention #2 (Spec #9)	60	0.00	0.00	0.00	0.00
		60	0.00	0.00	0.00	0.00
7. Infiltration						
	7.a. Infiltration #1 (Spec #8)	15	0.00	0.00	0.00	0.00
		15	0.00	0.00	0.00	0.00
	7.b. Infiltration #2 (Spec #8)	15	0.00	0.00	0.00	0.00
		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond						
	8.a. ED #1 (Spec #15)	10	0.00	0.00	0.00	0.00
		10	0.00	0.00	0.00	0.00
	8.b. ED #2 (Spec #15)	10	0.00	0.00	0.00	0.00
		10	0.00	0.00	0.00	0.00
9. Sheetflow to Conservation Area or Filter Strip						
	9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	0	0.00	0.00	0.00	0.00
		0	0.00	0.00	0.00	0.00
	9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	0	0.00	0.00	0.00	0.00
		0	0.00	0.00	0.00	0.00
	9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	0	0.00	0.00	0.00	0.00
		0	0.00	0.00	0.00	0.00

TOTAL PHOSPHORUS REMOVAL REQUIRED ON SITE (lbs/yr) 9.45
TOTAL RUNOFF REDUCTION IN D.A. A (cf) 6,378
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr) 5.65
TOTAL RUNOFF REDUCTION IN D.A. A (cf) 6,378
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr) 43.95

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
10. Wet Swale (Coastal Plain)									
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
11. Filtering Practices									
11.a. Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
12. Constructed Wetland									
12.a. Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
13. Wet Ponds									
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
14. Manufactured BMP									
14. Insert Name of Device	impervious acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00	

Practice	Unit	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)						
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	20	0.00	0.00	0.00	0.00
11. Filtering Practices						
11.a. Filtering Practice #1 (Spec #12)	impervious acres draining to filter	20	0.00	0.00	0.00	0.00
	turf acres draining to filter	20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	20	0.00	0.00	0.00	0.00
	turf acres draining to filter	20	0.00	0.00	0.00	0.00
12. Constructed Wetland						
12.a. Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	20	0.00	0.00	0.00	0.00
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	20	0.00	0.00	0.00	0.00
13. Wet Ponds						
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	20	0.00	0.00	0.00	0.00
14. Manufactured BMP						
14. Insert Name of Device	impervious acres draining to device	0	0.00	0.00	0.00	0.00
	turf acres draining to device	0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A 0.00
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr) 5.65

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A 0.00
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr) 43.95

Virginia Runoff Reduction Method Worksheet -- Revised 03/25/2011					
Site Data					
Project Name: Lynnhaven Drive-Olsen Court Swale Retrofit					
Date: 8-16-2013					
	data input cells				
	calculation cells				
	constant values				
1. Post-Development Project & Land Cover Information					
Constants					
Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26		Nitrogen EMC (mg/L)	1.86	
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	7.46	7.46
Impervious Cover (acres)	0.00	0.00	0.00	4.98	4.98
				Total	12.44
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95	0.95	0.95	0.95	
Land Cover Summary					
Forest/Open Space Cover (acres)	0.00				
Weighted Rv(forest)	0.00				
% Forest	0%				
Managed Turf Cover (acres)	7.46				
Weighted Rv(turf)	0.25				
% Managed Turf	60%				
Impervious Cover (acres)	4.98				
Rv(impervious)	0.95				
% Impervious	40%				
Total Site Area (acres)	12.44				
Site Rv	0.53				
Post-Development Treatment Volume (acre-ft)	0.55				
Post-Development Treatment Volume (cubic feet)	23,943				
Post_Development Load (TP) (lb/yr)	15.74		Post_Development Load (TN) (lb/yr)	112.63	
Total Load (TP) Reduction Required (lb/yr)	10.64				

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	7.46	7.46
Impervious Cover (acres)	0.00	0.00	0.00	4.98	4.98
				Total	12.44

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Vegetated Roof														**1. Green Roof**				
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2. Rooftop Disconnection														**2. Impervious Surface Disconnection**				
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		80	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
3. Permeable Pavement														**3. Permeable Pavement**				
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
4. Grass Channel														**4. Grass Channel**				
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	4.98	0	5152	12021	15	0.00	1128	4.57	6.71		20	0.00	80.68	35.50	45.18
	turf acres draining to grass channels	30% runoff volume reduction	0.30	7.46	0	2031	4739	15	0.00	445	1.80	2.85		20	0.00	31.81	14.00	17.81
5. Dry Swale														**5. Dry Swale**				
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00		25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00		35	0.00	0.00	0.00	0.00
6. Bioretention														**6. Bioretention**				
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00		40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00		60	0.00	0.00	0.00	0.00
7. Infiltration														**7. Infiltration**				
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00		15	0.00	0.00	0.00	0.00
8. Extended Detention Pond														**8. Extended Detention Pond**				
8.a. ED #1 (Spec #15)	impervious acres draining to	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	impervious acres draining to	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00		10	0.00	0.00	0.00	0.00
9. Sheetflow to Filter/Open Space														**9. Sheetflow to Conservation Area or Filter Strip**				
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

TOTAL PHOSPHOROUS REMOVAL REQUIRED ON SITE (lb/yr)	10.64
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	7,183
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	6.37

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

TOTAL RUNOFF REDUCTION IN D.A. A (cf)	7,183
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	49.50

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)										**10. Wet Swale (Coastal Plain)**				
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11. Filtering Practices										**11. Filtering Practices**				
11.a.Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12. Constructed Wetland										**12. Constructed Wetland**				
12.a.Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13. Wet Ponds										**13. Wet Ponds**				
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00		20	0.00	0.00	0.00	0.00
14. Manufactured BMP										**14. Manufactured BMP**				
14. Insert Name of Device	impervious acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00
	turf acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00		0	0.00	0.00	0.00	0.00

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	6.37

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	49.50

Virginia Runoff Reduction Method Worksheet -- Revised 03/25/2011					
Site Data					
Project Name: Hydrodynamic Separators in School Parking Lots					
Date: 8-16-2013					
	data input cells				
	calculation cells				
	constant values				
1. Post-Development Project & Land Cover Information					
Constants					
Annual Rainfall (inches)	45				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.26		Nitrogen EMC (mg/L)	1.86	
Target Phosphorus Target Load (lb/acre/yr)	0.41				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	1.17	1.17
				Total	1.17
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95	0.95	0.95	0.95	
Land Cover Summary					
Forest/Open Space Cover (acres)	0.00				
Weighted Rv(forest)	0.00				
% Forest	0%				
Managed Turf Cover (acres)	0.00				
Weighted Rv(turf)	0.00				
% Managed Turf	0%				
Impervious Cover (acres)	1.17				
Rv(impervious)	0.95				
% Impervious	100%				
Total Site Area (acres)	1.17				
Site Rv	0.95				
Post-Development Treatment Volume (acre-ft)	0.09				
Post-Development Treatment Volume (cubic feet)	4,035				
Post_Development Load (TP) (lb/yr)	2.65		Post_Development Load (TN) (lb/yr)	18.98	
Total Load (TP) Reduction Required (lb/yr)	2.17				

Drainage Area A

Drainage Area A Land Cover (acres)	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	117	117
				Total	117

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Credit	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs)	Phosphorus Removed By Practice (lbs)	Remaining Phosphorus Load (lbs)	Downstream Treatment to be Employed
1. Vegetated Roof													
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2. Rooftop Disconnection													
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design	0.00	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3. Permeable Pavement													
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
4. Grass Channel													
4.a. Grass Channel A/B Soils (Spec #3)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.b. Grass Channel C/D Soils (Spec #3)	impervious acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	10% runoff volume reduction	0.10	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	impervious acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to grass channels	30% runoff volume reduction	0.30	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
5. Dry Swale													
5.a. Dry Swale #1 (Spec #10)	impervious acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	40% runoff volume reduction	0.40	0.00	0	0	0	20	0.00	0.00	0.00	0.00	
5.b. Dry Swale #2 (Spec #10)	impervious acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
	turf acres draining to dry swale	60% runoff volume reduction	0.60	0.00	0	0	0	40	0.00	0.00	0.00	0.00	
6. Bioretention													
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	40% runoff volume reduction	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration													
7.a. Infiltration #1 (Spec #8)	impervious acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	50% runoff volume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	impervious acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
	turf acres draining to infiltration	90% runoff volume reduction	0.90	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond													
8.a. ED #1 (Spec #15)	impervious acres draining to	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	0% runoff volume reduction	0.00	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	impervious acres draining to	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
	turf acres draining to ED	15% runoff volume reduction	0.15	0.00	0	0	0	15	0.00	0.00	0.00	0.00	
9. Sheetflow to Filter/Open Space													
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	impervious acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	75% runoff volume reduction for treated area	0.75	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	impervious acres draining to conserved open space	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
	turf acres draining to conserved open space	50% runoff reduction volume for treated area	0.50	0.00	0	0	0	0	0.00	0.00	0.00	0.00	

TOTAL PHOSPHORUS REMOVAL REQUIRED ON SITE (lbs/yr)	2.17
TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
PHOSPHORUS REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	0.00

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
1. Green Roof					
1.a. Vegetated Roof #1 (Spec #5)	0	0.00	0.00	0.00	0.00
1.b. Vegetated Roof #2 (Spec #5)	0	0.00	0.00	0.00	0.00
2. Impervious Surface Disconnection					
2.a. Simple Disconnection to A/B Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.b. Simple Disconnection to C/D Soils (Spec #1)	0	0.00	0.00	0.00	0.00
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	0	0.00	0.00	0.00	0.00
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	15	0.00	0.00	0.00	0.00
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	15	0.00	0.00	0.00	0.00
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	40	0.00	0.00	0.00	0.00
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	80	0.00	0.00	0.00	0.00
2.h. To Rainwater Harvesting (Spec #6)	0	0.00	0.00	0.00	0.00
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	40	0.00	0.00	0.00	0.00
3. Permeable Pavement					
3.a. Permeable Pavement #1 (Spec #7)	25	0.00	0.00	0.00	0.00
3.b. Permeable Pavement #2 (Spec #7)	25	0.00	0.00	0.00	0.00
4. Grass Channel					
4.a. Grass Channel A/B Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.b. Grass Channel C/D Soils (Spec #3)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
4.c. Grass Channel with Compost Amended Soils as per specs (see Spec #4)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
5. Dry Swale					
5.a. Dry Swale #1 (Spec #10)	25	0.00	0.00	0.00	0.00
	25	0.00	0.00	0.00	0.00
5.b. Dry Swale #2 (Spec #10)	35	0.00	0.00	0.00	0.00
	35	0.00	0.00	0.00	0.00
6. Bioretention					
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	40	0.00	0.00	0.00	0.00
	40	0.00	0.00	0.00	0.00
6.b. Bioretention #2 (Spec #9)	60	0.00	0.00	0.00	0.00
	60	0.00	0.00	0.00	0.00
7. Infiltration					
7.a. Infiltration #1 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
7.b. Infiltration #2 (Spec #8)	15	0.00	0.00	0.00	0.00
	15	0.00	0.00	0.00	0.00
8. Extended Detention Pond					
8.a. ED #1 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
8.b. ED #2 (Spec #15)	10	0.00	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00
9. Sheetflow to Conservation Area or Filter Strip					
9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	0	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

TOTAL RUNOFF REDUCTION IN D.A. A (cf)	0
NITROGEN REMOVAL FROM RUNOFF REDUCTION PRACTICES IN D.A. A (lbs/yr)	0.00

Apply Practices that Remove Pollutants but Do Not Reduce Runoff Volume

Practice	Unit	Area (excluding areas treated by upstream practices)	Phosphorus Efficiency (%)	Runoff from Upstream RR Practices (cf)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
10. Wet Swale (Coastal Plain)									
10.a. Wet Swale #1 (Spec #11)	impervious acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	20	0.00	0.00	0.00	0.00	0.00	
10.b. Wet Swale #2 (Spec #11)	impervious acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet swale	0.00	40	0.00	0.00	0.00	0.00	0.00	
11. Filtering Practices									
11.a.Filtering Practice #1 (Spec #12)	impervious acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	60	0.00	0.00	0.00	0.00	0.00	
11.b. Filtering Practice #2 (Spec #12)	impervious acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to filter	0.00	65	0.00	0.00	0.00	0.00	0.00	
12. Constructed Wetland									
12.a.Constructed Wetland #1 (Spec #13)	impervious acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	50	0.00	0.00	0.00	0.00	0.00	
12.b. Constructed Wetland #2 (Spec #13)	impervious acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wetland	0.00	75	0.00	0.00	0.00	0.00	0.00	
13. Wet Ponds									
13.a. Wet Pond #1 (Spec #14)	impervious acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	50	0.00	0.00	0.00	0.00	0.00	
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	45	0.00	0.00	0.00	0.00	0.00	
13.c. Wet Pond #2 (Spec #14)	impervious acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	75	0.00	0.00	0.00	0.00	0.00	
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	impervious acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
	turf acres draining to wet pond	0.00	65	0.00	0.00	0.00	0.00	0.00	
14. Manufactured BMP									
Hydrodynamic Separator	impervious acres draining to device	1.17	15	0.00	0.00	2.65	0.40	2.25	
	turf acres draining to device	0.00	0	0.00	0.00	0.00	0.00	0.00	

PHOSPHORUS REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.40
TOTAL PHOSPHORUS REMOVAL IN D.A. A (lb/yr)	0.40

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

NITROGEN REMOVAL BY PRACTICES THAT DO NOT REDUCE RUNOFF VOLUME IN D.A. A	0.00
TOTAL NITROGEN REMOVAL IN D.A. A (lb/yr)	0.00

	Nitrogen Efficiency (%)	Nitrogen Load from Upstream RR Practices (lbs)	Untreated Nitrogen Load to Practice (lbs.)	Nitrogen Removed By Practice (lbs.)	Remaining Nitrogen Load (lbs.)
10. Wet Swale (Coastal Plain)					
10.a. Wet Swale #1 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
10.b. Wet Swale #2 (Spec #11)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11. Filtering Practices					
11.a.Filtering Practice #1 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
11.b. Filtering Practice #2 (Spec #12)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
12. Constructed Wetland					
12.a.Constructed Wetland #1 (Spec #13)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
12.b. Constructed Wetland #2 (Spec #13)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13. Wet Ponds					
13.a. Wet Pond #1 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.c. Wet Pond #2 (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	20	0.00	0.00	0.00	0.00
	20	0.00	0.00	0.00	0.00
14. Manufactured BMP					
Hydrodynamic Separator	0	0.00	18.96	0.00	18.96
	0	0.00	0.00	0.00	0.00

TOTAL SUSPENDED SOLIDS REDUCTION

Kraft Elementary Swale and Wetland									
Land Use	Dry Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA(lbs/yr)	Swale Removal Efficiency (%)	Potential TSS Load Removal (lbs/yr)	Wetland DA (acres)	TSS Load from DA (lbs/yr)	Wetland Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	0.41	675.86	277	50%	139	13.57	9310	60%	5586
Pervious Urban	1.38	92.26	127	50%	64	17.07	1639	60%	983
Forest	0	31.05	0	50%	0	1.39	43	60%	26
								Total =	6595

Aberdeen School Wetland					
Land Use	Wetland DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Wetland Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	14.99	675.86	10131	60%	6079
Pervious Urban	11.5	92.26	1061	60%	637
Forest	4.2	31.05	130	60%	78
				Total =	6794

Existing I-64/Mercury Blvd Interchange Pond									
Land Use	Wet Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA(lbs/yr)	Swale Removal Efficiency (%)	Potential TSS Load Removal (lbs/yr)	Dry Pond DA (acres)	TSS Load from DA (lbs/yr)	Dry Pond Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	21.12	675.86	14274	50%	7137	14.48	16924	10%	1692
Pervious Urban	8.05	92.26	743	50%	371	1.68	526	10%	53
Forest	1	31.05	31	50%	16	0	16	10%	2
								Total =	1747

I-64/Mercury Blvd Interchange Pond Conversion									
Land Use	Wet Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA(lbs/yr)	Swale Removal Efficiency (%)	Potential TSS Load Removal (lbs/yr)	Wet Pond DA (acres)	TSS Load from DA (lbs/yr)	Wet Pond Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	21.12	675.86	14274	50%	7137	14.48	16924	60%	10154
Pervious Urban	8.05	92.26	743	50%	371	1.68	526	60%	316
Forest	1	31.05	31	50%	16	0	16	60%	9
								Total =	10479

Lynnhaven Lake					
Land Use	Wet Pond DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Wet Pond Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	58.33	675.86	39423	60%	23654
Pervious Urban	68.58	92.26	6327	60%	3796
Forest	6.00	31.05	186	60%	112
				Total =	27562

Walker Road Swale					
Land Use	Dry Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Swale Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	4.78	675.86	3231	50%	1615
Pervious Urban	5.37	92.26	495	50%	248
Forest	0.00	31.05	0	50%	0
				Total =	1863

Aberdeen School Swale					
Land Use	Dry Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Swale Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	1.88	675.86	1271	50%	635
Pervious Urban	2.82	92.26	260	50%	130
Forest	0.00	31.05	0	50%	0
				Total =	765

Bethel Church Swale and Wetland									
Land Use	Amended Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA(lbs/yr)	Swale Removal Efficiency (%)	Potential TSS Load Removal (lbs/yr)	Wetland DA (acres)	TSS Load from DA (lbs/yr)	Wetland Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	2.54	675.86	1717	50%	858	2.54	2575	60%	1545
Pervious Urban	3.38	92.26	312	50%	156	3.38	468	60%	281
Forest	0	31.05	0	50%	0	0	0	60%	0
								Total =	1826

Bromsgrove Drive Amended Swale and Dry Swale									
Land Use	Amended Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA(lbs/yr)	Swale Removal Efficiency (%)	Potential TSS Load Removal (lbs/yr)	Dry Swale DA (acres)	TSS Load from DA (lbs/yr)	Swale Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	1.29	675.86	872	50%	436	3.13	2551	50%	1276
Pervious Urban	1.93	92.26	178	50%	89	4.7	523	50%	261
Forest	0	31.05	0	50%	0	0	0	50%	0
								Total =	1537

Lynnhaven-Olsen Amended Swale and Dry Swale									
Land Use	Amended Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA(lbs/yr)	Swale Removal Efficiency (%)	Potential TSS Load Removal (lbs/yr)	Dry Swale DA (acres)	TSS Load from DA (lbs/yr)	Swale Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	1.05	675.86	710	50%	355	3.93	3011	50%	1505
Pervious Urban	1.57	92.26	145	50%	72	5.89	616	50%	308
Forest	0	31.05	0	50%	0	0	0	50%	0
								Total =	1813

40 Hunt Club Blvd Retrofit					
Land Use	Wetland DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Wetland Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	12.50	675.86	8448	60%	5069
Pervious Urban	13.00	92.26	1199	60%	720
Forest	5.00	31.05	155	60%	93
				Total =	5882

1705 Todds Lane Retrofit					
Land Use	Wetland DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Wetland Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	7.94	675.86	5366	60%	3220
Pervious Urban	8.92	92.26	823	60%	494
Forest	2.32	31.05	72	60%	43
				Total =	3757

Hydrodynamic Separators					
Land Use	BMP DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	BMP Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	1.17	675.86	791	85%	672
Pervious Urban	0.00	92.26	0	85%	0
Forest	0.00	31.05	0	85%	0
				Total =	672

Hunt Club Blvd Bioretention Retrofit					
Land Use	Wetland DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Wetland Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	7.88	675.86	5326	80%	4261
Pervious Urban	1.00	92.26	92	80%	74
Forest	0.00	31.05	0	80%	0
				Total =	4334

Upper Watershed Swales					
Land Use	Dry Swale DA (acres)	Loading Rate (lbs/ac)	TSS Load from DA (lbs/yr)	Swale Removal Efficiency (%)	Potential Load Reduction (lbs/yr)
Impervious Urban	9.71	675.86	6563	50%	3281
Pervious Urban	14.57	92.26	1344	50%	672
Forest	0.00	31.05	0	50%	0
				Total =	3953

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
KRAFT ELEMENTARY SWALE AND ED WETLAND RETROFIT

I. DRAINAGE AREAS PRE/POST

PRE-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	12.97	0.95	12.32
		Managed Turf	17.49	0.25	4.37
		Forest	3.36	0.05	0.17
			33.82		0.50

Site Rv (existing) 0.50
% impervious (existing) 38%

Time of Concentration (Tc) = 40 minutes

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	13.98	0.95	13.28
		Managed Turf	18.45	0.25	4.61
		Forest	1.39	0.05	0.07
			33.82		0.53

Site Rv (existing) 0.53
% impervious (proposed) 41%

Time of Concentration (Tc) = 40 minutes

II. PROPOSED BMP

Amended Swale and Extended Detention Constructed Wetland
Phosphorous Removal EFF = 50%

Set Normal Pond Elevation at 10.00

TV = Total Acres x Site Rv x 1 inches
TV = 1.50 ac-ft
TV = 65206 Cu Ft

Required storage below permanent pool = 65,206 Cu Ft

Provided storage below permanent pool = 68,801 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
7.00	9,434				
8.00	11,049	10,242	10,242	10,242	
9.00	30,937	20,993	20,993	31,235	
10.00	44,196	37,567	37,567	68,801	Quality Storage
11.00	48,317	46,257	46,257	115,058	Additional Quantity Storage
12.00	52,168	50,243	50,243	165,300	

IV. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	20.72
TN	62.54
TSS	6595

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
ABERDEEN SCHOOL ED WETLAND RETROFIT

I. DRAINAGE AREAS PRE/POST

PRE-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	11.26	0.95	10.70
		Managed Turf	8.62	0.25	2.16
		Forest	0.30	0.05	0.02
	B	Impervious	2.81	0.95	2.67
		Managed Turf	3.70	0.20	0.74
		Forest	4.00	0.03	0.12
			30.69		0.53

Site Rv (existing) 0.53
% impervious (existing) 46%

Time of Concentration (Tc) = 46 minutes

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	12.18	0.95	11.57
		Managed Turf	7.80	0.25	1.95
		Forest	0.20	0.05	0.01
	B	Impervious	2.81	0.95	2.67
		Managed Turf	3.70	0.20	0.74
		Forest	4.00	0.03	0.12
			30.69		0.56

Site Rv (existing) 0.56
% impervious (proposed) 49%

Time of Concentration (Tc) = 46 minutes

II. PROPOSED BMP

Extended Detention Constructed Wetland
Phosphorous Removal EFF = 50%

Set Normal Pond Elevation at 10.00

TV = Total Acres x Site Rv x 1 inches
TV = 1.42 ac-ft
TV = 61930 Cu Ft

Required storage below permanent pool = 61,930 Cu Ft

Provided storage below permanent pool = 62,756 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
2.00	9,300				
3.00	10,018	9,659	9,659	9,659	
4.00	28,050	19,034	19,034	28,693	
5.00	40,075	34,063	34,063	62,756	Quality Storage
6.00	43,683	41,879	41,879	104,635	Additional Quantity Storage
7.00	47,374	45,529	45,529	150,163	

IV. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	19.30
TN	55.22
TSS	6794

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
I-64/MERCURY BLVD INTERCHANGE POND CONVERSION

I. DRAINAGE AREA

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	35.60	0.95	33.82
		Managed Turf	9.73	0.25	2.43
		Forest	1.00	0.05	0.05
			46.33		0.78

Site Rv (existing) 0.78
% impervious 77%

Time of Concentration (Tc) = 58 minutes

II. PROPOSED BMP Wet Pond Level 2
Phosphorous Removal EFF = 65%

Set Normal Pond Elevation at 7.20

TV = Total Acres x Site Rv x 1 inches
TV = 3.03 ac-ft
TV = 131778 Cu Ft

Required storage below permanent pool = 131,778 Cu Ft

Provided storage below permanent pool = 169,500 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
4.00	30,000				
5.00	50,000	25,000	25,000	25,000	
6.00	65,000	57,500	57,500	82,500	
7.20	80,000	72,500	87,000	169,500	Quality Storage
8.00	109,500	94,750	75,800	245,300	
9.00	113,500	111,500	111,500	356,800	
10.00	117,500	115,500	115,500	472,300	
11.00	121,500	119,500	119,500	591,800	
12.00	121,500	121,500	121,500	713,300	

IV. APPROX. NUTRIENT REMOVAL

Existing	
Pollutant	Load Reduction (lbs/yr)
TP	35.47
TN	170.05
TSS	1747

Proposed	
Pollutant	Load Reduction (lbs/yr)
TP	57.20
TN	175.73
TSS	10479

Pollutant	Load Reduction (lbs/yr)
TP	21.73
TN	5.68
TSS	8732

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
LYNNHAVEN LAKE IMPROVEMENTS

I. DRAINAGE AREA

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	58.33	0.95	55.41
		Managed Turf	68.58	0.25	17.15
		Forest	6.00	0.05	0.30
			132.91		0.55

Site Rv (existing) 0.55
% impervious (proposed) 44%

Time of Concentration (Tc) = 87 minutes

II. PROPOSED BMP Wet Pond Level 1
Phosphorous Removal EFF = 45%

Set Normal Pond Elevation at 4.60

TV = Total Acres x Site Rv x 1 inches
TV = 6.07 ac-ft
TV = 264476 Cu Ft

Required storage below permanent pool = 264,476 Cu Ft

Provided storage below permanent pool = 1,988,422 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
1.00	528,369				
2.00	538,050	533,210	533,210	533,210	
3.00	558,546	548,298	548,298	1,081,508	
4.60	575,097	566,822	906,914	1,988,422	Quality Storage
6.00	589,751	582,424	815,394	2,803,816	Additional Storage
7.00	600,316	595,034	595,034	3,398,849	
8.00	610,962	605,639	605,639	4,004,488	
9.00	621,689	616,326	616,326	4,620,814	
10.00	632,498	627,094	627,094	5,247,907	

IV. APPROX. NUTRIENT REMOVAL

Existing	
Pollutant	Load Reduction (lbs/yr)
TP	95.32
TN	360.35
TSS	27562

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
HUNT CLUB BLVD BIORETENTION RETROFIT

I. DRAINAGE AREAS PRE/POST

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	3.94	0.95	3.74
		Managed Turf	0.50	0.25	0.13
	B	Impervious (& water)	3.94	0.95	3.74
		Managed Turf	0.50	0.20	0.10
			8.88		0.87

Site Rv (existing) 0.87
% impervious (proposed) 89%

II. PROPOSED BMP Bioretention Level 1/Urban Bioretention
Phosphorous Removal EFF = 25%

TV = Total Acres x Site Rv x 1 inches
TV = 0.64 ac-ft
TV = 27991 Cu Ft

III. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	9.44
TN	78.56
TSS	4334

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
40 HUNT CLUB BLVD WETLAND RETROFIT

I. DRAINAGE AREAS PRE/POST

PRE-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	11.51	0.95	10.93
		Managed Turf	12.09	0.25	3.02
		Forest	6.90	0.05	0.35
			30.50		0.47

Site Rv (existing) 0.47
% impervious (existing) 38%

Time of Concentration (Tc) = 40 minutes

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	12.50	0.95	11.88
		Managed Turf	13.00	0.25	3.25
		Forest	5.00	0.05	0.25
			30.50		0.50

Site Rv (existing) 0.50
% impervious (proposed) 41%

Time of Concentration (Tc) = 40 minutes

II. PROPOSED BMP ED Wetland Level 1

Phosphorous Removal EFF = 50%

Set Normal Pond Elevation at 8.00

TV = Total Acres x Site Rv x 1 inches
TV = 1.28 ac-ft
TV = 55811 Cu Ft

Required storage below permanent pool = 55,811 Cu Ft

Provided storage below permanent pool = 59,050 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
5.00	7,000				
6.00	9,750	8,375	8,375	8,375	
7.00	26,300	18,025	18,025	26,400	
8.00	39,000	32,650	32,650	59,050	Quality Storage
9.00	44,064	41,532	41,532	100,582	Additional Quantity Storage
10.00	48,256	46,160	46,160	146,742	

IV. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	17.23
TN	49.30
TSS	5882

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
40 HUNT CLUB BLVD WET POND RETROFIT

I. DRAINAGE AREAS PRE/POST

PRE-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	11.51	0.95	10.93
		Managed Turf	12.09	0.25	3.02
		Forest	6.90	0.05	0.35
			30.50		0.47

Site Rv (existing) 0.47
% impervious (existing) 38%

Time of Concentration (Tc) = 40 minutes

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	12.50	0.95	11.88
		Managed Turf	13.00	0.25	3.25
		Forest	5.00	0.05	0.25
			30.50		0.50

Site Rv (existing) 0.50
% impervious (proposed) 41%

Time of Concentration (Tc) = 40 minutes

II. PROPOSED BMP Wet Pond Level 2

Phosphorous Removal EFF = 65%

Set Normal Pond Elevation at 8.00

TV = Total Acres x Site Rv x 1 inches
TV = 1.28 ac-ft
TV = 55811 Cu Ft

Required storage below permanent pool = 55,811 Cu Ft

Provided storage below permanent pool = 59,050 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
5.00	7,000				
6.00	9,750	8,375	8,375	8,375	
7.00	26,300	18,025	18,025	26,400	
8.00	39,000	32,650	32,650	59,050	Quality Storage
9.00	42,000	40,500	40,500	99,550	
10.00	48,256	45,128	45,128	144,678	

IV. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	27.42
TN	77.54
TSS	5882

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
1705 TODDS LANE WETLAND RETROFIT

I. DRAINAGE AREAS PRE/POST

PRE-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	7.67	0.95	7.29
		Managed Turf	8.61	0.25	2.15
		Forest	2.90	0.05	0.15
			19.18		0.50

Site Rv (existing) 0.50
% impervious (existing) 40%

Time of Concentration (Tc) = 36 minutes

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	7.94	0.95	7.54
		Managed Turf	8.92	0.25	2.23
		Forest	2.32	0.05	0.12
			19.18		0.52

Site Rv (existing) 0.52
% impervious (proposed) 41%

Time of Concentration (Tc) = 36 minutes

II. PROPOSED BMP ED Wetland Level 1

Phosphorous Removal EFF = 50%

Set Normal Pond Elevation at 8.00

TV = Total Acres x Site Rv x 1 inches
TV = 0.82 ac-ft
TV = 35897 Cu Ft

Required storage below permanent pool = 35,897 Cu Ft

Provided storage below permanent pool = 38,883 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
5.00	4,500				
6.00	6,316	5,408	5,408	5,408	
7.00	17,685	12,001	12,001	17,409	
8.00	25,264	21,475	21,475	38,883	Quality Storage
9.00	28,149	26,707	26,707	65,590	Additional Quantity Storage
10.00	31,162	29,656	29,656	95,245	

IV. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	11.13
TN	31.85
TSS	3757

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
40 HUNT CLUB BLVD WET POND RETROFIT

I. DRAINAGE AREAS PRE/POST

PRE-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	7.67	0.95	7.29
		Managed Turf	8.61	0.25	2.15
		Forest	2.90	0.05	0.15
			19.18		0.50

Site Rv (existing) 0.50
% impervious (existing) 40%

Time of Concentration (Tc) = 36 minutes

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	7.94	0.95	7.54
		Managed Turf	8.92	0.25	2.23
		Forest	2.32	0.05	0.12
			19.18		0.52

Site Rv (existing) 0.52
% impervious (proposed) 41%

Time of Concentration (Tc) = 36 minutes

II. PROPOSED BMP Wet Pond Level 2

Phosphorous Removal EFF = 65%

Set Normal Pond Elevation at 8.00

TV = Total Acres x Site Rv x 1 inches
TV = 0.82 ac-ft
TV = 35897 Cu Ft

Required storage below permanent pool = 35,897 Cu Ft

Provided storage below permanent pool = 52,000 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
5.00	7,000				
6.00	15,000	11,000	11,000	11,000	
7.00	21,000	18,000	18,000	29,000	
8.00	25,000	23,000	23,000	52,000	Quality Storage
9.00	28,149	26,575	26,575	78,575	
10.00	31,162	29,656	29,656	108,230	

IV. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	14.47
TN	31.85
TSS	3757

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
WALKER ROAD SWALE RETROFIT

I. DRAINAGE AREA

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	5.37	0.95	5.10
		Pervious	4.78	0.25	1.20
			10.15		0.62

Site Rv (existing) 0.62
% impervious 53%

Time of Concentration (Tc) = 18 minutes

II. PROPOSED BMP Amended Swale
Phosphorous Removal EFF = 40%

TV = Total Acres x Site Rv x 1 inches
TV = 0.52 ac-ft
TV = 22856 Cu Ft

III. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	5.81
TN	45.15
TSS	1863

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
WALKER ROAD DRY SWALE

I. DRAINAGE AREA

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	1.88	0.95	1.79
		Pervious	2.82	0.25	0.71
			4.70		0.53

Site Rv (existing) 0.53
% impervious 53%

Time of Concentration (Tc) = 18 minutes

II. PROPOSED BMP Amended Swale
Phosphorous Removal EFF = 40%

TV = Total Acres x Site Rv x 1 inches
TV = 0.21 ac-ft
TV = 9042 Cu Ft

III. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	2.95
TN	22.33
TSS	765

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
BROMSGROVE DRIVE SWALE RETROFIT

I. DRAINAGE AREA

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	4.42	0.95	4.20
		Pervious	6.63	0.25	1.66
			11.05		0.53

Site Rv (existing) 0.53
% impervious 40%

Time of Concentration (Tc) = 26 minutes

II. PROPOSED BMP Amended Grass Swales
Amended Swale Phosphorous Removal EFF = 15%
Dry Swale Phosphorous Removal EFF = 40%

TV = Total Acres x Site Rv x 1 inches
TV = 0.49 ac-ft
TV = 21259 Cu Ft

III. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	5.40
TN	42.00
TSS	1537

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
LYNNHAVEN DRIVE-OLSEN COURT SWALE RETROFIT

I. DRAINAGE AREA

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	4.98	0.95	4.73
		Pervious	7.46	0.25	1.87
			12.44		0.53

Site Rv (existing) 0.53
% impervious 40%

Time of Concentration (Tc) = 26 minutes

II. PROPOSED BMP Amended Grass Swales
Amended Swale Phosphorous Removal EFF = 15%
Dry Swale Phosphorous Removal EFF = 40%

TV = Total Acres x Site Rv x 1 inches
TV = 0.55 ac-ft
TV = 23943 Cu Ft

III. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	6.09
TN	47.30
TSS	1813

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
KRAFT ELEMENTARY AND ABERDEEN ROOFTOP DISCONNECTION

I. DRAINAGE AREA

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	3.19	0.95	3.03
			3.19		0.95

Site Rv (existing) 0.95
% impervious 100%

Time of Concentration (Tc) = 5 minutes

II. PROPOSED BMP Rooftop Disconnection to Dry Well or French Drain
Phosphorous Removal EFF = 25%

TV = Total Acres x Site Rv x 1 inches
TV = 0.25 ac-ft
TV = 11001 Cu Ft

III. APPROX. NUTRIENT REMOVAL

Kraft	
Pollutant	Load Reduction (lbs/yr)
TP	2.58
TN	17.00
TSS	0

Aberdeen	
Pollutant	Load Reduction (lbs/yr)
TP	1.78
TN	11.40
TSS	0

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
BETHEL CHURCH SWALE AND ED WETLAND

I. DRAINAGE AREAS PRE/POST

PRE-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	2.37	0.95	2.25
		Managed Turf	3.55	0.25	0.89
			5.92		0.53

Site Rv (existing) 0.53
% impervious (existing) 40%

Time of Concentration (Tc) = 24 minutes

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious (& water)	2.54	0.95	2.41
		Managed Turf	3.38	0.25	0.85
			5.92		0.55

Site Rv (existing) 0.55
% impervious (proposed) 43%

Time of Concentration (Tc) = 24 minutes

II. PROPOSED BMP

Amended Swale and Extended Detention Constructed Wetland
Swale Phosphorous Removal EFF = 15%
Wetland Phosphorous Removal EFF = 40%

Set Normal Pond Elevation at 10.00

TV = Total Acres x Site Rv x 1 inches
TV = 0.27 ac-ft
TV = 11827 Cu Ft

Required storage below permanent pool = 11,827 Cu Ft

Provided storage below permanent pool = 11,887 Cu Ft

III. APPROX. POND DIMENSIONS/STORAGE

Elevation	Area SF	Avg. Area SF	delta Volume CF	Sum Volume CF	
7.00	1,800				
8.00	2,000	1,900	1,900	1,900	
9.00	5,284	3,642	3,642	5,542	
10.00	7,405	6,345	6,345	11,887	Quality Storage
11.00	10,042	8,724	8,724	20,610	Additional Quantity Storage
12.00	12,760	11,401	11,401	32,011	

IV. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	5.02
TN	28.24
TSS	1826

PRELIMINARY STORMWATER MANAGEMENT SUMMARY SHEET
KRAFT ELEMENTARY AND ABERDEEN HYDRODYNAMIC SEPARATORS

I. DRAINAGE AREA

POST-DEVELOPMENT

Area	Soil Type	Type	Area (acres)	Rv	Site Rv
	D	Impervious	1.17	0.95	1.11
			1.17		0.95

Site Rv (existing) 0.95
% impervious 100%

Time of Concentration (Tc) = 5 minutes

II. PROPOSED BMP Hydrodynamic Separators
Phosphorous Removal EFF = 15%

III. APPROX. NUTRIENT REMOVAL

Pollutant	Load Reduction (lbs/yr)
TP	0.38
TN	0.00
TSS	672

Appendix E – Preliminary Cost Estimates and Permitting

Client: Parsons Brinckerhoff
Project: Back River Lake Shore
Summary of Watershed Improvements
10/1/2013

Area	Improvement Type	Length (l.f.)	Area (Ac.)	Delineation needed?	Permit Needed?	Estimated Cost Delineation	Estimated Cost of Permitting	Anticipated Permit needed	Estimated time for permitting (days)	Total Cost Estimate	Notes
Zone A	Amended Grass Swale	2,350	-	Yes	If Impacts	$ 3,500.00	$ 3,500.00	NWP-3, NWP-18	45-90		ditches don't appear to contain wetlands
	Wetland Creation	-	0.93	Yes	likely	$ 2,000.00	$ 3,000.00	NWP-18	45-90		wetland impact anticipated to tie in to drainage
	Stabilize Banks	1,000	-	Yes	Yes	$ 2,500.00	$ 3,500.00	NWP-13	45-90		District Engineer will need to waive length threshold
	Replace Structure	-	-	Yes	Yes	$ 1,500.00	$ 3,000.00	NWP-3 / NWP-18	45-90		
	Stormceptor	-	-	No	No	n/a	n/a	None	0		
Zone B	Amended Grass Swale	3,350	-	Yes	If Impacts	See Zone A		NWP-18	See Zone A		
	Wet Swale	~ 900	-	No	No	n/a	n/a	None	0		
	Replace Structure	-	-	Yes	Yes	$ 1,500.00	$ 3,000.00	NWP 3 Maintenance	45-90	$ 4,500.00	Permitting only necessary if wetlands are found in receiving waters
	Urban Bioretention	-	0.6	No	No	n/a	n/a	None	0		
Zone C	Amended Grass Swale	3,200	-	Yes	not likely	See Zone A		None	See Zone A		
	Replace Structure - Culvert and Drop Inlets	-	-	Yes	Yes	$ 1,500.00	$ 3,000.00	NWP-3	45-90		
	Stabilize banks	840	-	Yes	Yes	$ 2,000.00	$ 3,500.00	NWP-13	45-90		District Engineer will need to waive length threshold
Zone D	Amended Grass Swale	275	-	Yes	Yes	$ 1,500.00	$ 2,500.00	NWP-18	45-90		Permit will depend on pipe or open swale choice[1]
	Urban Bioretention	Varies	Varies	No	No	n/a	n/a	None	0		
Zone E	Replace Drop Inlet Structures & Culvert	-	-	Yes	Yes	$ 1,500.00	$ 3,000.00	NWP-3, NWP-18	45-90		Wetland delineation needed for outfall locations
	Urban Bioretention	-	Varies	No	No	n/a	n/a	None	0		
	Grade Channel, Stabilize banks	850	-	Yes	Yes	$ 2,500.00	$ 4,500.00	NWP-13	45-90		
	Stream Restoration - Channel Improvements	1,400	-	Yes	Yes	$ 4,500.00	$ 8,000.00	NWP-13, NWP-27	60-120		Will need to qualify for NWP-27 to avoid mitigation. NWP-27 will require monitoring for success criteria.
Zone F	Stream Restoration	650	-	Yes	Yes	$ 2,000.00	$ 6,000.00	NWP-13, NWP-27	60-120		Will need to qualify for NWP-27 to avoid mitigation
	Outfall Control Structure, to lake	-	-	Yes	Yes	$ 2,000.00	$ 2,500.00	NWP-3, NWP-43	45-90		
Zone G	Wet Swale	1,425	-	Yes	likely	$ 1,500.00	?	NWP-18	45-90		
	Constructed Wetlands	-	1.82	Yes	No	$ 1,500.00	n/a	None	0		Monitoring may be required if impacts to wetlands are necessary. Wetlands can be avoided if present
Zone H	Created Wetlands	-	0.87	Yes	Yes	$ 1,500.00	$ 2,500.00	NWP-7	45-90		Permit for outfall to tie into existing drainage
	Stabilize banks	380	-	Yes	Yes	$ 1,500.00	$ 3,500.00	NWP-13	45-90		
	Stream Restoration*	2,400	-	Yes	Yes	$ 4,500.00	$ 12,000.00	NWP-27, NWP-13	60-120		Restoration plan will require agency coordination. Landowner coordination may be limiting
	Dry Swale	750	-	Yes	Yes	$ 1,500.00	$ 2,500.00	NWP-7	0		Permit needed to tie into existing strucutre
	Stormceptor	-	-	No	No	n/a	n/a	None	0		
Zone I	Stream Restoration*	See Zone H - Above									

*Zone H and I Stream Restoration is the same project.

[1]If swale is perennial or considered a stream, stream mitigation may be required. Estimate $400/l.f. Wetland delineation of adjacent parcel will be necessary if used for BMP.

Kerr Environmental Services Corp.

Sustainable Ecological Restoration and Environmental Consulting

Memorandum

To: Melissa Pritchard, P.E.

CC:

From: Patrick Shearer and Curtis Hickman

Date: 10/1/2013

Re: Back River Lake Shore Permitting Evaluation, Hampton, Virginia

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Kerr Environmental Services (KES) is pleased to deliver this permitting evaluation and the associated summary spreadsheet for potential projects associated with the Back River Lake Shore Watershed Analysis performed by Parsons Brinckerhoff. The following is a summary of the anticipated permitting necessary for the associated projects, anticipated permitting timelines, and estimated costs for and associated with permitting services. These estimates are preliminary and are based on a desktop review of mapping and photographs of the project area.

Proposed Watershed Improvements

KES was provided mapping and descriptions of the proposed watershed improvements. Proposed watershed improvements include:

1. Drop Inlet and Culvert Replacements for Road drainage
2. Stormceptor Installation - Water Quality Device
3. Urban Bioretention
4. Wet Swales
5. Amended Grass Swales
6. Bioretention
7. Construction Wetlands
8. Stream Bank Stabilization
9. Stream Restoration
10. Grade and Stabilize Stream Channels
11. Replace Damaged Stormwater Control Structure at Lynnhaven Lake

Proposed Permitting Strategies are discussed further below.

Permitting Evaluation

Items Not Requiring Permits

Several of the stormwater improvements listed above will likely not require permits from the US Army Corps of Engineers (USACE) or the Department of Environmental Quality (DEQ) as the locations of the proposed improvements appear to lie outside of the waters of the United States. The installation of Stormceptor units should not require permits, due to the location of these improvements. Urban bioretention, primarily shown in the existing street medians, should not require permits from USACE or DEQ as the areas are currently impervious. The proposed bioretention on the paper street should also not require permits.

Drop Inlet and Culvert Replacement

The replacement of drop inlets and culverts would require permitting associated with impacts to the receiving waters at outfall locations. Wetland delineations would be required at the receiving water locations for the culverts and inlets. KES anticipates that USACE Nationwide Permit (NWP) 3 for maintenance of currently serviceable structures should be sufficient for this type of work. Pre-construction notification should be provided to the USACE, and anticipated time for permit verification should be expected within 45-90 days.

Wet Swales

The proposed wet swales should not require permits for wetland impacts, due to landscape location of the proposed location. However, should the existing swale exhibit an ordinary high water mark or are found to include wetlands, wetland permitting may be necessary. KES anticipates wetland delineations should be performed for these features, except where noted otherwise. Should impacts to waters of the US be necessary, NWP-18 for minor discharges could be applicable for minor impacts. Alternatively, if the impacts are associated with outfall structures from the proposed Wet swales discharging into waters NWP-7 for outfalls may be applicable. Pre-construction notification should be provided to the USACE, and anticipated time for permit verification should be expected within 45-90 days. If the areas where wet swales are proposed are found to be jurisdictional by the USACE, then more extensive permitting may be required. A maintenance plan for the proposed wet swales should be approved along with any permit applications to lay out future maintenance activity needs. Since wetlands may form within wet swales over time, future maintenance efforts may require permitting unless a maintenance plan describing future planned maintenance activities is approved by the USACE at the time of construction.

Amended Grass Swales

In general, amended grass swales should not require permits for wetland impacts, due to their location within the landscape. However, should the existing swale include wetlands or exhibit a high water mark, wetland permitting may be necessary.

KES anticipates wetland delineations should be performed for these features, to determine if they are jurisdictional. Should impacts to waters of the US be necessary, NWP-18 for minor discharges could be applicable. Alternatively, if the impacts are associated with outfall structures from the proposed Wet swales discharging into waters NWP-7 for outfalls may be applicable. Pre-construction notification should be provided to the USACE, and anticipated time for permit verification should be expected within 45-90 days.

Constructed Wetlands

The location of the proposed constructed wetlands within the forested woods south of Burton Street will require a wetland delineation. Should wetland impacts be necessary at this location NWP-18 for minor discharges may be applied, as its wetland impact threshold is less than 0.1 acres. Wetland impacts should be avoided where possible following the wetland delineation. The proposed wetland creation within the cloverleaf of the I-64 interchange appears to be mostly uplands, from the photos provided. However this area should be delineated as well. Should wetland impacts be necessary NWP-18 could be applied. NWP-7 should be used for any impacts associated with outfall structures. Pre-construction notification should be provided to the USACE, and anticipated time for permit verification should be expected within 45-90 days.

Stream Bank Stabilization

Stream bank stabilization activities qualify for NWP-13 for bank stabilization. There is a 500 linear feet threshold for this permit, but the District Engineer can waive this requirement, and we have been told by a USACE project manager that they have waived for projects with a purpose and need such as this. Pre-construction notification should be provided to the USACE, and anticipated time for permit verification should be expected within 45-90 days.

Channel Grading and Stabilization

Re-alignment of the channel would likely require an individual permit. However, grading the banks to include some floodplain and bank stabilization would qualify for NWP-13 for bank stabilization if the impacts are associated with re-grading and stabilizing banks. Due to the condition of the developed area adjacent to the stream channel re-alignment is not anticipated. Significant re-alignment of the channel is not recommended, as this could require more stringent permitting. Pre-construction notification should be provided to the USACE, and anticipated time for permit verification should be expected within 45-90 days.

Stream Restoration

We anticipate that the stream restoration would qualify for NWP 27 and would not require mitigation, as this type of project is typically considered self-mitigating. The NWP 27 states: “Compensatory mitigation is not required for activities authorized under this NWP since these activities must result in net increases in aquatic resource

functions and services." A Pre-Construction Notification (PCN) and post-construction monitoring would be required. Post construction monitoring will likely involve an as-built survey being performed and post construction photographic monitoring of the project. The as-built survey may require cross-sections be monitored for the first three years to detect for signs of change from the restored condition. Photo monitoring is anticipated for the first three years following construction. Pre-construction notification should be provided to the USACE, and anticipated time for permit verification should be expected within 60-120 days.

Replace Damaged Stormwater Control Structure at Lynnhaven Lake
A derelict stormwater control structure at the mouth of the stream where it connects to Lynnhaven Lake requires replacement. NWP-3 for maintenance would be applicable if the Client can provide documents showing the authorization of the existing control structure. Documents to prove authorization could be approved city plans, plats, or other historically recorded documents.

If it is a documented stormwater BMP with the City, NWP-43 for stormwater management may be applicable. NWP-43 is applicable to improve existing stormwater management facilities. NWP-43 has a threshold of 0.5 acres of wetland impacts. Therefore, raising the water level of the Lake is not recommended as it may exceed that threshold.

Should proof of the existing authorization for a control structure at this location be unobtainable or insufficient for agency requirements, then an alternative permitting strategy may be necessary. An Individual Permit may be required should the USACE consider this a new structure. Impacts associated with the impoundment of the stream may be incurred, should the USACE consider this a new structure.

Wetland Delineation Strategy – Economies of Scale
Wetland delineation services have been estimated based on the provided data, as well as desktop research of available resources. At this time, wetland delineations were estimated for each project as a single and complete project. Should the Client wish to pursue several of these improvements, a coordinated effort regarding the wetland delineation could be performed, to save in the collection of field data. If possible, the wetland delineation for all projects that move forward should be completed as a single delineation and confirmation, as opposed to several small wetland delineations for each project. This will reduce the time and effort required to prepare the necessary paperwork, and field work in an effort to increase efficiency. This could potentially reduce the cost of associated wetland delineations, should the Client choose this approach.

Estimated Design and Construction Costs for Stream Restoration
Stream restoration at the proposed locations shown on the plans would likely consist of bank stabilization and floodplain wetland creation along the existing stream

corridor. KES estimates that engineering design and construction of the stream restoration project in this location would cost approximately $250 per linear foot of stream restoration. Urban stream restorations typically involve many stakeholders, can have utility conflicts, and have to be built within a confined setting. For these reasons, urban stream restorations typically cost more than a stream restoration at an undeveloped site.

Lynnhaven Lake Outfall Structure				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$20,036.25	$20,036.25
Design Subtotal				$20,036.25
Construction Phase				
Clear and grub brush	SY	50	$1.50	$75.00
Trench Excavation	CY	250	$50.00	$12,500.00
Hauling off-site	SY	300	$5.50	$1,650.00
Sheeting	LF	120	$250.00	$30,000.00
Borrow	CY	250	$25.00	$6,250.00
Stone bedding	Ton	40	$23.00	$920.00
Weir concrete cap	each	1	$10,000.00	$10,000.00
Rip Rap	Ton	250	$75.00	$18,750.00
BMP Construction Subtotal				$80,145.00
20% Construction Contingencies				$16,029.00
Total				$116,210.25

Berkshire Terrace Culvert Replacement				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$22,727.50	$22,727.50
Design Subtotal				$22,727.50
Construction Phase				
Excavation	CY	400	$25.00	$10,000.00
Trench Excavation	CY	400	$50.00	$20,000.00
Remove and dispose curb and gutter	LF	60	$5.00	$300.00
Remove and dispose pavement	SY	240	$12.00	$2,880.00
Remove drop inlet	each	2	$585.00	$1,170.00
Pipe removal	LF	60	$200.00	$12,000.00
Pipe bedding	Ton	200	$23.00	$4,600.00
Grading	SY	240	$1.50	$360.00
Curb and Gutter	LF	80	$22.00	$1,760.00
Gravity sanitary sewer (Ductile iron)	LF	30	$40.00	$1,200.00
Asphalt Conc. SM-9.0A	Ton	50	$67.00	$3,350.00
Asphalt Conc. BM-25.0A	Ton	150	$63.00	$9,450.00
Curb Inlets	LF	12	$460.00	$5,520.00
15" RCP	LF	30	$36.00	$1,080.00
36" RCP	LF	120	$92.00	$11,040.00
EW-6	each	2	$3,000.00	$6,000.00
Seeding and Fertilizer	SY	50	$4.00	$200.00
BMP Construction Subtotal				$90,910.00
20% Construction Contingencies				$18,182.00
Total				$131,819.50

Willowtree Road Culvert Replacement				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$15,575.00	$15,575.00
Design Subtotal				$15,575.00
Construction Phase				
Excavation	CY	200	$25.00	$5,000.00
Trench Excavation	CY	100	$50.00	$5,000.00
Remove and dispose pavement	SY	150	$12.00	$1,800.00
Pipe removal	LF	100	$200.00	$20,000.00
Pipe bedding	Ton	200	$23.00	$4,600.00
Grading	SY	150	$1.50	$225.00
Asphalt Conc. SM-9.0A	Ton	25	$67.00	$1,675.00
Asphalt Conc. BM-25.0A	Ton	80	$63.00	$5,040.00
42" RCP	LF	120	$98.00	$11,760.00
EW-7	each	2	$3,500.00	$7,000.00
Seeding and Fertilizer	SY	50	$4.00	$200.00
BMP Construction Subtotal				$62,300.00
20% Construction Contingencies				$12,460.00
Total				$90,335.00

Kraft Elementary Swale and ED Wetland Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$90,931.25	$90,931.25
Design Subtotal				$90,931.25
Construction Phase				
Clear and grub brush	SY	6700	$1.50	$10,050.00
Excavation - 3' average depth	SY	6700	$10.00	$67,000.00
Grading	SY	7150	$1.50	$10,725.00
Hauling off-site	SY	6700	$5.50	$36,850.00
Pipe Removal	LF	422	$200.00	$84,400.00
Manhole	VF	5	$460.00	$2,300.00
Outlet structure	each	1	$2,500.00	$2,500.00
Landscape Topsoil (4", Fertilizer, Seed)	SY	1800	$0.50	$900.00
Wetland Plantings	SY	4700	$20.00	$94,000.00
24" RCP	LF	100	$65.00	$6,500.00
30" RCP	LF	500	$85.00	$42,500.00
EW-1	each	3	$2,000.00	$6,000.00
BMP Construction Subtotal				$363,725.00
20% Construction Contingencies				$72,745.00
Total				$527,401.25

Aberdeen School ED Wetland Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$52,455.00	$52,455.00
Design Subtotal				$52,455.00
Construction Phase				
Clear and grub brush	SY	5650	$1.50	$8,475.00
Excavation - 3' average depth	SY	5500	$10.00	$55,000.00
Grading	SY	5650	$1.50	$8,475.00
Hauling off-site	SY	5500	$5.50	$30,250.00
Outlet structure	each	1	$2,500.00	$2,500.00
Landscape Topsoil (4", Fertilizer, Seed)	SY	1200	$0.50	$600.00
Wetland Plantings	SY	4450	$20.00	$89,000.00
18" RCP	LF	140	$48.00	$6,720.00
24" RCP	LF	100	$65.00	$6,500.00
Drop Inlet	VF	5	$460.00	$2,300.00
BMP Construction Subtotal				$209,820.00
20% Construction Contingencies				$41,964.00
Total				$304,239.00

Northampton Neighborhood Swale Retrofits				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$52,500.00	$52,500.00
Design Subtotal				$52,500.00
Construction Phase				
Clear and grub brush	SY	5000	$1.50	$7,500.00
Excavation - 3' average depth	SY	3000	$10.00	$30,000.00
Hauling off-site	SY	5000	$5.50	$27,500.00
Amended Soils	SF	27000	$5.00	$135,000.00
Grading	SY	5000	$1.50	$7,500.00
Seeding	SY	5000	$0.50	$2,500.00
Construction Subtotal				$210,000.00
20% Construction Contingencies				$42,000.00
Total				$304,500.00

117 Winshester Road Improvements				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$11,946.25	$11,946.25
Design Subtotal				$11,946.25
Construction Phase				
Clear and grub brush	SY	150	$1.50	$225.00
Trench Excavation	CY	250	$50.00	$12,500.00
Grading	SY	150	$1.50	$225.00
Hauling off-site	SY	100	$5.50	$550.00
Pipe removal	LF	70	$200.00	$14,000.00
Pipe bedding	Ton	85	$23.00	$1,955.00
Landscape Topsoil (4", Fertilizer, Seed)	SY	150	$4.00	$600.00
42" RCP	LF	110	$98.00	$10,780.00
EW-2	each	1	$3,000.00	$3,000.00
Drop Inlet	VF	5	$460.00	$2,300.00
Fencing	LF	110	$15.00	$1,650.00
BMP Construction Subtotal				$47,785.00
20% Construction Contingencies				$9,557.00
Total				$69,288.25

Bethel Church Swale and Wetland Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$22,115.00	$22,115.00
Design Subtotal				$22,115.00
Construction Phase				
Clear and grub brush	SY	2520	$1.50	$3,780.00
Excavation - 3' average depth	SY	2520	$10.00	$25,200.00
Grading	SY	2520	$1.50	$3,780.00
Hauling off-site	SY	2000	$5.50	$11,000.00
Outlet structure	each	1	$2,500.00	$2,500.00
Landscape Topsoil (4", Fertilizer, Seed)	SY	1700	$0.50	$850.00
Wetland Plantings	SY	830	$20.00	$16,600.00
Amended Soils	SF	3900	$5.00	$19,500.00
18" RCP	LF	50	$65.00	$3,250.00
EW-1	each	1	$2,000.00	$2,000.00
BMP Construction Subtotal				$88,460.00
20% Construction Contingencies				$17,692.00
Total				$128,267.00

I-64/Mercury Blvd Pond Conversion				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$105,450.00	$105,450.00
Design Subtotal				$105,450.00
Construction Phase				
Clear and grub brush	SY	100	$1.50	$150.00
Excavation - 4' average depth	SY	8500	$10.00	$85,000.00
Grading	SY	12000	$1.50	$18,000.00
Hauling off-site	SY	8500	$5.50	$46,750.00
Outlet structure	each	1	$2,500.00	$2,500.00
Rip Rap	Ton	500	$75.00	$37,500.00
Landscape Topsoil (4", Fertilizer and seed)	SY	4100	$4.00	$16,400.00
Planting - above permanent pool	SY	4100	$20.00	$82,000.00
Planting - below permanent pool	SY	8900	$15.00	$133,500.00
BMP Construction Subtotal				$421,800.00
20% Construction Contingencies				$84,360.00
Total				$611,610.00

Walker Road Swale Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$5,050.00	$5,050.00
Design Subtotal				$5,050.00
Construction Phase				
Clear and grub brush	SY	550	$1.50	$825.00
Excavation - 3' average depth	SY	250	$10.00	$2,500.00
Grading	SY	550	$1.50	$825.00
Hauling off-site	SY	250	$5.50	$1,375.00
Amended Soils	SF	2880	$5.00	$14,400.00
Seeding	SY	550	$0.50	$275.00
Construction Subtotal				$20,200.00
20% Construction Contingencies				$4,040.00
Total				$29,290.00

40 Hunt Club Blvd Wetland Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$46,430.00	$46,430.00
Design Subtotal				$46,430.00
Construction Phase				
Clear and grub brush	SY	5400	$1.50	$8,100.00
Excavation - 3' average depth	SY	4400	$10.00	$44,000.00
Grading	SY	5400	$1.50	$8,100.00
Hauling off-site	SY	4400	$5.50	$24,200.00
Outlet structure	each	1	$2,500.00	$2,500.00
Landscape Topsoil (4", Fertilizer, Seed)	SY	1200	$0.50	$600.00
Wetland Plantings	SY	4460	$20.00	$89,200.00
18" RCP	LF	140	$48.00	$6,720.00
Drop Inlet	VF	5	$460.00	$2,300.00
BMP Construction Subtotal				$185,720.00
20% Construction Contingencies				$37,144.00
Total				$269,294.00

1705 Todds Lane Wetland Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$32,906.25	$32,906.25
Design Subtotal				$32,906.25
Construction Phase				
Clear and grub brush	SY	3500	$1.50	$5,250.00
Excavation - 3' average depth	SY	2900	$10.00	$29,000.00
Grading	SY	3500	$1.50	$5,250.00
Hauling off-site	SY	2900	$5.50	$15,950.00
Outlet structure	each	1	$2,500.00	$2,500.00
Landscape Topsoil (4", Fertilizer, Seed)	SY	600	$0.50	$300.00
Wetland Plantings	SY	2900	$20.00	$58,000.00
24" RCP	LF	200	$65.00	$13,000.00
Manhole	VF	5	$475.00	$2,375.00
BMP Construction Subtotal				$131,625.00
20% Construction Contingencies				$26,325.00
Total				$190,856.25

Bromsgrove Drive Swale Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$19,420.00	$19,420.00
Design Subtotal				$19,420.00
Construction Phase				
Clear and grub brush	SY	1220	$1.50	$1,830.00
Excavation - 3' average depth	SY	1220	$10.00	$12,200.00
Grading	SY	1220	$1.50	$1,830.00
Hauling off-site	SY	1220	$5.50	$6,710.00
Amended Soils	SF	10900	$5.00	$54,500.00
Seeding	SY	1220	$0.50	$610.00
Construction Subtotal				$77,680.00
20% Construction Contingencies				$15,536.00
Total				$112,636.00

Lynnhaven Drive/Olsen Court Swale Retrofit				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$16,885.00	$16,885.00
Design Subtotal				$16,885.00
Construction Phase				
Clear and grub brush	SY	1060	$1.50	$1,590.00
Excavation - 3' average depth	SY	1060	$10.00	$10,600.00
Grading	SY	1060	$1.50	$1,590.00
Hauling off-site	SY	1060	$5.50	$5,830.00
Amended Soils	SF	9480	$5.00	$47,400.00
Seeding	SY	1060	$0.50	$530.00
Construction Subtotal				$67,540.00
20% Construction Contingencies				$13,508.00
Total				$97,933.00

Hunt Club Blvd Bioretention Retrofits				
Description	Units	Quantity	Unit Cost	Total Estimated Price
Design Phase				
25% of Base Cost	each	1	$85,845.00	$85,845.00
Design Subtotal				$85,845.00
Construction Phase				
Clear and grub brush	SY	1700	$1.50	$2,550.00
Excavation - 4' average depth	SY	1700	$10.00	$17,000.00
Milling of Pavement	SY	12000	$8	$96,000.00
Asphalt Conc. SM-9.0A or SM-9.5A	Ton	500	$67	$33,500.00
Asphalt Conc. BM 25.0A	Ton	1000	$20	$20,000.00
Grading	SY	1700	$1.50	$2,550.00
Hauling off-site	SY	1700	$5.50	$9,350.00
Underdrain - with pea gravel and geotextile	LF	2600	$30.00	$78,000.00
Filter fabric	SY	1700	$10.00	$17,000.00
Overflow structure	each	8	$150.00	$1,200.00
Manhole	VF	30	$475.00	$14,250.00
18" RCP	LF	250	$48.00	$12,000.00
Seeding - above outlet elevation	SY	560	$0.50	$280.00
Planting - below outlet elevation	SY	1140	$30.00	$34,200.00
Gravel, #57 Stone	Ton	500	$18.00	$9,000.00
Mulch	SY	1700	$5.00	$8,500.00
BMP Construction Subtotal				$343,380.00
Total				$429,225.00